Curriculum Book

and

Assessment and Evaluation Scheme

based on

Outcome Based Education (OBE)

and Choice-Based Credit System (CBCS)

in Bachelor of Science (Hons.) in Biotechnology B. Sc. Hons. (Biotechnology)

4 Year Degree Program

Revised as on 01 August 2023 Applicable w.e.f. Academic Session 2023-24



AKS University

Satna 485001, Madhya Pradesh, India

Faculty of Life Sciences and Technology Department of Biotechnology

Dr. Kamlesh Choure Professor & Head Department of Biotechnology AKS University, Satna (MP) 485001

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AKS University

Faculty of Life Sciences and Technology

Department of Biotechnology

Curriculum & Syllabus of B.Sc. (Hons.) Biotechnology Program

(Revised as on 01 August 2023)

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AKS University

Faculty of Life Sciences and Technology

Department of Biotechnology Curriculum of B.Sc. (Hons.) Biotechnology Program

(Revised as on 2023)

Foreword

I am delighted to see that the Biotechnology Department's redesigned curriculum for the B.Sc. (Hons.) (Biotechnology) Programme smoothly incorporates the newest technological developments while adhering to NEP -2020 and UGC criteria. The curriculum has been redesigned with consideration to include the Sustainable Development Goals and NEP-2020 guidelines.

The alignment of course outcomes (COs), Programme Outcomes (POs), and Programme Specific Outcomes (PSOs) has been intricately executed, aligning perfectly with the requisites of NEP-2020 and NAAC standards. I hold the belief that this revised syllabus will significantly enhance the skills and employability of our students.

With immense satisfaction, I hereby present the revised curriculum for the B.Sc. (Hons.)- Biotechnology program for implementation in the upcoming session.

Er. Anant Soni Pro Chancellor & Chairman AKS University, Satna

01 August 2023



AKS University, Faculty of Life Sciences and Technology

Department of Biotechnology Curriculum of B.Sc. (Hons.) Biotechnology Program (Revised as on 2023)

From the Desk of the Vice-Chancellor

AKS University is currently undergoing a process to revamp its curriculum into an outcome-based approach, to enhance the teaching and learning process. The foundation of quality of quality education lies in the implementation of a curriculum that aligns with both societal and industrial needs, focusing on relevant outcomes. This entails dedicated and inspired faculty members, as well as impactful industry internships. Hence, it is of utmost importance to begin this



endeavor by crafting an outcome-based curriculum in collaboration with academia and industry experts. This curriculum design should be informed by the latest technological advancements, market demands, the guidelines outlined in the National Education Policy (NEP) of 2020, and sustainable goals.

I'm delighted to learn that the revised curriculum has been meticulously crafted by the Biotechnology Department, in consultation with an array of experts from the Biotechnology industry, research institutes, and academia. This curriculum effectively integrates the principles outlined in the NEP-2020 guidelines, as well as sustainable goals. It also adeptly incorporates the latest advancements in Biotechnology manufacturing technology.

The curriculum tailored for the Indian biotechnology industry prioritizes the production of cost-effective, high-quality microbial products while emphasizing energy optimization. It integrates insights on waste heat recovery systems to minimize power consumption in biotechnological plants, fostering independent thinking among students for potential enhancements. This holistic approach not only equips students with essential knowledge but also nurtures a culture of innovation, preparing them to make meaningful contributions to the industry's advancement.

I am confident that the updated curriculum for B.Sc. (Hons.) Biotechnology will not only enhance students' technical skills but also contribute significantly to their employability. During the process of revising the curriculum, I am pleased to observe that the Biotechnology department has diligently adhered to the guidelines provided by the UGC. Additionally, they have maintained a total credit requirement of 92 for the M. Sc. Microbiology program.

It's worth noting that curriculum revision is an ongoing and dynamic process, designed to address the continuous evolution of technological advancements and both local and global concerns. This ensures that the curriculum remains responsive and attuned to the changing landscape of education and industry. AKS University warmly invites input and suggestions from industry expert technocrats and Alumni students to enhance the curriculum and make it more student-centered. Your valuable insights will greatly contribute to shaping an education that best serves the needs and aspirations of our students.

AKS University, Satna 01 August 2023 Professor B. A. Chopade Vice-Chancellor

Preface

As part of our commitment to ongoing enhancement, the Department of Biotechnology consistently reviews and updates its B.Sc. (Hons) Biotechnology curriculum every three years. Through this process, we ensure that the curriculum remains aligned with the latest technological advancements, as well as local and global industrial and social demands.

During this procedure, the existing curriculum for the B. Sc.(Hons.) Biotechnology Program undergoes evaluation by a panel of technocrats, industry specialists, and academics. Following meticulous scrutiny, the revised curriculum has been formulated and is set to be implemented starting from August 01, 2023. This implementation is contingent upon the endorsement of the curriculum by the University's Board of Studies and Governing Body.

This curriculum closely adheres to the NEP model syllabus distributed in 2020. It seamlessly integrates the guidelines set forth by the Ministry of Higher Education, Government of India, through NEP- 2020, as well as the principles of Sustainable Development Goals. To foster the holistic skill development of students, a range of practical activities, including Hands-On Training, Industrial Visits, Project planning and execution, Report Writing, Seminars, and Industrial on-the-job training, have been incorporated. Furthermore, in alignment with UGc's directives, the total credit allocation for the B. Sc.(Hons.) Biotechnology program is capped at 13 credits.

This curriculum is enriched with course components in alignment with UGC guidelines, encompassing various disciplines such as Major Courses, Minor Course, Generic Electives, Skill Enhancement Course, Ability Enhancement Core Courses, and Discipline Specific Courses.

To ensure a comprehensive learning experience, detailed evaluation schemes and rubrics have also been meticulously provided.

For each course, a thorough mapping of Course Outcomes, Program Outcomes, and Programme Specific Outcomes has been undertaken. As the course syllabus is meticulously developed, various elements such as session outcomes, laboratory instruction, classroom instruction, self-learning activities, assignments, and mini-projects are meticulously outlined.

We hold the belief that this dynamic curriculum will undoubtedly enhance the independent thinking, skills, and overall employability of the students.

OVERVIEW OF THE DEPARTMENT

The Department of Biotechnology is established in 2006 with the objective to provide excellent and sensible teaching with maximum practical and research exposure to create skilled and well-trained bio-technocrats and entrepreneurs as per academia and industry needs in the frontier areas of Microbiology and Biotechnology. We, at the Department of Biotechnology, endorse each student by providing them maximum practical approach to understand their subjects in a better way of global standards and making them technologically advanced and ethically of high quality to serve the society.

VISION

The vision of the department is to dedicate research for Human and Environmental welfare. To become a center of excellence for biotechnology education, research, training, and entrepreneurship under the direction of good scientific principles, excellent instruction, and an ambition for continuous improvisation.

MISSION

At the Biotechnology Department, our mission is to be at the forefront of biotechnological innovation, research, and education. We are committed to advancing the frontiers of biotechnology through cutting-edge research, interdisciplinary collaboration, and the development of skilled and ethical professionals. Our aim is to address global challenges, improve human well-being, and contribute to sustainable development through the application of biotechnological solutions by following aspects:

M1. To develop a strong Biotechnology program based on quality education, research and training.

M2. To impart quality education to the students and enhance their skills which will make them globally competitive.

M3. To create trained biotechnology professionals who can contribute to the continuous improvement of biotechnological services and products.

M4. To design scientific and/or technical resources as per biotechnology industry demands.

M5. To develop as a benchmark University in emerging technologies.

M6. To provide state-of-the-art teaching learning process and R&D environment.

M7. To harness human capital for sustainable competitive edge and social relevance.

PROGRAM OUTCOMES (POs)

PO1: Capable of demonstrating comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings of the laws of nature that govern all natural processes, develop a sense of inquisitiveness that would lead them to explore the reasons and logic behind scientific phenomena/principles through established methods of observation, modelling, experimentation and calculations.

PO2: Demonstrate knowledge for in-depth scientific, analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies, & Academia.

PO3:Perceive things and the events that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) in the light of scientific principles.

PO4: Develop state-of-the-art laboratory skills like proper handling of scientific instruments, knowledge of SOPs on laboratory protocols, planning and executionin the areas of life sciences and biotechnology.

PO5: Apply the scientific research method to design, execute and analyze an experiment and also demonstrate the scientific procedures, experimental observation and inferences derived from collected practical data.

PO6: Inculcate critical thinking abilities, problem-solving through accuracy and validity of practical knowledge, and to validate their assumptions and ideas based on accurate results from careful research and observations

PO7: Elevate the student's awareness about the issues of environmental deterioration, pollution and sustainable development. Developing critical problem-solving approach for these societal concerns via bioremediation and integrated management.

PO8: Design solutions for complex scientific problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO9: Recognize the need for, and have the preparation and ability toengage in independent and life-long learning in the broadest context of technological change aimed at personal development and for improving knowledge/skill development and reskilling.

PO10: Development of effective professional communication skills for speak, read and write up in scientific literature and other social media platform related to biotechnology by connecting people, ideas, books, media and technology.

PO11: Expand their learning avenues through use of multiple learning resources to keep themselves abreast of the scientific developments worldwide; take up advanced studies in the fields of 1Life sciences and Applied Sciences.

PO12: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

GRADUATE ATTRIBUTES (GA)

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all programs.

1. Technical Knowledge: Apply the knowledge of mathematics, science, and a specialization to identify the solutions of complex life science-based challenges.

2. Problem Findings: Identify, formulate, review and analyze complex biotechnology problems reaching substantiated conclusions using multidisciplinary approach.

3. Skill Development: Design solutions for complex problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations with core and soft skills.

4. Research Oriented Learning: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Technical Development: Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modeling to complex activities with an understanding of the limitations.

6. Contribution in Society Development: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional practice.

7. Environment and Sustainability: Understand the impact of the professional technical solutions in societal and environmental contexts, and demonstrate the knowledge of, and needfor sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the biotechnical procedures.

9. 3Ts: Function effectively as a member or a leader in diverse teams, and in multidisciplinary work styles empowering Time, Team and Task management

10. Project and Practical Skills: Demonstrate knowledge and understanding of the biotechnology principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

11. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Recognized as technologists and leaders, who would help solve industry's scientific problems

PEO2: Demonstrate professional integrity and ethical attitude with awareness of global and national competencies and think about the social entailment of their work, especially its impact on safety, health and environment for sustainable development.

PEO3: Create new opportunities through innovations in startup sector and pursue higher education in multidisciplinary domains of biotechnology

PEO4: Apply the acquired practical skills and broad biotechnological training in product, process and inculcate leadership qualities for innovative entrepreneurship to meet the societal demands.

PEO5: Develop leadership qualities and propose techno-economic and social considerations, and aptitude for life-long learning, and get introduced to professional ethics and ethos.

PROGRAM SPECIFIC OBJECTIVES (PSOs)

PSO1: To impart an ability to apply biotechnology skills (including molecular & micro biology, immunology & genetic engineering, bioprocess & fermentation, enzyme & food technology and bioinformatics) and its applications in core and allied fields.

PSO2: To provide students with the concepts and research approaches with professional ethics in analytical, scientific and technical domains for their higher career in the field of biotechnology and develop their scientific interest.

PSO3: To impart in-depth practical oriented knowledge and transferable skills to students in various thrust areas of biotechnology, so as to meet the demands of industry and academia for job trades and employment opportunities.

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

General Course Structure and Credit Distribution

A. Definition of Credit:

B. Range of Credits:

As per the UGC model Curriculum for the UG Degree Course in Biotechnology, the total number of credits proposed for the Four-year B. Sc. (Biotechnology) is kept as 160.

C. Structure of UG Program in Biotechnology:

The structure of the UG program in Biotechnology shall have essentially the following categories of courses with the breakup of credits as given:

S. No.	Category	Breakup of Credits
1	Major Course	48
2	Minor Course	32
3	Generic Elective Course	16
4	Ability Enhancement Course	08
5	Skill Enhancement Course	12
6	Discipline Specific Core Course	16

7	Field	Project/ Internship/ Apprenticeship	28
		TOTAL	<mark>160</mark>
D. Course Cod	le and I	Definition:	
Course coo	de	Definitions	
L		Lecture	
Т		Tutorial	
Р		Practical	
С		Credits	

B.Sc. (Hons.)in Biotechnology Four-Year Full Time Degree Programme

B.Sc. – First Semester

(Undergraduate Certificate in Biotechnology)

The department provides a Four-year B.Sc. (Hons) programme in Biotechnology using a Choice Based Credit System (CBCS) that consists of Eight semesters. In which after completion of I and II Semester student get Undergraduate Certificate in Biotechnology, III and IV Semester student get Undergraduate Diploma in Biotechnology, V and VI Semester student get Undergraduate Degree in Biotechnology and after VII and VII Semester completion he get B.Sc. (Hons.) in Biotechnology. The regulations for the B.Sc. (Hons.) in Biotechnology provided by AKS University under the Choice Based Credit System (CBCS) are shown here.

S No	Subject	Subject Code Subject/Paper Title		Subject	I	Period	s	Credit	Marks Distribution		
3.110.	Subject	Subject Code	Subject/Faper The	area	L	Т	Р	Crean	Internal	External	Total
Major S	ubject										
1.	Distashnalagu	01BT101	Cell Structure & Introduction to Biotechnology	MJ 1	4	-	-	4	50	50	100
2.	biotechnology	01BT101-L	Cell Biology & Basic Instrumentation Lab	MJ 1 P	-	-	4	2	50	50	100
Minor S	ubject (Choose	Any one)									
3.	Mianahialaan	02MB101	Basics of Microbiology	MI 1	4	-	-	4	50	50	100
4.	Microbiology	02MB101-L	Microbial Techniques Lab	MI 1 P	-	-	4	2	50	50	100
5.		02BC101	General Biochemistry	MI 1	4	-	-	4	50	50	100
6.	Biochemistry	02BC101-L	General Biochemistry Lab	MI 1 P	-	-	4	2	50	50	100
Generic	Elective Course	e (Choose Any C)ne)	•					1	1	
•	Student can opt	second group of N	/ /inor Subject as a generic elective course but crea	lit will be 3:1.							
7.	Microbiology	03MB101	Basics of Microbiology	GEC 1	3	-	-	3	50	50	100
8.	Microbiology	03MB101-L	Microbial Techniques Lab	GEC 1 P	-	-	2	1	50	50	100
9.	Biochemistry	03BC101	General Biochemistry	GEC 1	3	-	-	3	50	50	100
10.		03BC101-L	General Biochemistry Lab	GEC 1 P	-	-	2	1	50	50	100
Ability	Enhancement Co	ourse									
11.	English	0SSD101	English Language	AEC 1	2	-	-	2	50	50	100
12.	SDG	0SDG102	Sustainable Development Goals	AEC 2	2	-	-	2	50	50	100
	TOTAL 15 - 10 20 400 800										

B.Sc. (Hons.)in Biotechnology Four-Year Full Time Degree Programme B.Sc. – Second Semester (Undergraduate Certificate in Biotechnology)

Subject Subject Periods **Marks Distribution** S.No. Subject Credit Subject/Paper Title Internal Ρ External Total Code L Т area Major Subject 50 50 100 01BT201 Molecular Biology & Diagnostic Techniques MJ 2 4 4 1. --Biotechnology 50 50 100 2 2. Molecular Biology & Diagnostic Techniques Lab MJ 2 P 4 01BT201-L Minor Subject (Choose Any one) 50 50 100 Microbial Physiology MI 2 4 02MB201 4 3. --Microbiology 50 50 100 MI 2 P 4 2 4. Microbial Physiology Lab 02MB201-L --50 50 100 MI 2 4 02BC201 **Bioenergetics and Metabolism** 4 5. Biochemistry 50 50 100 6. MI 2 P 2 02BC201-L Advanced Biochemistry Lab 4 --Generic Elective Course (Choose Any One) Student can opt second group of Minor Subject as a generic elective course but credit will be 3:1. • 50 50 100 3 7. 03MB201 Microbial Physiology GEC 2 3 _ Microbiology 100 50 50 8. GEC 2 P 2 1 03MB201-L Microbial Physiology Lab _ 50 50 100 GEC 2 3 3 9. 03BC201 **Bioenergetics and Metabolism** _ Biochemistry 50 50 100 GEC 2 P 2 1 Advanced Biochemistry Lab 10. 03BC201-L -**Ability Enhancement Course** 50 100 50 0IKS201 Indian Knowledge System AEC 3 2 2 IKS 11. --50 100 50 AEC 4 2 2 0EVS202 **Environmental Studies** 12. Environment TOTAL **400** 400 15 800 10 20 -

B.Sc. (Hons.)in Biotechnology Four-Year Full Time Degree Programme B.Sc. – Third Semester (Undergraduate Diploma in Biotechnology)

S No	Subject	Subject	Subject/Depor Title	Subject	I	Period	ls	Credit	Mark	s Distributi	ion
5.INU.	Subject	Code	Subject/Faper Title	area	L	Т	Р	Creuit	Internal	External	Total
Major S	Subject										
1.	Distashu ala ay	01BT301	Bioanalytical Tools and Techniques	MJ 3	4	-	-	4	50	50	100
2.	Biotechnology	01BT301-L	Bioanalytical Tools and Techniques Lab	MJ 3 P	-	-	4	2	50	50	100
Minor S	Subject (Choose	Any one)									
3.	Mianahialaan	02MB301	Fermentation Technology	MI 3	4	-	-	4	50	50	100
4.	Microbiology	02MB301-L	Fermentation Technology Lab	MI 3 P	-	-	4	2	50	50	100
5.	Dischargister	02BC301	Clinical Biochemistry	MI 3	4	-	-	4	50	50	100
6.	Biochemistry	02BC301-L	Clinical Biochemistry Lab	MI 3 P	-	-	4	2	50	50	100
Generic	Elective Course	e (Choose Any	One)						•		
•	Student can opt	second group o	Minor Subject as a generic elective course but credit	will be 3:1.		-			-		
7.	Microbiology	03MB301	Fermentation Technology	GEC 3	3	-	-	3	50	50	100
8.	Microbiology	03MB301-L	Fermentation Technology Lab	GEC 3 P	-	-	2	1	50	50	100
9.		03BC301	Clinical Biochemistry	GEC 3	3	-	-	3	50	50	100
10.	Biochemistry	03BC301-L	Clinical Biochemistry Lab	GEC 3 P	-	-	2	1	50	50	100
Skill En	hancement Cou	rse					•				
11.	SEC	04BT301	Plant Tissue Culture Technology	SEC 1	3	-	-	3	50	50	100
12.	SEC	04BT301-L	Plant Tissue Culture Technology Lab	SEC 1 P	-	-	2	1	50	50	100
	•		·	TOTAL	14	-	12	20	400	400	800

B.Sc. (Hons.)in Biotechnology Four-Year Full Time Degree Programme B.Sc. – Fourth Semester (Undergraduate Diploma in Biotechnology)

S No	Subject	Subject	Subject/Paper Title	Subject	I	eriod	ls	Cradit	Mark	s Distributi	on
5.INU.	Subject	Code	Subject/Paper Title	area	L	Т	Р	Crean	Internal	External	Total
Major S	ubject										
1.	Biotechnology	01BT401	Genetics	MJ 4	4	-	-	4	50	50	100
2.	Diotectinology	01BT401-L	Genetics Lab	MJ 4 P	-	-	4	2	50	50	100
Minor S	ubject (Choose	Any one)							·		
3.	Microbiology	02MB401	Medical Microbiology	MI 4	4	-	-	4	50	50	100
4.	wherobiology	02MB401-L	Medical Microbiology Lab	MI 4 P	-	-	4	2	50	50	100
5.	Biochemistry	02BC401	Enzymology	MI 4	4	-	-	4	50	50	100
б.	Dioenennistry	02BC401-L	Enzymology Lab	MI 4 P	-	-	4	2	50	50	100
Generic	Elective Course	e (Choose Any	One)						•		-
•	Student can opt s	second group of	f Minor Subject as a generic elective course but credit will	be 3:1.							
7.	Microbiology	03MB401	Medical Microbiology	GEC 4	3	-	-	3	50	50	100
8.	wherebolology	03MB401-L	Medical Microbiology Lab	GEC 4 P	-	-	2	1	50	50	100
9.	Biochemistry	03BC401	Enzymology	GEC 4	3	-	-	3	50	50	100
10.	Dioenennistry	03BC401-L	Enzymology Lab	GEC 4 P	-	-	2	1	50	50	100
Skill En	hancement Cou	rse					1		1		
11.	SEC	04BT401	Entrepreneurship in Biotechnology	SEC 2	2	-	-	2	50	50	100
12.	SEC	04BT402	Basics of Forensic Science	SEC 3	2	-	-	2	50	50	100
			•	TOTAL	15	-	10	20	400	400	800

B.Sc. (Hons.) in Biotechnology Four-Year Full Time Degree Programme B.Sc. – Fifth Semester (Undergraduate Degree in Biotechnology)

S No	Subject	Subject	Subject/Denser Title	Subject		Period	5	Credit	Mark	s Distribut	ion
5.INO.	Subject	Code	Subject/Paper Title	area	L	Т	Р	Crean	Internal	External	Total
Major S	Subject(Core)										
1.	Biotechnology	01BT501	Genetic Engineering & Technology	MJ 5	4	-	-	4	50	50	100
2.	Diotectiniology	01BT501-L	Genetic Engineering & Technology Lab	MJ 5 P	-	-	4	2	50	50	100
Major (I	DSC)			·							
3.		05BT501	Environmental Biotechnology	MJD1	3	-	-	3	50	50	100
4.	Any One	05BT501-L	Environmental Biotechnology Lab	MJD1P	-	-	2	1	50	50	100
5.	They one	05BT502	Food Biotechnology	MJD1	3	-	-	3	50	50	100
6.		05BT502-L	Food Biotechnology Lab	MJD1P	-	-	2	1	50	50	100
						•					
Skill En	hancement Cou	rse									
7		04BT501	Biosafety, Bioethics IPRs and patenting	SEC 4	2	-	-	2	50	50	100
8	SEC	04BT501-L	Biosafety, Bioethics IPRs and patenting Lab	SEC 4 P	-		2	1	50	50	100
9		04BT502	Yoga Science	SEC 5 P	-	-	2	1	50	50	100
Field P	roject	1	1	1	1	1	1	1	1	1	1
10	FP	06BT501-P	Field Project/ Internship/ Apprenticeship	FP1	-	-	12	6	50	50	100
	1	1		TOTAL	9	-	22	20	400	400	800

B.Sc. (Hons.) in Biotechnology Four-Year Full Time Degree Programme B.Sc. – Sixth Semester (Undergraduate Degree in Biotechnology)

S No	.No. Subject Subje		Subject/Denor Title	Subject]	Periods	5	Credit	Mark	s Distributi	ion
5.110.	Subject	Code	Subject/raper Title	area	L	Т	Р	Creuit	Internal	External	Total
Major S	ubject (Core)										
1.	Biotechnology	01BT601	Immunology and Immuno Technology	MJ 5	4	-	-	4	50	50	100
2.	Diotectinology	01BT601-L	Immunology and Immuno Technology Lab	MJ 5 P	-	-	4	2	50	50	100
Major (I	DSC)										
3.		05BT601	Animal Biotechnology	MJD2	3	-	-	3	50	50	100
4.	Any One	05BT601-L	Animal Biotechnology Lab	MJD2P	-	-	2	1	50	50	100
5.	They one	05BT602	Agriculture Biotechnology	MJD2	3	-	-	3	50	50	100
6.		05BT602-L	Agriculture Biotechnology Lab	MJD2P	-	-	2	1	50	50	100
7.		05BT603	Nano Biotechnology	MJD3	3	-	-	3	50	50	100
8.		05BT603-L	Nano Biotechnology Lab	MJD3P	-	-	2	1	50	50	100
9.	Any One	05BT604	Biostatistics	MJD3	3	-	-	3	50	50	100
10.		05BT504-L	Biostatistics Lab	MJD3P	-	-	2	1	50	50	100
Field Pr	roject										
11.	FP	06BT601-P	Field Project/ Internship/ Apprenticeship	FP2	-	-	12	6	50	50	100
			·	TOTAL	10	-	20	20	350	350	700

B.Sc. (Hons.) in Biotechnology Four-Year Full Time Degree Programme B.Sc. – Seventh Semester (Honors in Biotechnology)

S No	Subject	Subject	Subject/Denser Title	Subject]	Periods	6	Credit	Mark	s Distributi	ion
5. 1NO.	Subject	Code	Subject/Paper Title	area	L	Т	Р	Credit	Internal	External	Total
Major S	Subject (Core)										
1.	Biotechnology	01BT701	Computational Biology and Bioinformatics	MJ 5	4	-	-	4	50	50	100
2.	Diotectiniology	01BT701-L	Computational Biology and Bioinformatics Lab	MJ 5 P	-	-	4	2	50	50	100
Major (I	DSC)										
3.		05BT701	Pharmaceutical Biotechnology	MJD2	3	-	-	3	50	50	100
4.	Any One	05BT701-L	Pharmaceutical Biotechnology Lab	MJD2P	-	-	2	1	50	50	100
5.		05BT702	Stem Cell and Tissue Engineering	MJD2	3	-	-	3	50	50	100
6.		05BT702-L	Stem Cell and Tissue Engineering Lab	MJD2P	-	-	2	1	50	50	100
Minor S	Subject			·							
7.	RM	02RM701	Research Methodology	MI5	3	-	-	3	50	50	100
8.	RM	02RM701-L	Research Methodology Lab	MI5	-	-	2	1	50	50	100
Skill En	hancement Cou	rse				•	-				
9	FP	06BT701-P	Field Project/ Internship/ Apprenticeship	FP3	-	-	12	6	50	50	100
	L	1	•	TOTAL	10	-	20	20	350	350	700

B.Sc. (Hons.) in Biotechnology Four-Year Full Time Degree Programme B.Sc. – Eighth Semester (Honors in Biotechnology)

S No	Subject	Subject	Subject/Denor Title	Subject		Period	s	Credit	Mar	ks Distribut	ion
3. 1 10.	Subject	Code	Subject/Paper The	area	L	Т	Р		Internal	External	Total
Major S	ubject (Core)										
1.	Biotechnology	01BT801	Genomics and Proteomics	MJ 5	4	-	-	4	50	50	100
2.	Dioteennoiogy	01BT801-L	Genomics And Proteomics Lab	MJ 5 P	-	-	4	2	50	50	100
Minor S	ubject										
3.	Biochemistry	02BC801	Mammalian Physiology	MI 6	3	-	-	3	50	50	100
4.	Dioeneninsury	02BC801-L	Mammalian Physiology Lab	MI6P	-	-	2	1	50	50	100
5.	Microbiology	02MB801	Bioprocess Engineering	MI 6	3	-	-	3	50	50	100
6.		02MB801-L	Bioprocess Engineering Lab	MI6P	-	-	2	1	50	50	100
Skill En	hancement Cou	rse									
7.	SEC	06BT801-P	Field Project/ Internship/ Apprenticeship	FP2		-	20	10	50	50	100
				TOTAL	7	-	26	20	250	250	500

Program Name	Bachelor of Science (BSc) Honours- Biotech	nology							
Semester	Ι								
Course Code:	01BT101								
Course title:	Cell Structure and Biotechnology	Curriculum Developer: Paras Koshe, Assistant Professor							
Pre-requisite:	udent should have basic knowledge of cell structure and organelles								
Rationale:	The B.Sc first-semester course in cell biology a and genetic mechanisms. By delving into a understanding of life at the molecular level. T cellular functions to inheritance patterns, and se	The B.Sc first-semester course in cell biology and genetics serves as a crucial introduction to the fundamental building blocks of life—cells and genetic mechanisms. By delving into cellular structures, processes, and genetic principles, students establish a foundational understanding of life at the molecular level. This course paves the way for comprehending intricate biological phenomena, ranging from cellular functions to inheritance patterns, and sets the stage for future explorations in biotechnology, RDT, and related fields.							
Course Outcomes (COs):	CO1-01BT101 .1: Students will demonstrate a CO2-01BT101. 2: Students will exhibit proficie CO3-01BT101. 3: Evaluate the roles cell divisi CO4-01BT101. 4: Students will exhibit mastery CO5-01BT101. 5: Illustrate recombinant DNA	 CO1-01BT101 .1: Students will demonstrate a thorough understanding of cell, cell theory, cell types, biological membranes and cytoskeleton. CO2-01BT101. 2: Students will exhibit proficiency in drawing and explaining ultra structure of Endoplasmic reticulum and Ribosome. CO3-01BT101. 3: Evaluate the roles cell division, cell cycle and cell signaling. CO4-01BT101. 4: Students will exhibit mastery of Biotechnology and know about the Applications of Biotechnology for human welfare CO5-01BT101. 5: Evaluate the roles cell division and evaluate the complexity of Biotechnology and know about the Applications of Biotechnology for human welfare 							

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)
MAJOR	01BT101	Cell Structure and Biotechnology	4	4	1	5	14	4+2=6

Legends:CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each	Class Test 2 (2 best out of 3) 10 marks	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			(CA)	each (CT)					
MAJOR	01BT101	Cell Biology and Genetics	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MAJOR	01BT101-L	Cell Biology and Genetics	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the	Approximate Hours						
course and session levels, which students are anticipated to accomplish through		T.	CI	тт	aw	CT.	T. (1
various modes of instruction including Classroom Instruction (CI). Laboratory		Item	CI	LI	SW	SL	Total
Instruction (LI). Sessional Work (SW), and Self Learning (SL). As the course		Approx. Hrs	12	10	01	06	29
progresses, students should showcase their mastery of Session Outcomes (SOs),							
culminating in the overall achievement of Course Outcomes (COs) upon the							
course's conclusion.							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-01BT101 .1: Students will demonstrate a thorough understanding of cell, cell theory, cell types, biological membranes and cytoskeleton	SO1.1 Understand Cell as basic unit of living System	LI1 Study and observation of Prokaryotic cell and eukaryotic under microscope	Unit-1 CI1.1 Cell as basic unit of living System	SL1.1 Study of prokaryotic and eukaryotic cell
	SO1.2 Understand classification of organisms by cell structure	LI 2 Demonstration of all equipment used in cell biology	CI1.2 classification of organisms by cell structure	SL1.2 Difference between unicellular and multicellular organisms
	SO1.3 Illustration of cell theory	LI 3 To prepare a slide of onion cells to view under microscope	CI1.3 cell theory	SL1.3 Write postulates of cell theory
	SO1.4 Learn and draw PPLO cell	LI4 study of microscope	CI1.4 ultra structure of cell types PPLOs,	
	SO1.5 Learn and draw Bacterial cell	Li5 preparation of slide	CI1.5 Bacteria	SL1.4 Draw and label ultra structure of bacteria
	SO1.6 Learn and draw Plant cell and draw animal cell		CI1.6 Plant Cell and Animal Cell	
	SO1.7 Focus on principle and process of cell fractionation.		CI1.7 cell fractionation	
	SO1.8 Illustrate Chemical components of biological membranes		CI1.8 Cell Membrane and Permeability: Chemical components of biological membranes	SL1.5 Learn about osmosis and diffusion
	SO1.9Understandprocessandtypesmembrane transport		CI1.9 membrane transport	SL1.6 Role of cytoskeleton in cell division and movement and muscle contraction
	SO1.10DescribethecomponentofCytoskeleton		CI1.10 Structure and function of microtubules	
	SO1.11 Learn Structure and function of microfilaments.		CI1.11 microfilaments.	

SO1.12 Learn Structure and function of Intermediate filaments.	CI1.12 Intermediate filaments	
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Suggested Sessional	SW1.1 Assignments	Differentiate between prokaryotic and eukaryotic cell		
Work (SW):anyone	SW1.2Mini Project	Prepare list of microorganisms of prokaryotic and eukaryotic type		
	SW1.3 Other Activities (Specify)	Prepare chart on tools and techniques of cell biology		

This course syllabus illustrates the expected learning achievements, both at the course and session	Approxima	ate Hours					
levels, which students are anticipated to accomplish through various modes of instruction including	Г	- .	<i>a</i> 1	* *		a r	
Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning	-	Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs),	l	Approx. Hrs	12	00	01	05	18
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-01BT101.2: Students will exhibit proficiency in drawing	SO2.1 Explore the structure of Endoplasmic reticulum		Unit-II CI2.1 Ultra structure of Endoplasmic reticulum	SL2.1 Learn structure and function of endomembrane system
and explaining ultra structure of Endoplasmic reticulum and Ribosome	SO2.2 Describe structure and function of cell organelles, endoplasmic reticulum		CI2.2 structure and function of cell organelles, endoplasmic reticulum,	SL2.2 Write a note on Golgi complex
	SO2.3 Study function of endoplasmic reticulum		CI2.3 function of ER including role in protein segregation	SL2.3 Learn about contents of cytosol
	SO2.4 Explain structure and function of Golgi bodies		CI2.4 Golgi complex: Structure and functions	SL2.3 Discuss role of ribosome in protein synthesis
	SO2.5 Assessing the Role of Golgi complex in cell		CI2.5 functions including role in protein secretion	
	SO2.6 Explaining the structure of Lysosomes.		CI2.6 Lysosomes and its types	SL2.5 Prepare diagram of ribosome
	SO2.7 Explaining functions of lysosomes		CI2.7 functions and importance of lysosomes.,	

SO2.8 Understand the structure and functions of Vacuoles	CI2.8 structure and functions of Vacuoles	
SO2.9 Explain structure and functions of micro bodies.	CI2.9 micro bodies: Structure and functions	
SO2.10 Describing the structure of ribosome's	CI2.10 Ribosome: Structures and function	
SO2.11 Explain types of ribosome	CI2.11 Ribosome - types	
SO2.12 Analyze function including role in protein synthesis.	CI2.12 Ribosomes : Structures and function including role in protein synthesis.	

Suggested Sessional Work	SW2.1 Assignments	Draw a well labelled diagram of Endoplasmic reticulum and describe it.							
(SW):anyone	SW2.2Mini Project	Prepare chart on cell organelles.	Prepare chart on cell organelles.						
	SW2.3 Other Activities (Specify)	Prepare collection of photos from internet of different cellular organisations and electron micrograph of cell organelles							
This course syllabus illustra which students are anticipa	Approx	ximate Hours							
Instruction (CI). Laboratory	Instruction (LI). Sessional Work (SW	<i>T</i>), and Self Learning (SL). As the course		Item	Cl	LI	SW	SL	Total
progresses, students should	showcase their mastery of Session Ou	tcomes (SOs), culminating in the overall		Approx.	12	12	01	05	30
achievement of Course Outcomes (COs) upon the course's conclusion.				Hrs					

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning(SL)
		Instruction(LI)	(CI)	
CO3-01BT101. 3: Evaluate the	SO3.1 Explain Structure and	LI1 Study of mitosis	Unit-III	SL3.1 Read about cell division
roles cell division, cell cycle	function of Mitochondria	with onion root tip	CI3.1 Mitochondria:	
and cell signaling.			Structure and function	
	SO3.2 Assessing Structure	LI 2 Study of meiosis	CI3.2 Mitochondria:	SL3.2 Draw a diagram of Meiosis
	and function of	with onion bud	Structure and	
	Mitochondria		function	
	SO3.3 Understand Biogenesis	LI 3 To prepare	CI3.3 biogenesis	SL3.3 Illustration about different
	of Mitochondria	temporary mount of		stages of cell cycle and checkpoints
		a leaf peel in order to		
		show the stomata of		

	leaf							
SO3.4 Explain the structure and functions of chloroplasts	LI 4 To examine chloroplast inside plant cell with the help of microscope	CI3.4 Chloroplasts: Structure and function						
SO3.5 Explain the structure	LI1.5 Study of mitosis	CI3.5 Chloroplasts:						
and functions of chloroplasts		Structure and function						
SO3.6 Describing the structure	LI 6 Study of meiosis	CI3.6 Nucleus: Structure	SL3.4	Write	а	note	on	cell
and functions of Nucleus		and function	signalli	ng				
SO3.7 Describe chromosomes		CI3.7 chromosomes	SL3.5	Diagran	nma	tically	expla	in
and their structure		and their structure	structur	re of abn	orma	al chro	moso	mes
SO3.8 Study Composition of		CI3.8 Extracellular						
 Extracellular Matrix:,		Matrix: Composition						
SO3.9 Illustrate the mechanism		CI3.9 Signal						
of cell transduction		transduction						
SO3.10		CI3.10 Apoptosis						
SO3.2 SO3.11 Illustrate Cell cycle and all stages		CI3.11 Cell cycle						
SO3.12 Describe cell division and its types		CI3.12 Cell division.						

Suggested Sessional	SW3.1 Assignments	Describe cell division and cell cycle
Work (SW): anyone	SW3.2 Mini Project	Prepare complete draft on cell signalling and its types
	SW3.3 Other	Collect links of videos based on Apoptosis process and explain them in front of class
	Activities (Specify)	

Approximate Hours						
I	ltem	Cl	LI	SW	SL	Total
A	Approx. Hrs	12	00	01	05	18

Cou	urse Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning(SL)
CO4 exhi Biot the	I-01BT101. 4 : Students will bit mastery of echnology and know about Applications of	SO4.1 Understand Scopes and importance of Biotechnology		Unit-IV CI4.1 Introduction to Biotechnology	SL4.1 Learn about terms used in Biotechnology
Biot welf	echnology for human are	SO4.2 Assessing the various definitions of biotechnology		CI4.2 Definitions	SL4.2 Discuss top most biotechnology companies in india.
		SO4.3 Learn about the Historical perspectives of biotechnology.		CI4.3 Historical perspectives	SL4.3 Practice about Good laboratory practices in your institute
		SO4.4 Illustrate Scope and importance of Biotechnology		CI4.4 Scope and importance	SL4.4 Studies related to Red and Green Biotechnology
		SO4.5 Understand the rules and procedure of Good laboratory practices.		CI4.5 Good laboratory practices	
		SO4.6 Analyze the Role of Biotechnology in India and Global trends		CI4.6 Biotechnology in India and Global trends	SL4.5 Evaluate the bio safety and bioethics in biotechnology
		SO4.7 Evaluate the need of Biotechnology in India and Global trends		CI4.7 Biotechnology in India and Global trends.	
		SO4.8 Illustrate the Applications of Biotechnology for human welfare (agriculture)		Cl4.8 Applications of Biotechnology for human welfare(agriculture)	
		SO4.9 Explain Applications of Biotechnology for human welfare(medicine)		CI4.9 Applications of Biotechnology for human welfare(medicine)	
		SO4.10 Focus on 1 Applications of Biotechnology for human welfare(Industries)		Cl4.10 Applications of Biotechnology for human welfare(Industries)	
		SO4.11 Explain principles and rules of bio safety and bioethics in biotechnology		Cl4.11 bio safety and bioethics in biotechnology	
		SO4.12 Describe bio safety and bioethics in biotechnology		Cl4.12 bio safety and bioethics in biotechnology	
L	Suggested Sessional	SW4.1 Assignments	Describe laws of inheritance of	viven by Mendel	<u> </u>
	Work (SW): anvone	SW4.2 Mini Project	Describe the examples of Inte	rgenic interactions	
		SW4.3 Other Activities (Specify)	Prepare list of assumption of	Hardy-Winberg Law /equilibrium a	nd give its derivation

Approximate Hours						
	Item	Cl	LI	SW	SL	Total
	Approx. Hrs	12	08	01	06	27

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self- Learning(SL)
CO5-01BT101. 5 : Illustrate recombinant DNA technology, stem cell technology and characteristics and molecular basis of cancer	SO5.1 Define Recombinant DNA Technology: its historical perspectives and scopes.	LI 1 To perform transformation experiment	Unit-V CI5.1 Recombinant DNA Technology: Introduction	SL5.1 learn about in vivo and invitro gene cloning
	SO5.2 Illustrate Tools of rDNA Technology	LI 2 Identify Barr Body in female buccal epithelium	CI5.2 Tools of rDNA Technology	SL5.2 learn about enzymes and vectors used in RDT
	SO5.3 Elaborate Steps of rDNA Technology,	LI3 Demonstration of PCR	CI5.3 Steps of rDNA Technology,	SL5.3 Give role of RDT in quality enhancement
	SO5.4 Understand principle and requirement of PCR	LI4 Isolation of DNA from human cheek cell	CI5.4 Polymerase Chain Reaction (PCR) introduction	SL5.4 Learn about diseases caused by abnormal chromosomes
	SO5.5 Understand the steps of Polymerase Chain Reaction (PCR) and cycles		CI5.5 Polymerase Chain Reaction (PCR) steps and cycles	Give diagrammatic representation of types cancer and its types
	SO5.6 Describe applications of PCR		CI5.6 Polymerase Chain Reaction (PCR) applications	
	SO5.7 Describe Variants of PCR		CI5.7 Variants of PCR	
	SO5.8 Elaborate Transgenic Plants with Beneficial Traits		CI5.8 Transgenic Plants with Beneficial Traits.	SL5.5 Learn genetically modified organisms and their impacts.
	SO5.9 Elaborate Transgenic Animals with Beneficial Traits		CI5.9 Transgenic animals with Beneficial Traits.	

SO5.10 Explain principle and steps of Stem cell technology	CI5.10 Stem Cell Technology	SL5.6 Write about regenerative medicine.
SO5.11 Learn about the characteristics and types of cancer	CI5.11 Cancer: characteristics	
SO5.12 Illustrate molecular basis of cancer.	CI5.12 Cancer: molecular basis of cancer.	

Suggested Sessional	SW5.1 Assignments	Describe principle steps, variants and applications of PCR.					
Work (SW): anyone	SW5.2 Mini Project Write a detail note on Recombinant DNA Technology						
	SW5.3 Other	Prepare a detail draft on stem cell technology.					
	Activities (Specify)						

Course Code: 01BT101

Course duration (in hours) to attain Course Outcomes:

Course Title: Cell Structure and Biotechnology

Course Outcomes(COs) Class lecture Laboratory Self-Learning **Total Hours** Sessional work **Instruction**(LI) (SL) (**SW**) (Li+CI+SL+SW) (**CI**) CO1-01BT101.1: Students will demonstrate a thorough 12 10 29 6 1 understanding of cell, cell theory, cell types, biological membranes and cytoskeleton CO2-01BT101. 2: Students will exhibit proficiency in 12 18 0 5 1 drawing and explaining ultra structure of Endoplasmic reticulum and Ribosome. CO3-01BT101. 3: Evaluate the roles cell division, cell 12 12 5 1 30 cycle and cell signalling. CO4-01BT101. 4: Students will exhibit mastery of 12 0 5 1 18 Biotechnology and know about the Applications of Biotechnology for human welfare CO5-01BT101. 5: Illustrate recombinant DNA technology, 12 8 27 6 1 stem cell technology and characteristics and molecular basis of cancer **Total Hours** 60 30 27 05 122

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Cell Structure and Biotechnology

Course Code: 98BT107

Course Outcomes				
	Α	An	Ε	Total Marks
CO1-01BT101.1: Students will demonstrate a thorough understanding of cell, cell theory, cell	02	02	01	05
types, biological membranes and cytoskeleton				
CO2-01BT101. 2: Students will exhibit proficiency in drawing and explaining ultra structure of	03	05	02	10
Endoplasmic reticulum and Ribosome.				
CO3-01BT101. 3 : Evaluate the roles cell division, cell cycle and cell signaling.	05	05	05	15
CO4-01BT101. 4: CO4-01BT101. 4: Students will exhibit mastery of Biotechnology and know	04	03	03	10
about the Applications of Biotechnology for human welfare.				
CO5-01BT101. 5: Illustrate recombinant DNA technology, stem cell technology and	05	04	01	10
characteristics and molecular basis of cancer				
Total Marks	19	19	12	50

Legend: A, Apply; An, Analyze, Evaluate;

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Cell & molecular biology- De Robertis B.J. publications Pvt.Ltd.
2	Cell & molecular biology - Gerald karp john wills & essential cell biology Balberts D. Bray
3	Developmental biology- SF Gilbert senior associates.
4	Molecular Biology of Cell- Alberts, B et al.
5	Genetics- Strickberger, 2 nd
6	Microbial Genetics – D. Frifielder.

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: Bachelor of Science (BSc) Honours- Biotechnology

Semester: I

Course Title: Cell Structure and BiotechnologyCourse Code:									e: 01BT101						
CO/PO Mapping															
Course Outcome Program Outcomes (POs)											Program Specific Outcomes (PSOs)				
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-01BT101.1 : Students will demonstrate a thorough understanding of cell, cell theory, cell types, biological membranes and cytoskeleton	-	-	1	2	2	2	2	-	1	2	2	3	3	-	-
CO2-01BT101. 2: Students will exhibit proficiency in drawing and explaining ultra structure of Endoplasmic reticulum and Ribosome.	-	-	-	-	-	-	-	-	2	2	3	3	2	-	1
CO3-01BT101. 3 : Evaluate the roles cell division, cell cycle and cell signalling.	-	1	1	1	-	2	2	-	3	3	3	2	2	2	1
CO4-01BT101. 4: Students will exhibit mastery of Biotechnology and know about the Applications of Biotechnology for human welfare	-	1	1	2	2	2	2	3	-	1	2	2	2	2	2
CO5-01BT101. 5 : Illustrate recombinant DNA technology, stem cell technology and characteristics and molecular basis of cancer	1	1	1	-	-	3	3	3	1	2	3	2	2	2	1

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom Instruction	Self-Learning
			Instruction (LI)	(CI)	(SL)
PO	CO1-01BT101.1: Students will	SO1.1 SO1.2 SO1.3	LI1, LI2 LI3, LI4,	1.1,1.2,1.3,1.4,1.5, 1.6,	1SL-1,2,3,4,5,6
1,2,3,4,5,6,7,8,9,10,11,12	demonstrate a thorough	SO1.4 SO1.5 SO1.6	LI5	1.7, 1.8, 1.9, 1.10, 1.11,	
	understanding of cell, cell theory, cell	SO1.7 SO1.8 SO1.9		1.12	
PSO 1,2,3	types, biological membranes and	SO1.10 SO1.11			
	cytoskeleton	SO1.12			
PO	CO2-01BT101. 2: Students will	SO2.1 SO2.2 SO2.3		2.1, 2.2, 2.3, 2.4, 2.5,	2SL-1,2,3,4,5
1,2,3,4,5,6,7,8,9,10,11,12	exhibit proficiency in drawing and	SO2.4 SO2.5 SO2.6		2.6, 2.7, 2.8,2.9, 2.10,	
PSO 1,2,3	explaining ultra structure of	SO2.7 SO2.8 SO2.9		2.11, 2.12	
	Endoplasmic reticulum and	SO2.10 SO2.11			
	Ribosome.	SO2.12			
PO	CO3-01BT101. 3: Evaluate the roles	SO3.1 SO3.2 SO3.3	LI1, LI2 LI3, LI4,	3.1,3.2,3.3,3.4,3.5, 3.6,	3SL-1,2,3,4,5
1,2,3,4,5,6,7,8,9,10,11,12	cell division, cell cycle and cell	SO3.4 SO3.5 SO3.6	LI5 LI6	3.7, 3.8, 3.9, 3.10, 3.11,	
PSO 1,2,3	signalling.	SO3.7SO3.8 SO3.9		3.12	
		SO3.10 SO3.11			
		SO3.12			
PO	CO4-01BT101. 4: Students will	SO4.1 SO4.2 SO4.3		4.1,4.2,4.3,4.4, 4.5, 4.6,	4SL-1,2,3,4,5
1,2,3,4,5,6,7,8,9,10,11,12	exhibit mastery of Biotechnology and	SO4.4 SO4.5 SO4.6		4.7, 4.8, 4.9,	
	know about the Applications of	SO4.7 SO4.8 SO4.9		4.10,4.11,4.12	
PSO 1,2,3	Biotechnology for human welfare	SO4.10 SO4.11			
		SO4.12			
PO	CO5-01BT101. 5: Illustrate	SO5.1 SO5.2 SO5.3	LI1, LI2, LI3, LI4	5.1,5.2,5.3,5.4,5.5,	5SL-1,2,3,4,5,6
1,2,3,4,5,6,7,8,9,10,11,12	recombinant DNA technology, stem	SO5.4 SO5.5 SO5.6		5.6,5.7,5.8,5.9,5.10,5.11	
PSO 1,2,3	cell technology and characteristics	SO5.7 SO5.8 SO5.9		5.12	
	and molecular basis of cancer	SO5.10 SO5.11			
		SO5.12			

Program Name	Bachelor of Science (Hons.) Biotechnology				
Semester	Ι				
CourseCode:	02BC101				
Coursetitle:	General Biochemistry	General Biochemistry Curriculum Developer: Mrs. Pratima Mishra, Guest Faculty			
Pre-requisite:	Students should have basic knowledge of Biology and Chemistry				
Rationale:	For a successful biotechnologist is it essential to learn about basic concepts of those molecules which governs the anatomical and physiological components of biological world. This course aims to provide students with a depth of knowledge of a number of topics in biochemistry that will build upon the foundations established in earlier subjects. The main themes to be explored are, the advanced theoretical concepts and techniques of biochemistry and molecular biology that underpin the developments of molecular sciences and Microbiology. The practical component will aim to make the students highly competent in several experimental and research techniques in these areas.				
Course Outcomes (COs):	CO1-02BC101.1: Understanding of the compone CO2-02BC101.2: Learning in-depth information CO3-02BC101.3: Recognize various concepts rel CO4-02BC101.4: Assess various concepts related CO5-02BC101.5: Appraise the relationship betw	ents of biological systems, significant functional groups, pH and buffers, and proteins. regarding the composition and characteristics of numerous categories of carbohydrates. ated the structure, characteristics, function and biological role of nucleic acids and central dogma. d the structure, characteristics, function and biological role of different types of lipids. yeen principles molecular transport, cell junction and cell signaling in Cell and Cellular components.			

Scheme of Studies:

Board of Study	Course Code	CourseTitle	Cl	LI	LI SW SL Total Study Hours(CI+LI+SW+		Total Study Hours(CI+LI+SW+SL)	(L:T:P=4:0:2)	
Minor	02BC101	General Biochemistry	4	4	1	5	14	4+2=6	

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02BC101	General Biochemistry	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)	-		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02BC101-L	General Biochemistry	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are	App	roximateHours					
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI),	11						
Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session		Item	Cl	LI	SW	SL	Total
Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.		Approx.Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class ro	oom Instruction(CI)	Self-Learning(SL)
CO1-02BC101.1: Understanding of the components of biological systems, significant functional groups, pH and buffers, and proteins	SO1.1 Define and Describe concept of pH and Buffer	LI1.1 Calibration of pH meter and preparation of buffer	Unit 1 CI1.1 pKa,	Concept of pH and buffers	SL1.1 Search various reference books and study material to start the learning
	SO1.2 DescribeaboutHenderson-Hasselbalchequation		CI1.2 equatior	Henderson– Hasselbalch n,	SL1.2 Check the properties of water and buffers
	SO1.3 Describe about water	LI1.2 Identification of amino acids	CI1.3	Water	SL1.3 Learn about various categories of amino acids
	SO1.4 Explain about amino acids		CI1.4	Amino Acids: Classification	SL1.4 Enlist the structure and properties of different amino acids and their role
	SO1.5 Describe structure of amino acids		CI1.5	structure	
	SO1.6 Describe Properties of amino acids		CI1.6	properties	
	SO1.7 Study the different types of amino acids		CI1.7 acids,	unusual and modifies amino	SL1.5 Enlist the structure and properties of different proteins and their role
	SO1.8 Study of peptides.		CI1.8	peptides,	
	SO1.9 Describe concept of Zwitter ion		CI1.9	Isoelectric point, Zwitter ion,	
	SO1.10 Assess the concept of proteins	LI1.3 Identification of Proteins	CI1.10	Proteins: Classification,	
	SO1.11 Describe structure of proteins		CI1.11	structure	
	SO1.12 Describe function of proteins		CI1.12	functions `	

Suggested Sessional	SW1.1 Assignments	Describe in detail pH, buffer and water
Work (SW):anyone	SW1.2Mini Project	Draw structure of various types of amino acids
-	SW1.3 Other Activities (Specify)	Collect the data about biological role of proteins and their deficiencies.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	05	24

Course	Session Outcomes	Laboratory Instruction (LI)	Classroom Instruction	Self Learning (SL)
Outcome (CO)	(SOs)		(CI)	
CO2-02BC101.2: Learning	SO2.1 Assess the concept of	LI2.1 Identification of	Unit-II	SL2.1 Enlist the different
in-depth information	carbohydrate	carbohydrate	CI2.1 Carbohydrate:	properties of carbohydrates
regarding the composition			Classification, structure	
and characteristics of				
numerous categories of				
carbohydrates.				
	SO2.2 Explain properties and		CI2.2 Properties and	SL2.2 Assess biological role of
	function of carbohydrate		Function	carbohydrate.
	SO2.3 Explain about	LI2.2 Identification of	CI2.3 Aldoses, ketoses	SL2.3 Learn structure and
	monosaccharides	reducing sugars	monosaccharide	function of monosaccharide
	SO2.4 Explain about	LI2.3 Identification of	CI2.4 disaccharides,	SL2.4 Learn structure and
	disaccharides and	Non reducing sugar	polysaccharides	function of oligosaccharide
	polyasccharides			
	SO2.5 Describe the role of		CI2.5 Glycosaminoglycans,	SL2.5 Learn structure and
	hetero polysaccharides		homo and Hetero	function of polysaccharide
			polysaccharides,	
	SO2.6 Describe structure and		CI2.6 Starch,	
	function of starch			
	SO2.7 Describe about		CI2.7 Glycogen, Chitin,	
	glycogen, chitin			
	SO2.8 Describe biological		CI2.8 Cellulose	
	role of cellutose,			
	SO2.9 Describe role of		CI2.9 Peptidoglycan.	
	peptidoglycan, heparin		Heparin	
	SO2.10 Describe		CI2.10 Optical activity.	
	Optical activity			
	SO2.11 Describe		CI2.11 mutarotation	
	properties of mutarotation			
	SO2 12 Assess concent		CI2 12 oxidation of	
	of monoascenarides oxidation		monosaccharides	
	SO2.6 Describe structure and function of starchSO2.7 Describe glycogen, chitinabout about glycogen, chitinSO2.8 Describe role of cellutose,biological role of cellutose,SO2.9 Describe peptidoglycan, heparinof peptidoglycan, heparinSO2.10 Optical activityDescribe Describe properties of mutarotationSO2.11 SO2.12 of monoasccharides oxidationDescribe Assess concept of monoasccharides oxidation		polysaccharides,CI2.6Starch,CI2.7Glycogen, Chitin,CI2.8CelluloseCI2.9Peptidoglycan, HeparinCI2.10Optical activity,CI2.11mutarotation,CI2.12oxidation monosaccharides	

Suggested Sessional	SW2.1 Assignments	Describe in detail various types of carbohydrate and their biological role.
Work (SW) :anyone	SW2.2 Mini Project	Detection of carbohydrate in different food products and living organisms
· · · · ·	SW2.3 Other Activities (Specify)	Develop methods for qualitative and quantitative detection of carbohydrates.

			Item	CI LI SW SL Total
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	rox.Hrs 12 06 01 05 24 Self-Learning(SL)
CO3-02BC101.3: Recognize various concepts related the structure, characteristics, function and biological role of nucleic acids and central dogma.	SO3.1 Explain the concept of Nucleic acid.	SL3.1 Isolation of nucleic acid	Unit-III CI3.1 Nucleic Acids:	SL3.1 Read about various types of nucleic acids and its derivatives.
	SO3.2Assessingthestructure of nucleotidesSO3.3study structure of DNA	SL3.2 Isolation of DNA	CI3.2 Structure of nucleotides. CI3.3 Structure of DNA	SL3.2 Illustrate structure of different types of DNA and RNA
	SO3.4 Assessing structure of RNA		CI3.4 Structure of RNA	
	SO3.4 Assessing properties of DNA and RNA		CI3.5 properties,	
	SO3.6 Study variation from Watson and Crick Model	SL3.3 Isolation of RNA	CI3.6 Variation from Watson and Crick model	
	SO3.7 Assessing different structure present in DNA		CI3.7 Special types of structures present in DNA	SL3.3 Study the variation in DNA structure from Watson and Crick model.
	SO3.8 Describe about hybridization,		CI3.8 Hybridization,	
	SO3.9 Describe about hypo and hyperchromic shift		CI3.9 Hypo and hyperchromic shift,	
	SO3.10 Describe about Tm SO3.11 Assessing the role of central Dogma		CI3.10 Tm CI3.11 Concept of Central Dogma,	SL3.4 Study the mechanism of central dogma
	SO3.12 Describe about gene and its regulation		CI3.12 Concept of genes and their regulation.	SL3.5 Study the impact of gene regulation

Suggested Sessional	SW3.1 Assignments	Describe in detail structure and function of different types of nucleic acids.							
Work (SW): anyone	SW3.2 Mini Project	Describe the role of nucleic acids in biological system.							
	SW3.3 Other Prepare a model for explaining the structure of DNA and RNA.								
	Activities (Specify)								
					~		GTT	ar	_
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				Item			SW	SL	Total
(\mathbf{C}_{0})		T - h 4	Classes and Laster	Approx.H	rs 12	06	01	05	24
Course Outcome (CO)	Session Outcomes(SOS)	Laboratory Instruction(LI)	Classroom Instruc	ction(CI)	Self-Le	arning	g(SL)		
	2011		T T 1 / T T		GT 4.4	T			
CO4- 02BC101.4: Assess		LI4.1 Isolation of lipids	S.1 Isolation of lipids Unit-IV				SL4.1 Learn about		
various concepts related the	Exploring the concept of lipids	from different sources	CI4.1 Lipids: Cla	CI4.1 Lipids: Classification, di		t class	es of li	pids	
structure, characteristics,	and their types								
different types of linids									
	SO4 2 Assessing structure of	LI4 2 Determination of	CIA 2 structure		SL4 2	Discu	ss type	s and	
	lipids	solubility of lipids	cinz structure,		stru	cture of	of lipid	s und	
	SO4.3 Assessing types of	LI4.3 Determination of	CI4.3 Types,		SL4.3	Learn	about	~	
	lipids	acid value of lipids	51		biologic	al fun	ction o	f lipic	ls
	SO4.4 Explaining the	^	CI4.4 biological	functions				•	
	biological function of lipids								
	SO4.5 Explaining the role of		CI4.5 Oils, fats,	waxes,	SL4.4	Learn		ab	out
	oils, fats and waxes				biologic	al fu	nction	of fa	tty
					acids				
	SO4.6 Evaluate role of fatty		CI4.6 fatty acids,	,					
	acids,								
	SO4.7 Evaluate role of		CI4.7 phospholip	ids,	SL4.5	Learn	about		
	phospholipids				sigr	ifican	ce of li	pids	
	SO4.8 Describe the impact of		CI4.8 Sphingolip	ids,					
	Sphingolipids								
	SO4.9 Describe the impact of		CI4.9 galactolipic	ls,					
	galactolipids								
	SO4.10 Describe the impact of		CI4.10 Sulpholipic	ls,					
	Sulpholipids								
	SU4.11 Describe the impact of		CI4.11 Steroids						
	Steroids		CIA 12 Linida in ai	anal					
	in signal transduction		transduction	gnai					
	in signal transduction		transduction						

Suggested Sessional	SW4.1 Assignments	Explain about different categories of lipids and their biological role.
Work (SW): anyone	SW4.2 Mini Project	Describe the various types of lipids its structure, properties and applications
	SW4.3 Other	Develop methods for qualitative and quantitative detection of lipids.
	Activities (Specify)	

 Item
 Cl
 LI
 SW
 SL
 Total

 Approx.Hrs
 12
 06
 01
 05
 24

Course Outcome (CO)	Soggion Outcomog(SOg)	LaboratoryInstr	ClassroomInstruction(CI)	Solf Looming(SL)
Course Outcome (CO)	SessionOutcomes(SOS)	Laboratorynistr	Classrooministruction(C1)	Self-Learning(SL)
		uction(L1)		
CO5 02BC101 5. Approise	SO51 Define the concent of	T 15 1	TI: 4 X7	SI 5.1 loom about
the relationship between	SUS.1 Define the concept of	LI5.1 Demonstration of	Unit-V CI5.1 Transport of Molecules	SL5.1 learn about
the relationship between	transport of molecules in the cen		Active and massive	basic concept
principles molecular transport,		memorane	Active and passive	transport of
cell junction and cell		transport		molecules
signating in Cell and Cellular				
components.	SO52 Able to execute role of	1 15 2	CI52 diffusion Group	SI 5 2 Review concept
	diffusion and group translocation	Demonstration of	translocation	of diffusion and group
	unrusion and group transfocation	Diffusion	transiocation,	translocation
	SOF 3 Apply the role of		CI5.2 Jonophore	SI 5 2learn how to
	sos.s Apply the role of	LI5.2 Demonstration of	C15.5 Ionophore.	SL5.Slearn now to
	tonophore and memorane protein	Demosis		worke
		OSIIIOSIS		WOIKS.
	SO5.4 Evaluate the role of cell		CI5.4 Membrane proteins,	
	junctions.			
	SO5.5 Assess the molecular		CI5.5 Cell Junctions,	
	mechanism of signal transduction			
	pathways			
	SO5.6 Apply the role of		CI5.6 Molecular mechanism	SL5.4 Learn about
	PKC,PLC, GPCR		of signal transduction pathways	signalling pathways
	SO5.7 Apply the role of PKC,		СІ5.7 РКС,	
	SO5.8 Apply the role of PLC,		CI5.8 PLC	
	SO5.9 Apply the role of GPCR		CI5.9 GPCR	
	SO5.10 Explore about Signalling		CI5.10 Insulin Glucagon	
	pathways		signalling	
	SU5.11 Elaborate the role of		CI5.11 Endotoxins	
	endotoxins			
	SU5.12 Elaborate the role of		CI5.12 exotoxins.	SL5.5 Learn about
	exotoxins			toxins

Suggested Sessional	SW5.1 Assignments	Explain general mechanism of cell signalling pathways.
Work (SW): anyone	SW5.2 Mini Project	Describe the various components and types of membrane transport
	SW5.3 Other	Prepare one model for showing mechanism of cell signalling
	Activities (Specify)	

Course duration (in hours) to attain Course Outcomes:

Course Title: General Bioc		Course Code:02BC101					
Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours		
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)		
CO1-02BC101.1: Understanding of the components of	12	6	5	1	24		
biological systems, significant functional groups, pH and buffers, and proteins.							
CO2-02BC101.2: Learning in-depth information regarding the	12	6	5	1	24		
composition and characteristics of numerous categories of							
carbohydrates.							
CO3-02BC101.3: Recognize various concepts related the	12	6	5	1	24		
structure, characteristics, function and biological role of							
nucleic acids and central dogma.							
CO4-02BC101.4: Assess various concepts related the	12	6	5	1	24		
structure, characteristics, function and biological role of							
different types of lipids.							
CO5-02BC101.5: Appraise the relationship between principles	12	6	5	1	24		
molecular transport, cell junction and cell signaling in Cell and							
Cellular components.							
Total Hours	60	30	25	05	120		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: General Biochemistry

Course Code:02BC101

Course Outcomes					
	Α	An	Е	С	Total Marks
CO1-02BC101.1: Understanding of the components of biological systems, significant functional groups, pH and buffers, and proteins.	2	1	1	1	5
CO2-02BC101.2: Learning in-depth information regarding the composition and characteristics of numerous categories of carbohydrates.	2	4	2	2	10
CO3-02BC101.3: Recognize various concepts related the structure, characteristics, function and biological role of nucleic acids and central dogma.	3	5	5	2	15
CO4-02BC101.4: Assess various concepts related the structure, characteristics, function and biological role of different types of lipids.	2	3	3	2	10
CO5-02BC101.5: Appraise the relationship between principles molecular transport, cell junction and cell signaling in Cell and Cellular components.	5	4	1	0	10
Total Marks	14	17	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Biochemistry by G. Zubey.
2	Biochemistry, D. Freifilder, W.H. Freeman & Company.
3	Harper's Biochemistry, Murray et al., Mc Graw Hill.
4	Principles of Biochemistry, Lehininger, Nelson and Cox.
5	Clinical Biochemistry by MN Chaterji and Rana Shinde

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Hons Biotechnology

Semester: I Semester

Course Title: General Biochemistry **Course Code:** 02BC101

Course Outcome (Cos)		Program Outcomes (POs)									Program Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02BC101.1: Understanding of the components of biological systems, significant functional groups, pH and buffers, and proteins.	1	1	2	2	3	1	2	3	2	1	2	3	2	2	2
CO2-02BC101.2: Learning in-depth information regarding the composition and characteristics of numerous categories of carbohydrates.	1	1	1	1	2	1	2	2	1	2	2	2	2	3	2
CO3-02BC101.3: Recognize various concepts related the structure, characteristics, function and biological role of nucleic acids and central dogma.	1	1	2	2	1	1	1	1	2	1	2	2	1	2	1
CO4-02BC101.4: Assess various concepts related the structure, characteristics, function and biological role of different types of lipids.	1	1	2	1	2	1	2	2	2	2	1	3	1	2	1
CO5-02BC101.5: Appraise the relationship between principles molecular transport, cell junction and cell signaling in Cell and Cellular components.	1	1	2	1	1	1	1	1	1	2	2	3	1	2	1

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
PO 1,2,3,4,5, 6,	CO1-02BC101.1: Understanding of the	SO1.1 SO1.2	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4,	1SL-1,2,3,4,5
7,8,9,10,11, 12	components of biological systems, significant	SO1.3 SO1.4		1.5, 1.6, 1.7, 1.8,	
	functional groups, pH and buffers, and proteins.	SO1.5 SO1.6		1.9, 1.10, 1.11,	
PSO 1,2,3		SO1.7 SO1.8		1.12	
		SO1.9 SO1.10			
		SO1.11 SO1.12			
PO 1,2,3,4,5, 6,	CO2-02BC101.2: Learning in-depth	SO2.1 SO2.2	2.1, 2.2, 2.3,	2.1, 2.2, 2.3, 2.4,	2SL-1,2,3,4,5
7,8,9,10,11, 12	information regarding the composition and	SO2.3 SO2.4		2.5, 2.6, 2.7, 2.8,	
	characteristics of numerous categories of	SO2.5 SO2.6		2.9, 2.10, 2.11,	
PSO 1,2,3	carbohydrates.	SO2.7 SO2.8		2.12	
		SO2.9 SO2.10			
		SO2.11 SO2.12			
PO 1,2,3,4,5, 6,	CO3-02BC101.3: Recognize various concepts	SO3.1 SO3.2	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4,	3SL-1,2,3,4,5
7,8,9,10,11, 12	related the structure, characteristics, function	SO3.3 SO3.4		3.5, 3.6, 3.7, 3.8,	
	and biological role of nucleic acids and central	SO3.5 SO3.6		3.9, 3.10, 3.11,	
PSO 1,2,3	dogma.	SO3.7 SO3.8		3.12	
		SO3.9 SO3.10			
		SO3.11 SO3.12			
PO 1,2,3,4,5, 6,	CO4-02BC101.4: Assess various concepts	SO4.1 SO4.2	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4,	4SL-1,2,3,4,5
7,8,9,10,11, 12	related the structure, characteristics, function	SO4.3 SO4.4		4.5, 4.6, 4.7, 4.8,	
	and biological role of different types of lipids.	SO4.5 SO4.6		4.9, 4.10, 4.11,	
PSO 1,2,3		SO4.7 SO4.8		4.12	
		SO4.9 SO4.10			
		SO4.11 SO4.12			
PO 1,2,3,4,5, 6,	CO5-02BC101.5: Appraise the relationship	SO5.1 SO5.2	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4,	5SL-1,2,3,4,5
7,8,9,10,11, 12	between principles molecular transport, cell	SO5.3 SO5.4		5.5, 5.6, 5.7, 5.8,	
	junction and cell signaling in Cell and Cellular	SO5.5 SO5.6		5.9, 5.10, 5.11,	
PSO 1,2,3	components.	SO5.7 SO5.8		5.12	
		S05.9 SO5.10			
		SO5.11 SO5.12			

Program Name	B.Sc. (HONS.) BIOTECHNOLOGY -								
Semester	Ι								
CourseCode:	02MB101	2MB101							
Coursetitle:	Basics of Microbiology Curriculum Developer: Mrs. Maahi Choure, Guest Faculty								
Pre-requisite:	To understand and work effectively in microbiology, especially when preparing consortia as you described, it's important to have a strong foundation in the basics of microbiology.								
Rationale:	Understanding the basics of microbiology, including microbial classification, cell structure, metabolism, genetics, and laboratory techniques, is essential to effectively study and manipulate microorganisms. This foundation enables accurate identification, cultivation, and utilization of microbes for various applications, such as creating beneficial consortia, ensuring experimental accuracy, and maintaining laboratory safety.								
CourseOutcomes (COs):	 CO1-02MB101.1: Understand the role and infections and their implications. CO2-02MB101.2: Describe the morphology, p by S. aureus and M. tuberculosis. CO3-02MB101.3: Explain the morphology, pa gonorrhoeae. CO4-02MB101.4: Identify the major viral pat and symptoms. CO5-02MB101.5: Recognize the morphology Dermatophytoses and Malaria. 	significance of normal microflora in the human body and recognize various nosocomial pathogenesis, and symptoms of major gram-positive bacterial infections such as those caused athogenesis, and symptoms of key gram-negative bacterial pathogens, including E. coli and N. chogens, including Picornaviruses and Retroviruses, and understand their disease mechanisms gy and clinical manifestations of significant fungal and protozoan infections, such as							

Scheme of Studies:

Board of Study	CourseCode	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)	
Minor	02MB101	Basics of microbiology	4	4	1	2	11	4+2=6	

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

				-	Progressive A	ssessment (PRA)			
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02MB101	Basics of Microbiology	15	20	5	5	5	50	50

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)									
				Progressive Assessment (PRA)									
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)				
Minor	02MB101-L	Basics of Microbiology	35	5	5	5	50	50	100				

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Approximate	eHours					
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	12	06	01	02	21
achievement of Course Outcomes (COs) upon the course's conclusion.	-						

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-02MB101.1: Understand the role and significance of normal	SO1.1 Overview of microbiology, its history, and major milestones.	LI1.1 Learn how to handle pathogens	CI1.1 Overview of microbiology, its history, and major milestones.	SL1.1 Remember Carriers in Disease Transmission
human body and recognize various	SO1.2 Key contributions of historical figures.	LI1.2Learn about basic instrumentation	CI1.2 Key contributions of historical figures.	SL1.2 Explore micro flora of university
nosocomial infections and their implications.	SO1.3 Overview of microbial taxonomy	LI1.3learn sterilization	CI1.3 Overview of microbial taxonomy	
	SO1.4 Introduction to molecular techniques in taxonomy.		CI1.4 Introduction to molecular techniques in taxonomy.	
	SO1.5 Understanding evolutionary relationships.		CI1.5 Understanding evolutionary relationships.	
	SO1.6 Study of modern classification systems.		CI1.6 Study of modern classification systems.	
	SO1.7 Discussion on various classification criteria.		CI1.7 Criteria in Microbial Taxonomy	
	SO1.8 Timeline of microbial evolution		CI1.8 Evolutionary History	
	SO1.9 Exploration of microbial diversity through history.		CI1.9 Microbial Diversity	
	SO1.10 Famous experiments and their impacts on microbiology		CI1.10 Case Studies on microbiology	
	SO1.11 Review Session		CI1.11 Summary and Q&A on key topics.	
	SO1.12 Interactive session to assess understanding and discuss future trends.		CI1.12 Assessment and Discussion	

Suggested Sessional	SW1.1 Assignments	Summarizes the Analysis on Septic Shock.				
Work (SW):anyone	SW1.2Mini Project	DemonstrateTypes and Mechanisms of Toxins.				
	SW1.3 Other Activities (Specify)	Documentation of instruments used in microbiology				

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	6	1	2	21

Course	SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction (CI)	Self Learning (SL)				
Outcome								
(CO)								
CO2-02MB101.2:	SO2.1 Overview of microbial	LI2.1 Preparation of cotton	CI2.1 Introduction to Microbial	SL2.1 Research on M.				
Describe the	diversity.	plug	Diversity	tuberculosis				
morphology,	SO2.2 Prokaryotic vs. Eukaryotic	LI2.2 Preparation of NAM	CI2.2 Prokaryotic vs. Eukaryotic	SL2.2 Case Study on C.				
pathogenesis, and	Cells: Key differences and	media	Cells	diphtheriae				
symptoms of major	characteristics.			-				
gram-positive	SO2.3 Bacterial Morphology:	LI2.3Preparation of NBM	CI2.3 Bacterial Morphology					
bacterial infections	Structure and function.	media						
such as those caused	SO2.4 Algae and Fungi:		CI2.4 Algae and Fungi					
by S. aureus and M.	Characteristics and significance.							
tuberculosis.	SO2.5 Protozoa: Morphology and		CI2.5 Protozoa					
	role in ecosystems.							
	SO2.6 Viruses: Unique features and		CI2.6 Viruses.					
	life cycles.							
	SO2.7 Microbial Distribution:		CI2.7 Microbial Distribution					
	Environmental factors							
	influencing distribution		CI29 Characterization Techniques					
	SO2.8 Characterization Techniques:		C12.8 Characterization Techniques.					
	diversity							
	SO2 9 Microbial Ecology: Role of		CI2 9 Microbial Ecology					
	microorganisms in ecosystems		C12.9 Wherobian Leology					
	microorganisms in ecosystems.							
	SO2.10 Case Studies: Unique		CI2.10 Case Studies					
	microbial habitats and their							
	inhabitants.							
	SO2.11 Review Session: Summary		CI2.11 Review Session: Summary and					
	and Q&A on key topics.		Q&A on key topics.					
	SO2.12 Assessment and Discussion:		CI2.12 Assessment and Discussion:					
	Interactive session to assess		Interactive session to assess					
	understanding and discuss future		understanding and discuss future					
<u> </u>	researcn.		researcn.					
Suggested Sessional	SW2.1 Assignments	Justity the role of Prevent	Justify the role of Preventive Measures and Chemotherapy.					
Work (SW):anyone	SW2.2Mini Project	Understand the pathoger	nesis of M. leprae.					
	SW2.3 Other Activities (Specify) Remember laboratory diagnosis technique.							

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	6	1	2	21

Course Outcome (CO)			Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning(SL)	
				Instruction(LI)	(CI)		
CO.	3-02MB101.3: Explain	the	SO3.1 Importance of cultivating	LI3.1 Perform gram	CI3.1 Introduction to	SL3.1Practice local	
mor	phology, pathogenesis,	and	microorganisms.	staining, spore staining	Cultivation	alignment	
sym	ptoms of key gram-nega	ative	SO3.2 Different nutritional	LI3.2 Perform	CI3.2 Nutritional Categories	SL3.2Practice global	
bact	erial pathogens, includin	ng E.	needs of microorganisms.	negative staining,		alignment	
coli	and N. gonorrhoeae		SO3.3 Methods for isolating microorganisms	hanging drop	CI3.3 Isolation Techniques		
			SO34 Techniques for purifying	LI3 3 enumeration of	CI3.4 Purification Methods		
			microbial cultures	microorganism- total	CI3.4 I unification Methods		
			merobiar cultures.	& viable count			
			SO35 Mathada for long term		CI3 5 Preservation Techniques		
			preservation		CI3.5 Treservation rechinques		
			preservation.				
			SO3.6 Types of media used for microbial growth		CI3.6 Cultivation Media		
			SO3.7 Factors affecting		CI3.7 Growth Conditions		
			microbial cultivation.				
			SO3.8 Safe handling and		CI3.8 Laboratory Practices		
			maintenance of cultures.				
			SO3.9 Understanding the		CI3.9 Microbial Growth		
			growth curve.		Phases		
			SO3.10 Case Studies: Successful		CI3.10 Case Studies: Successful		
			cultivation of challenging		cultivation of challenging		
			microorganisms.		microorganisms.		
			SO3.11 Review Session:		CI3.11 Review Session:		
			Summary and Q&A on key		Summary and Q&A on key		
			topics.		topics.		
			SO3.12 Assessment and		CI3.12 Assessment and		
			Discussion: Interactive		Discussion: Interactive session		
			session to assess		to assess understanding and		
			understanding and discuss		discuss advanced techniques.		
			advanced techniques.				
	Suggested Sessional	SW3	.1 Assignments	Write about Local and	Write about Local and global alignment.		
	Work (SW): anyone	SW3	.2 Mini Project				
	Γ	rita lab and there find alignment me	ethods.				

									Item	Cl	LI	SW	SL	Total
									Approx.Hrs	12	6	1	2	21
Course Outcome (CO)	Session Outcomes(S	Os)	Labor	atory	(Classro	oom Inst	ruct	ion(CI)	Self	-Lea	rning	(SL)	
			Instru	iction(LI)										
CO4-02MB101.4: Identify	SO4.1 Basic cor	ncepts and	LI4.1	Determination	of (CI4.1	Introduc	ction	to Microbia	al SL4	.1 I	Learn	tech	niques
the major viral pathogens,	, importance.		ba	cterial cell size l	ŊУ	Gro	owth				of pr	eventi	ve mea	asures
including Picornaviruses and	1		m	icrometry										
Retroviruses, and understand	SO4.2 Phases of	microbial	LI4.2	Method of isolation	on (CI4.2	Growth	Curv	ve Analysis	SL4	.2 U	Jnders	tand	
their disease mechanisms and	growth.		of	bacteria from soil						sym	otoms	of va	rious di	seases
symptoms.	SO4.3 Generation	Time:	LI4.3	Methods of isolation	on (CI4.3	Generati	ion	Time	e:				
	Calculating and	understanding	of bac	teria from air		Cal	lculating	and	understandin	g				
	its significance.	~ .				its	significan	nce.						
	SO4.4 Batch and	Continuous			0	CI4.4	Batch	and	1 Continuou	S				
	Culture: Met	hods and				Cu	lture:	M	ethods an	a				
	applications.					app CT4 5	Magazina	•	t Tashnisusa					
	s04.5 Methods	o measure			ľ	(14.5	Measure	emer	it rechniques					
	SO4 6 Environment	al and			- (CI4 6	Factors	Δffe	cting Growth					
	nutritional factor				Ì		1 actors 1	7 1110	etting Growth					
	SO4.7 Overview	of microbial			(CI4.7	Metabol	lic Pa	athways					
	metabolism.						1.10000001		and the ages					
	SO4.8 Integration	of catabolic			(CI4.8	Amphi-c	catal	oolic Pathways					
	and biosynthetic	pathways.					ľ		2					
	SO4.9 Mechanisms	and			(CI4.9 Bacterial Reproduction								
	processes.								_					
	SO4.10 Endospores	and			CI4.10 Endospores and				d					
	Sporulation: Fo	rmation and				Spo	orulation:	: F	formation an	d				
	significance					sig	nificance							
	SO4.11 Review	Session:			0	CI4.11	Review	Ses	sion: Summar	У				
	Summary and C	Q&A on key				and	l Q&A or	n key	v topics.					
	topics.					01440			1.5.	_				
	SO4.12 Assessment	and			0	CI4.12	Assessm	nent	and Discussion	1:				
	Discussion: Inter	active session				Inte	eractive	sess	ion to asses	S				
	to assess under	standing and			understanding and discuss			s						
Suggested Seguenal	SW4 1 Assignments	Mrite about I	Marah	alogy and Dathagana		auv		pics.						I
Work (SW). anyong	SW4.1 Assignments	Documentation	on of of	baractoristic of basts	515 C	лпер	es virus.							
work (Sw). unyone	SW4.2 IVIIII Project	Documentation of characteristic of bacteria												
	Activities (Specify)	Search and le	arn via	1 out use now to tal	ke Pi	revent	ive ivleasi	ures	and chemothe	егару т	orth	e Pap	Jva vi	us.
	Activities (specify)													

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	6	1	2	21

Course Outcome	Session Outcom	es(SOs)	s(SOs) Laboratory			n	Self-		
(CO)				Instruction(LI)	Instruction	CI)	Learning(SL)		
CO5-02MB101.5: Recogni	ze SO5.1 Introduction	on to Microbial	LI5.1	Isolation of bacteria	CI5.1 Introducti	on to	SL5.1Learn how		
the morphology and clinic	cal Control: Importanc	e and methods.			Microbial Contro	: Importance	Chemotherapy for		
manifestations of significa	int Go zo II				and methods.	~ .	Systemic Infections		
fungal and protozo	an SO5.2 Heat,	radiation, and	L15.2	Biochemical	CI5.2 Physical	Control	SL5.2 Classify all Fungal		
infections, such	as filtration.		charact	erization of bacteria	Methods		and Protozoan		
Dermatophytoses and Malari	a.			T 1			Infections		
	SO5.3 Disinfecta	nts and antiseptics	LI5.3	Identification	CI5.3 Chemical	Control			
	SO5 1 Antibiotic	and their	charact	erization of bacteria	CI54 Chamatha	rapoutic			
	mechanisms	s and uten			Agents	apeutie			
	SO5.5 Bacterial	pollutants and			CI5.5 Water Mi	robiology			
	indicators.	r							
	SO5.6 Coliforms	and Non-			CI5.6 Coliforms	and Non-			
	coliforms: Detectio	n and significance.			coliforms: Det	ection and			
					significance.				
SO5.7 Sewage		Composition and			CI5.7 Sewage	Composition			
Disposal: M		and importance.			and Disposal:	Aethods and			
SOF 9 Each		Microbiology			importance.	Mianahialaan			
	Microorganisms in	n food production			Microorganisms	in food			
	and spoilage.	i lood production			production and spo	ilage.			
	SO5.9 Foodborne	e Infections and			CI5.9 Foodborn	e Infections			
	Intoxications: Caus	es and prevention			and Intoxications:	Causes and			
		-			prevention				
	SO5.10 Food Pres	servation Methods:			CI5.10 Food	Preservation			
	Techniques and app	plications.			Methods: Tech	niques and			
		· · ·			applications.				
	SO5.11 Microorga	inisms in			CI5.11 Fermented	l Foods:			
	SO5 12 Assessment	nt and Discussion:			CI5 12 Assessme	at and			
	Interactive sess	in and Discussion.			Discussion: Interac	tive session to			
	understanding and	d discuss control			assess understandi	and discuss			
methods.					control methods.	ig und diseuss			
Suggested Sessional	SW5.1 Assignments	Write aboutTreat	ment Str	ategies for Fungal and	Protozoan Infections				
Work (SW): anyone	SW5.2 Mini Project								
	SW5.3 Other	Try to learn and a	pply pre	ventive Measures and C	hemotherapy for Ma	aria.			
	Activities (Specify)	(Specify)							

Course duration (in hours) to attain Course Outcomes:

Course Title:Medical Microbiology

Course Code:

Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-02MB101.1: Understand the role and significance of normal microflora in the human body and recognize various nosocomial infections and their implications.	12	6	2	1	21
CO2-02MB101.2: Describe the morphology, pathogenesis, and symptoms of major gram-positive bacterial infections such as those caused by S. aureus and M. tuberculosis.	12	6	2	1	21
CO3-02MB101.3: Explain the morphology, pathogenesis, and symptoms of key gram-negative bacterial pathogens, including E. coli and N. gonorrhoeae.	12	6	2	1	21
CO4-02MB101.4: Identify the major viral pathogens, including Picornaviruses and Retroviruses, and understand their disease mechanisms and symptoms.	12	6	2	1	21
CO5-02MB101.5: Recognize the morphology and clinical manifestations of significant fungal and protozoan infections, such as Dermatophytoses and Malaria.	12	6	2	1	21
Total Hours	60	30	10	05	105

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: basics of microbiology

Course Code:

Course Outcomes		n			
	Α	An	Ε	С	Total Marks
CO1-02MB101.1: Understand the role and significance of normal microflora in the human body	02	03	04	1	10
and recognize various nosocomial infections and their implications.					
CO2-02MB101.2: Describe the morphology, pathogenesis, and symptoms of major gram-	03	04	02	1	10
positive bacterial infections such as those caused by S. aureus and M. tuberculosis.					
CO3-02MB101.3: Explain the morphology, pathogenesis, and symptoms of key gram-negative	02	05	02	1	10
bacterial pathogens, including E. coli and N. gonorrhoeae.					
CO4-02MB101.4: Identify the major viral pathogens, including Picornaviruses and Retroviruses,	02	05	02	1	10
and understand their disease mechanisms and symptoms.					
CO5-02MB101.5: Recognize the morphology and clinical manifestations of significant fungal	03	04	03	1	11
and protozoan infections, such as Dermatophytoses and Malaria.					
Total Marks	12	21	13	05	51

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details		
1	Essentials of Medical Microbiology Sastry Apurba S, Bhat Sand	dhyaJaypee Brothers Medical Publishers	2020
2	Medical Microbiology RajanMJP Publishers 2021		

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Research lab (BSL-1)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc.(Hons) Biotechnology Semester: I Course Title: Basics of Microbiology Course Code:

					CO/P	O/PSO	Mappin	g							
Course Outcome (Cos)					Pro	gram O	utcome	es (POs)					Prog	gram Spe	cific
						201		-	-	2010			Out	comes (Pa	SUS)
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02MB101.1: Understand the															
role and significance of normal															
microflora in the human body and	-	-	-	1	2	2	1	-	1	2	2	3	3	3	1
recognize various nosocomial															
infections and their implications.															
CO2-02MB101.2: Describe the															
morphology, pathogenesis, and															
symptoms of major gram-positive							2		2	2	2	2	1	1	2
bacterial infections such as those	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
caused by S. aureus and M.															
tuberculosis.															
CO3-02MB101.3: Explain the															
morphology, pathogenesis, and															
symptoms of key gram-negative	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
bacterial pathogens, including E. coli															
and N. gonorrhoeae.															
CO4-02MB101.4: Identify the major															
viral pathogens, including															
Picornaviruses and Retroviruses, and	-	1	1	-	2	2	2	3	-	1	-	-	1	2	3
understand their disease mechanisms															
and symptoms.															
CO5-02MB101.5: Recognize the															
morphology and clinical															
manifestations of significant fungal	1	1	1	-	-	2	3	3	1	2	2	2	1	-	2
and protozoan infections, such as															
Dermatophytoses and Malaria.															

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
	CO1-02MB101.1: Understand the role and	SO1.1 SO1.2	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4, 1.5,	
PO 4,5,6	significance of normal microflora in the	SO1.3 SO1.4		1.6, 1.7, 1.8, 1.9,	
7,9,10,11,12	human body and recognize various	SO1.5 SO1.6		1.10, 1.11, 1.12	161 1 2
	nosocomial infections and their	SO1.7 SO1.8			13L-1,2
PSO 1,2, 3	implications.	SO1.9 SO1.10			
		SO1.11 SO1.12			
	CO2-02MB101.2: Describe the	SO2.1 SO2.2	2.1, 2.2, 2.3,	2.1, 2.2, 2.3, 2.4, 2.5,	
PO 7 9 10 11 12	morphology, pathogenesis, and symptoms	SO2.3 SO2.4		2.6, 2.7, 2.8, 2.9,	
107,5,10,11,12	of major gram-positive bacterial infections	SO2.5 SO2.6		2.10, 2.11, 2.12	261 1 2
	such as those caused by S. aureus and M.	SO2.7 SO2.8			Z3L-1,Z
PSU 1,2, 3	tuberculosis.	SO2.9 SO2.10			
		SO2.11 SO2.12			
	CO3-02MB101.3: Explain the morphology,	SO3.1 SO3.2	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4, 3.5,	
PO 2,3,4,	pathogenesis, and symptoms of key gram-	SO3.3 SO3.4		3.6, 3.7, 3.8, 3.9,	
7,9,10,11,12	negative bacterial pathogens, including E.	SO3.5 SO3.6		3.10, 3.11, 3.12	351-1.2
	coli and N. gonorrhoeae.	SO3.7 SO3.8			JJL-1,2
PSO 1,2, 3		SO3.9 SO3.10			
		SO3.11 SO3.12			
	CO4-02MB101.4: Identify the major viral	SO4.1 SO4.2	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4, 4.5,	
PO 2,3,5,6	pathogens, including Picornaviruses and	SO4.3 SO4.4		4.6, 4.7, 4.8, 4.9,	
7,8,10,11,12	Retroviruses, and understand their disease	SO4.5 SO4.6		4.10, 4.11, 4.12	151-1 2
	mechanisms and symptoms.	SO4.7 SO4.8			+3L-1,2
PSO 1,2, 3		SO4.9 SO4.10			
		SO4.11 SO4.12			
	CO5-02MB101.5: Recognize the	SO5.1 SO5.2	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5,	
PO 1,2,3,6	morphology and clinical manifestations of	SO5.3 SO5.4		5.6, 5.7, 5.8, 5.9,	
7,8,9,10,11,12	significant fungal and protozoan infections,	SO5.5 SO5.6		5.10, 5.11, 5.12	5SL-1
	such as Dermatophytoses and Malaria.	SO5.7 SO5.8			
PSO 1, 2, 3		S05.9 SO5.10			
		SO5.11 SO5.12			

Program Name	Bachelor of Science (Hons.) Biotechnology	chelor of Science (Hons.) Biotechnology						
Semester	Ι							
CourseCode:	03BC101	BC101						
Coursetitle:	General Biochemistry	General Biochemistry Curriculum Developer: Mrs. Pratima Mishra, Guest Faculty						
Pre-requisite:	Students should have basic knowledge of Biolo	tudents should have basic knowledge of Biology and Chemistry						
Rationale:	For a successful biotechnologist is it essenti physiological components of biological world. biochemistry that will build upon the founda theoretical concepts and techniques of bioche Microbiology. The practical component will ai these areas.	or a successful biotechnologist is it essential to learn about basic concepts of those molecules which governs the anatomical and any siological components of biological world. This course aims to provide students with a depth of knowledge of a number of topics in ochemistry that will build upon the foundations established in earlier subjects. The main themes to be explored are, the advanced accretical concepts and techniques of biochemistry and molecular biology that underpin the developments of molecular sciences and licrobiology. The practical component will aim to make the students highly competent in several experimental and research techniques in these areas.						
Course Outcomes (COs):	CO1-03BC101.1: Understanding of the compone CO2-03BC101.2: Learning in-depth information CO3-03BC101.3: Recognize various concepts rel CO4-03BC101.4: Assess various concepts related CO5-03BC101.5: Appraise the relationship betw	ents of biological systems, significant functional groups, pH and buffers, and proteins. regarding the composition and characteristics of numerous categories of carbohydrates. ated the structure, characteristics, function and biological role of nucleic acids and central dogma. d the structure, characteristics, function and biological role of different types of lipids. yeen principles molecular transport, cell junction and cell signaling in Cell and Cellular components.						

Scheme of Studies:

Board of Study Co		CourseTitle						
	Course Code		Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)
Generic Elective	03BC101	General Biochemistry	3	2	1	5	11	3+1=4

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

			Scheme of Assessment (Marks)									
					Progressive Ass	essment (PRA)						
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)			
Generic Elective	03BC101	General Biochemistry	15	20	10	5	50	50	100			

Scheme of Assessment: Practical

					nent (Marks)				
					Progressive A	ssessment (PRA)	-		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03BC101-L	General Biochemistry	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and	ApproximateHours						
session levels, which students are anticipated to accomplish through various modes of			-				
instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional		Item	Cl	LI	SW	SL	Total
Work (SW), and Self Learning (SL). As the course progresses, students should showcase		Approx.Hrs	09	04	01	05	19
their mastery of Session Outcomes (SOs), culminating in the overall achievement of							
Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-03BC101.1: Understanding of the components of biological systems, significant functional groups, pH and buffers, and proteins	SO1.1 Define and Describe concept of pH and Buffer	LI1.1 Calibration of pH meter and preparation of buffer	Unit 1 CI1.1 Concept of pH and buffers pKa,	SL1.1 Search various reference books and study material to start the learning
	SO1.2 Describe about Henderson- Hasselbalch equation		CI1.2 Henderson– Hasselbalch equation, Water	SL1.2 Check the properties of water and buffers
	SO1.3 Explain about amino acids and its classification	LI1.2 Identification of amino acids	CI1.3 Amino Acids: Classification	SL1.3 Learn about various categories of amino acids
	SO1.4 Describe structure & Properties of amino acids		CI1.4 structure and properties	SL1.4 Enlist the structure and properties of different amino acids and their role
	SO1.5 Study the different types of amino acids		CI1.5 unusual and modifies amino acids,	
	SO1.6 Study of peptides.		CI1.6 peptides,	
	SO1.7 Describe concept of Zwitter ion		CI1.7 Isoelectric point, Zwitter ion,	
	SO1.8 Assess the concept of proteins		CI1.8 Proteins: Classification,	SL1.5 Enlist the structure and properties of different proteins and their role
	SO1.9 Describe structure and function of proteins		CI1.9 structure and functions	

Suggested Sessional	SW1.1 Assignments	Describe in detail pH, buffer and water
Work (SW):anyone	SW1.2Mini Project	Draw structure of various types of amino acids
	SW1.3 Other Activities (Specify)	Collect the data about biological role of proteins and their deficiencies.

				Item		Cl	LI	SW	SL	Total
				Appro	ox.Hrs	09	04	01	05	19
Course	Session Outcomes	Laboratory Instruction (LI)	Classroom Instruction		Self L	earnin	g (SL	.)		
Outcome (CO)	(SOs)		(CI)							
CO2-03BC101.2: Learning	SO2.1 Assess the concept of	LI2.1 Identification of	Unit-II		SL2.1	Enlist	t	he	differ	ent
in-depth information	carbohydrate	carbohydrate	CI2.1 Carbohydrate:		propert	ies of c	arbol	nydrat	es	
regarding the composition			Classification, struct	ure						
and characteristics of										
carbohydrates.										
	SO2.2 Explain about		CI2.2 Properties	and	SL2.2	Asses	s bio	logica	l role	of
	properties and function of carbohydrate		Function		carboh	ydrate				
	SO2.3 Explain about monosaccharides	LI2.2 Identification of reducing sugars	CI2.3 Aldoses, ke monosaccharide	etoses	SL2.3 functio	Learn on of m	s ionos	tructu: acchai	re a ride	and
	SO2.4 Explain about disaccharides and polyasccharides		CI2.4 disaccharides, polysaccharides		SL2.4 function	Learn on of o	s igosa	tructu	re a ide	and
	SO2.5 Describe the role of hetero polysaccharides		CI2.5 Glycosaminogly homo and H polysaccharides,	cans, letero	SL2.5 function	Le on of p	arn olysa	struct cchari	ture de	and
	SO2.6 Describe structure and		CI2.6 Starch, Glyce	ogen,						
	function of starch, glycogen,		Chitin,							
	chitin									
	SO2.7 Describe biological		CI2.7 Cellulose,							
	role of cellutose,		Peptidoglycan, Hepa	rin.						
	peptidoglycan, heparin				ļ					
	SO2.8 Describe properties of		CI2.8 Optical act	ivity,						
	monoasccharides		mutarotation,							
	SO2.9 Assess the concept of		CI2.9 oxidation	of						
	oxidation of monoasccharides		monosaccharides							

Suggested Sessional	SW2.1 Assignments	Describe in detail various types of carbohydrate and their biological role.					
Work (SW) :anyone	SW2.2 Mini Project	Detection of carbohydrate in different food products and living organisms					
	SW2.3 Other Activities (Specify)	Develop methods for qualitative and quantitative detection of carbohydrates.					

Item	Cl	LI	SW	SL	Total	
Approx.Hrs	09	02	01	05	17	

Course Outcome (CO	0)	Session Outo	comes(SOs)	Laboratory Instruction(LI)	Class 1 (CI)	room Instruction	Self-Learning(SL)
CO3-03BC101.3: Recognize various concepts related the structure, characteristics, function and biological role of		SO3.1 Expland structure	ain the concept of Nucleic acid.		Unit CI3.1 Str nuc	t-III Nucleic Acids: ructure of cleotides.	SL3.1 Read about various types of nucleic acids and its derivatives.
nucleic acids and centra	al dogma.	SO3.2 A structure an RNA and DN	ssessing the ad function of IA	SL3.1 Isolation of DNA	CI3.2 and	Structure of RNA d DNA	SL3.2 Illustrate structure of different types of DNA and RNA
		SO3.3 Expla of DNA	aining properties		CI3.3 Va Wa mc	properties, riation from atson and Crick odel	SL3.3 Study the variation in DNA structure from Watson and Crick model.
		SO3.4 Assettypes of stru DNA	essing different acture present in		CI3.4 str	Special types of uctures present in NA	
		SO3.5 De hybridization hyperchromic	escribe about a, hypo and c shift		CI3.5	Hybridization,	
		SO3.6 Asset hyperchromic	ssing hypo and c shift		CI3.6 hyj	Hypo and perchromic shift,	SL3.4 Study the mechanism of central dogma
		SO3.7 De concept of Tr	escribe about		CI3.7 Tm.		SL3.5 Study the impact of gene regulation
		SO3.6 Asses	sing the role of		CI3.8 Ce	Concept of ntral Dogma,	SL3.6
		SO3.7 Describe about concept of gene and its regulation			CI3.9 and	Concept of genes d their regulation	SL3.7
Suggested Sessional	SW3.1 A	ssignments	Describe in deta	il structure and function	on of dif	ferent types of nuclei	c acids.
Work (SW): anyone	SW3.2 N	Iini Project	Describe the role	e of nucleic acids in bi	ological	system.	
	SW3.3 C	Other	Prepare a model	for explaining the stru	icture of	DNA and RNA.	
	Activities	s (Specify)	-				

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	05	19

Course Outcome (Co	D) Session Outcomes(SOs)	Laboratory	Classroom Instruction(CI)	Self-Learning(SL)				
		Instruction(L1)						
CO4- 03BC101.4: A	ssess SO4.1		Unit-IV	SL4.1 Learn about				
various concepts re the struc characteristics, fun and biological role	lated Exploring the concept of lipids eture, and their types ction e of		CI4.1 Lipids: Classification,	different classes of lipids				
different types of lipic								
	SO4.2 Assessing role of lipids and its structure	L14.1 Determination of solubility of lipids	C14.2 structure, Types,	SL4.2 Discuss types and structure of lipids				
	SO4.3 Explaining the biological function of lipids	LI4.2 Determination of acid value of lipids	CI4.3 biological functions	SL4.3 Learn about biological function of lipids				
	SO4.4 Explaining the role of oils, fats and waxes		CI4.4 Oils, fats, waxes,					
	SO4.5 Evaluate role of fatty		CI4.5 fatty acids.	SL4.4 Learn about				
	acids, phospholipids		phospholipids,	biological function of fatty acids				
	SO4.6 Describe the impact of Sphingolipids and galactolipids		CI4.6 Sphingolipids, galactolipids,					
	SO4.7 Describe the impact of Sulpholipids		CI4.7 Sulpholipids,	SL4.5 Learn about significance of lipids				
	SO4.8 Describe the impact of Steroids		CI4.8 Steroids					
	SO4.9 Evaluate role of lipids in signal transduction		CI4.9 Lipids in signal transduction					
Suggested Sessional	SW4.1 Assignments	Explain about dif	ferent categories of lipids and the	ir biological role.				
Work (SW): anyone	SW4.2 Mini Project	Describe the varie	ous types of lipids its structure. p	roperties and applications				
· · •	SW4.3 Other Activities (Specify)	Develop methods	Develop methods for qualitative and quantitative detection of lipids					

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	01	01	05	16

Course Outcome (CO)	SessionOutcomes(SOs)	LaboratoryIns truction(LI)	ClassroomInstruction(CI)	Self- Learning(SL)
CO5-03BC101.5: Appraise the relationship between principles molecular transport, cell junction and cell signaling in Cell and Cellular components.	SO5.1 Define the concept of transport of molecules in the cell	LI5.1 Demonstration of membrane transport	Unit-V CI5.1 Transport of Molecules- Active and passive	SL5.1 learn about basic concept transport of molecules
	SO5.2 Able to execute role of diffusion and group translocation		CI5.2 diffusion, Group translocation,	SL5.2 Review concept of diffusion and group translocation
	SO5.3 Apply the role of ionophore and membrane protein		CI5.3 Ionophore. Membrane proteins,	SL5.3learn how to membrane proteins works.
	SO5.4 Evaluate the role of cell junctions.		CI5.4 Cell Junctions,	
	SO5.5 Assess the molecular mechanism of signal transduction pathways		CI5.5 Molecular mechanism of signal transduction pathways	
	SO5.6 Apply the role of PKC,PLC, GPCR		CI5.6 PKC PLC, GPCR	SL5.4 Learn about signalling pathways
	SO5.7 Explore about Signalling pathways		CI5.7 Insulin Glucagon signalling	
	SO5.8 Elaborate the role of endotoxins		CI5.8 Endotoxins	SL5.5 Learn about endotoxins and exotoxins
	SO5.9 Elaborate the role of exotoxins		CI5.9 exotoxins.	

Suggested Sessional	SW5.1 Assignments	Explain general mechanism of cell signalling pathways.
Work (SW): anyone	SW5.2 Mini Project	Describe the various components and types of membrane transport
	SW5.3 Other	Prepare one model for showing mechanism of cell signalling
	Activities (Specify)	

Course duration (in hours) to attain Course Outcomes:

Course Title: General Bioc		Course Code:03BC101					
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)		
CO1-03BC101.1: Understanding of the components of biological systems, significant functional groups, pH and buffers, and proteins.	9	4	5	1	19		
CO2-03BC101.2: Learning in-depth information regarding the composition and characteristics of numerous categories of carbohydrates.	9	4	5	1	19		
CO3-03BC101.3: Recognize various concepts related the structure, characteristics, function and biological role of nucleic acids and central dogma.	9	2	5	1	17		
CO4-03BC101.4: Assess various concepts related the structure, characteristics, function and biological role of different types of lipids.	9	4	5	1	19		
CO5-03BC101.5: Appraise the relationship between principles molecular transport, cell junction and cell signaling in Cell and Cellular components.	9	1	5	1	16		
Total Hours	45	15	25	05	90		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: General Biochemistry

Course Code:03BC101

Course Outcomes					
	Α	An	Е	С	Total Marks
CO1-03BC101.1: Understanding of the components of biological systems, significant functional groups, pH and buffers, and proteins.	2	1	1	1	5
CO2-03BC101.2: Learning in-depth information regarding the composition and characteristics of numerous categories of carbohydrates.	2	4	2	2	10
CO3-03BC101.3: Recognize various concepts related the structure, characteristics, function and biological role of nucleic acids and central dogma.	3	5	5	2	15
CO4-03BC101.4: Assess various concepts related the structure, characteristics, function and biological role of different types of lipids.	2	3	3	2	10
CO5-03BC101.5: Appraise the relationship between principles molecular transport, cell junction and cell signaling in Cell and Cellular components.	5	4	1	0	10
Total Marks	14	17	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Biochemistry by G. Zubey.
2	Biochemistry, D. Freifilder, W.H. Freeman & Company.
3	Harper's Biochemistry, Murray et al., Mc Graw Hill.
4	Principles of Biochemistry, Lehininger, Nelson and Cox.
5	Clinical Biochemistry by MN Chaterji and Rana Shinde

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Hons Biotechnology Semester: I Semester

Course Title: General Biochemistry **Course Code:** 03BC101

Course Outcome (Cos)		Program Outcomes (POs)										Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-03BC101.1: Understanding of the components of biological systems, significant functional groups, pH and buffers, and proteins.	1	1	2	2	3	1	2	3	2	1	2	3	2	2	2
CO2-03BC101.2: Learning in-depth information regarding the composition and characteristics of numerous categories of carbohydrates.	1	1	1	1	2	1	2	2	1	2	2	2	2	3	2
CO3-03BC101.3: Recognize various concepts related the structure, characteristics, function and biological role of nucleic acids and central dogma.	1	1	2	2	1	1	1	1	2	1	2	2	1	2	1
CO4-03BC101.4: Assess various concepts related the structure, characteristics, function and biological role of different types of lipids.	1	1	2	1	2	1	2	2	2	2	1	3	1	2	1
CO5-03BC101.5: Appraise the relationship between principles molecular transport, cell junction and cell signaling in Cell and Cellular components.	1	1	2	1	1	1	1	1	1	2	2	3	1	2	1

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO1-03BC101.1: Understanding of the components of biological systems, significant functional groups, pH and buffers, and proteins.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	1.1,1.2,	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9,	1SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO2-03BC101.2: Learning in-depth information regarding the composition and characteristics of numerous categories of carbohydrates.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	2.1, 2.2,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9,	2SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO3-03BC101.3: Recognize various concepts related the structure, characteristics, function and biological role of nucleic acids and central dogma.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	3.1,	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9,	3SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO4-03BC101.4: Assess various concepts related the structure, characteristics, function and biological role of different types of lipids.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	4.1,4.2	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9,	4SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO5-03BC101.5: Appraise the relationship between principles molecular transport, cell junction and cell signaling in Cell and Cellular components.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 S05.9	5.1,	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	5SL-1,2,3,4,5

Program Name	B.Sc. (HONS.) BIOTECHNOLOGY -					
Semester	Ι					
CourseCode:	03MB101					
Coursetitle:	Basics of Microbiology	Curriculum Developer: Mrs. Maahi Choure, Guest Faculty				
Pre-requisite:	To understand and work effectively in microbiology, especially when preparing consortia as you described, it's important to have a strong foundation in the basics of microbiology.					
Rationale:	Understanding the basics of microbiology, including microbial classification, cell structure, metabolism, genetics, and laboratory techniques, is essential to effectively study and manipulate microorganisms. This foundation enables accurate identification, cultivation, and utilization of microbes for various applications, such as creating beneficial consortia, ensuring experimental accuracy and maintaining laboratory safety.					
CourseOutcomes (COs):	 CO1-03MB101.1: Understand the role and infections and their implications. CO2-03MB101.2: Describe the morphology, p by S. aureus and M. tuberculosis. CO3-03MB101.3: Explain the morphology, pa gonorrhoeae. CO4-03MB101.4: Identify the major viral pat and symptoms. CO5-03MB101.5: Recognize the morphology Dermatophytoses and Malaria. 	significance of normal microflora in the human body and recognize various nosocomial pathogenesis, and symptoms of major gram-positive bacterial infections such as those caused athogenesis, and symptoms of key gram-negative bacterial pathogens, including E. coli and N. hogens, including Picornaviruses and Retroviruses, and understand their disease mechanisms gy and clinical manifestations of significant fungal and protozoan infections, such as				

Scheme of Studies:

					Scheme of	fstudies (Hou	rs/Week)	
Board ofStudy	CourseCode	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)
Generic Elective	03MB101	Basics of Microbiology	3	2	1	2	8	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

				-	Progressive As	ssessment (PRA)			
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03MB101	Basics of Microbiology	15	20	5	5	5	50	50

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)						
					Progressive A	ssessment (PRA)				
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
Generic Elective	03MB101-L	Basics of Microbiology	35	5	5	5	50	50	100	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	02	16

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-03MB101.1: Understand the role and significance of normal	SO1.1 Overview of microbiology, its history, and major milestones.	LI1.1 Learn about Sterilization	CI1.1 Overview of microbiology, its history, and major milestones.	SL1.1 Remember Carriers in Disease Transmission
microflora in the human body and recognize various	SO1.2 Key contributions of historical figures.	LI1.2Learn about basic instrumentation	CI1.2 Key contributions of historical figures.	SL1.2 Explore micro flora of university
nosocomial infections and their implications.	SO1.3 Overview of microbial taxonomy		CI1.3 Overview of microbial taxonomy	
	SO1.4 Introduction to molecular techniques in taxonomy.		CI1.4 Introduction to molecular techniques in taxonomy.	
	SO1.5 Understanding evolutionary relationships.		CI1.5 Understanding evolutionary relationships.	
	SO1.6 Study of modern classification systems.		CI1.6 Study of modern classification systems.	
	SO1.7 Discussion on various classification criteria.		CI1.7 Criteria in Microbial Taxonomy	
	SO1.8 Timeline of microbial evolution		CI1.8 Evolutionary History	
	SO1.9 Exploration of microbial diversity through history.		CI1.9 Microbial Diversity	

Suggested Sessional	SW1.1 Assignments	Summarizes the Analysis on Septic Shock.
Work (SW):anyone	SW1.2Mini Project	DemonstrateTypes and Mechanisms of Toxins.
	SW1.3 Other Activities (Specify)	Documentation of instruments used in microbiology

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	2	1	2	14

Course	SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction (CI)	Self Learning (SL)
Outcome		-		
(CO)				l
CO2-03MB101.2:	SO2.1 Overview of microbial		CI2.1 Introduction to Microbial	SL2.1 Research on M.
Describe the	diversity.		Diversity	tuberculosis
morphology,	SO2.2 Prokaryotic vs. Eukaryotic	LI2.1 Preparation of NAM	CI2.2 Prokaryotic vs. Eukaryotic	SL2.2 Case Study on C.
pathogenesis, and	Cells: Key differences and	and NBM media	Cells	diphtheriae
symptoms of major	characteristics.			·· r ·
gram-positive	SO2.3 Bacterial Morphology:		CI2.3 Bacterial Morphology	
bacterial infections	Structure and function.			
such as those caused	SO2.4 Algae and Fungi:		CI2.4 Algae and Fungi	
by S. aureus and M.	Characteristics and significance.			
tuberculosis.	SO2.5 Protozoa: Morphology and		CI2.5 Protozoa	
	role in ecosystems.			
	SO2.6 Viruses: Unique features and		CI2.6 Viruses.	
	life cycles.			<u> </u>
	SO2.7 Microbial Distribution:		CI2.7 Microbial Distribution	
	Environmental factors			
	influencing distribution			
	SO2.8 Characterization Techniques:		CI2.8 Characterization Techniques.	
	Methods to study microbian			
<u> </u>	diversity.		CIA Missobial Ecology	
	SO2.9 MICrobial Ecology. Kole of		C12.9 Microbial Ecology	
	microorganisms mecosystems.			
Suggested Sessional	SW2.1 Assignments	Justify the role ofPrevent	ive Measures and Chemotherapy.	
Work (SW):anyone	SW2.2Mini Project	Understand the pathoger	nesis of M. leprae.	
	SW2.3 Other Activities (Spec	ify) Remember laboratory dia	agnosis technique.	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	4	1	2	16

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning(SL)
		Instruction(LI)	(CI)	
CO3-03MB101.3: Explain	the SO3.1 Importance of cultivating	LI3.1 Perform gram	CI3.1 Introduction to	SL3.1Practice local
morphology, pathogenesis,	and microorganisms.	staining, spore staining	Cultivation	alignment
symptoms of key gram-nega	ative SO3.2 Different nutritional	LI3.2 Perform	CI3.2 Nutritional Categories	SL3.2Practice global
bacterial pathogens, includin	g E. needs of microorganisms.	negative staining,		alignment
coli and N. gonorrhoeae	SO3.3 Methods for isolating microorganisms.	hanging drop method	CI3.3 Isolation Techniques	
	SO3.4 Techniques for purifying microbial cultures.		CI3.4 Purification Methods	
	SO3.5 Methods for long-term preservation.		CI3.5 Preservation Techniques	
	SO3.6 Types of media used for microbial growth		CI3.6 Cultivation Media	
	SO3.7 Factors affecting microbial cultivation.		CI3.7 Growth Conditions	
	SO3.8 Safe handling and maintenance of cultures.		CI3.8 Laboratory Practices	
	SO3.9 Understanding the		CI3.9 Microbial Growth	
	growth curve.		Phases	
Suggested Sessional	SW3.1 Assignments	Write about Local and	global alignment.	
Work (SW): anyone	SW3.2 Mini Project			
	SW3.3 Other Activities (Specify)	Search and find the am	rita lab and there find alignment m	ethods.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	2	1	2	14

Course Outcome (CO)	Session Outcomes(S	Os)	Laborator Instructio	ory Classroom Instruction(CI) ion(LI)		Self-Learning(SL)						
CO4-03MB101.4: Identify	SO4.1 Basic con	ncepts and	LI4.1 De	etermination	of	CI4.1	Introductio	n to Mic	crobial	SL4.1	Learn	techniques
the major viral pathogens	, importance.		bacteri	ial cell size	by	Gr	owth			of	preventiv	ve measures
including Picornaviruses and	1		micror	metry								
Retroviruses, and understand	I SO4.2 Phases of	microbial				CI4.2	Growth Cu	rve Analysi	is	SL4.2	Underst	and
their disease mechanisms and	l growth.									symptor	ms of vari	ious diseases
symptoms.	SO4.3 Generation	Time:				CI4.3	Generation	l	Time:			
	Calculating and	understanding				Ca	lculating ar	nd understa	anding			
	its significance.					its	significance	•				
	SO4.4 Batch and	Continuous				CI4.4	Batch a	nd Conti	inuous			
	Culture: Me	thods and				Cu	lture: N	Methods	and			
	applications.					apj	olications.					
	SO4.5 Methods	to measure				CI4.5	Measurem	ent Techniq	ques			
	microbial growth	l										
	SO4.6 Environment	al and				CI4.6	Factors Af	fecting Grov	wth			
	nutritional factor	s.										
	SO4.7 Overview	of microbial				CI4.7	Metabolic	Pathways				
	metabolism.											
	SO4.8 Integration	of catabolic				CI4.8	Amphi-cat	abolic Pathy	ways			
	and biosynthetic	pathways.								<u> </u>		
	SO4.9 Mechanisms	and				CI4.9	Bacterial R	eproduction	n			
	processes.											
Suggested Sessional	SW4.1 Assignments	Write about	Morphology	y and Pathoge	enesis	ofHerp	es Virus.					
Work (SW): anyone	SW4.2 Mini Project	Documentati	on of chara	cteristic of bac	cteria							
	SW4.3 Other	Search and le	arn via You	uTube how to	take	Prevent	ive Measure	es and Chem	nother	apy for	the Papo	va Virus.
	Activities (Specify)											

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	3	1	2	15

Course Outcome	Session Outcome	es(SOs)	Labo	ratory	Classroo	m	Self-		
(CO)			Instruc	tion(LI)	Instruction	n(CI)	Learning(SL)		
CO5-03MB101.5: Recognize the morphology and clinical manifestations of significant	SO5.1 Introduction Control: Importance	on to Microbial e and methods.	LI5.1 Charac bacteria	cterization of	CI5.1 Introduct Microbial Contrand methods.	tion to to to: Importance	SL5.1Learn Chemotherapy Systemic Infection	how for s	
fungal and protozoan infections, such as Dermatophytoses and Malaria.	SO5.2 Heat, filtration.	radiation, and			CI5.2 Physical Methods	Control	SL5.2 Classify all I and Prot Infections	Fungal :ozoan	
	SO5.3 Disinfecta	nts and antiseptics			CI5.3 Chemica Methods	l Control			
	SO5.4 Antibiotics mechanisms	and their CI5.4 Chemotherapeutic Agents							
	SO5.5 Bacterial indicators.	pollutants and			CI5.5 Water M	icrobiology			
	SO5.6 Coliforms coliforms: Detection	and Non- n and significance.			CI5.6 Coliform coliforms: De significance.	s and Non- etection and			
	SO5.7 Sewage Disposal: Methods	Composition and and importance.			CI5.7 Sewage and Disposal: importance.	Composition Methods and			
	SO5.8 Food Microorganisms ir and spoilage.	Microbiology: food production			CI5.8 Food Microorganisms production and sp	Microbiology: in food oilage.			
	SO5.9 Foodborne Infections and Intoxications: Causes and prevention		CI5.9 Foodborne Infections and Intoxications: Causes and prevention			ne Infections s: Causes and			
Suggested Sessional SW5.1 Assignme		Write aboutTreat	ment Strategies	for Fungal and Pr	otozoan Infection	S.			
Work (SW): anyone SV	W5.2 Mini Project		0	~					
SV	W5.3 Other	Try to learn and apply preventive Measures and Chemotherapy for Malaria.							

Course duration (in hours) to attain Course Outcomes:

Course Title:Medical Microbiology

Course Code:

Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(U)	Instruction(L1)	(SL)	(SW)	(LI+CI+SL+SW)
CO1-03MB101.1: Understand the role and significance of	9	4	2	1	16
normal microflora in the human body and recognize					
various nosocomial infections and their implications.					
CO2-03MB101.2: Describe the morphology, pathogenesis,	9	2	2	1	14
and symptoms of major gram-positive bacterial infections					
such as those caused by S. aureus and M. tuberculosis.					
CO3-03MB101.3: Explain the morphology, pathogenesis,	9	4	2	1	16
and symptoms of key gram-negative bacterial pathogens,					
including E. coli and N. gonorrhoeae.					
CO4-03MB101.4: Identify the major viral pathogens,	9	2	2	1	14
including Picornaviruses and Retroviruses, and understand					
their disease mechanisms and symptoms.					
CO5-03MB101.5: Recognize the morphology and clinical	9	3	2	1	15
manifestations of significant fungal and protozoan					
infections, such as Dermatophytoses and Malaria.					
Total Hours	45	15	10	05	75

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: basics of microbiology

Course Code:

Course Outcomes					
	А	An	Ε	С	Total Marks
CO1-03MB101.1: Understand the role and significance of normal microflora in the human body	02	03	04	1	10
and recognize various nosocomial infections and their implications.					
CO2-03MB101.2: Describe the morphology, pathogenesis, and symptoms of major gram-	03	04	02	1	10
positive bacterial infections such as those caused by S. aureus and M. tuberculosis.					
CO3-03MB101.3: Explain the morphology, pathogenesis, and symptoms of key gram-negative		05	02	1	10
bacterial pathogens, including E. coli and N. gonorrhoeae.					
CO4-03MB101.4: Identify the major viral pathogens, including Picornaviruses and Retroviruses,	02	05	02	1	10
and understand their disease mechanisms and symptoms.					
CO5-03MB101.5: Recognize the morphology and clinical manifestations of significant fungal		04	03	1	11
and protozoan infections, such as Dermatophytoses and Malaria.					
Total Marks	12	21	13	05	51
Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details	
1	Essentials of Medical Microbiology Sastry Apurba S, Bhat SandhyaJaypee Brothers Medical Publishers	2020
2	Medical Microbiology RajanMJP Publishers 2021	

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Research lab (BSL-1)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc.(Hons) Biotechnology Semester: I Course Title: Basics of Microbiology Course Code:

CO/PO/PSO Mapping															
Course Outcome (Cos)		Program Outcomes (POs)							Program Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-03MB101.1: Understand the role and significance of normal microflora in the human body and recognize various nosocomial infections and their implications.	-	-	-	1	2	2	1	-	1	2	2	3	3	3	1
CO2-03MB101.2: Describe the morphology, pathogenesis, and symptoms of major gram-positive bacterial infections such as those caused by S. aureus and M. tuberculosis.	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
CO3-03MB101.3: Explain the morphology, pathogenesis, and symptoms of key gram-negative bacterial pathogens, including E. coli and N. gonorrhoeae.	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
CO4-03MB101.4: Identify the major viral pathogens, including Picornaviruses and Retroviruses, and understand their disease mechanisms and symptoms.	-	1	1	-	2	2	2	3	-	1	-	-	1	2	3
CO5-03MB101.5: Recognize the morphology and clinical manifestations of significant fungal and protozoan infections, such as Dermatophytoses and Malaria.	1	1	1	-	-	2	3	3	1	2	2	2	1	-	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
PO 4,5,6 7,9,10,11,12	CO1-03MB101.1: Understand the role and significance of normal microflora in the human body and recognize various	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	1.1,1.2,	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9,	161 1 2
PSO 1,2, 3	nosocomial infections and their implications.	SO1.7 SO1.8 SO1.9			15L-1,2
PO 7,9,10,11,12 PSO 1,2, 3	CO2-03MB101.2: Describe the morphology, pathogenesis, and symptoms of major gram-positive bacterial infections such as those caused by S. aureus and M. tuberculosis.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	2.1, ,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9,	2SL-1,2
PO 2,3,4, 7,9,10,11,12 PSO 1,2, 3	CO3-03MB101.3: Explain the morphology, pathogenesis, and symptoms of key gramnegative bacterial pathogens, including E. coli and N. gonorrhoeae.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	3.1,3.2	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9,	3SL-1,2
PO 2,3,5,6 7,8,10,11,12 PSO 1,2, 3	CO4-03MB101.4: Identify the major viral pathogens, including Picornaviruses and Retroviruses, and understand their disease mechanisms and symptoms.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	4.1,	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9,	4SL-1,2
PO 1,2,3,6 7,8,9,10,11,12 PSO 1, 2, 3	CO5-03MB101.5: Recognize the morphology and clinical manifestations of significant fungal and protozoan infections, such as Dermatophytoses and Malaria.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 S05.9	5.1,	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	5SL-1

ABILITY ENHANCEMENT COURSE ON SUSTAINABLE DEVELOPMENT GOALS (SDGs) FOR B.Sc. (HONS) BIOTECHNOLOGY

Course Code:	0SDG102
Course Title :	Sustainable Development Goals (SDGs)
Pre-requisite:	Student should have basic knowledge of Environment, Natural resources, Climate change and sustainability.
Rationale:	To inculcate the knowledge base on sustainable development with a view to balance our economic, environmental and social needs, allowing prosperity for now and future generations. To train students to undertake major initiatives in the efficient management of natural resources and the prevention of environmental pollution with focus on Sustainable Development. To use environmental management tools that help to improve the quality of environment, to assess local vulnerabilities with respect to climate, natural disasters and to achieve sustainable developmental needs.
Course Outcomes:	•

0SDG102.1Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.

- **0SDG102.2:**Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability.
- **0SDG102.3:** Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.
- **0SDG102.4**Develop skills to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.
- **0SDG102.5**:Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes.

Board of					Schen	Scheme of studies(Hours/Week)				
Study			Cl	LI	SW	SL	Total Study Hours	Credits		
	Cours	Course Title					(CI+LI+SW+SL)	(C)		
	eCode									
AEC	0SDG102	Sustainable Development Goal	2	0	1	1	4	2		

Scheme of Studies:

Legend: CI: Class room Instruction (Includes different instructional strategies i.e.Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini projectetc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure out come of Learning.

Scheme of Assessment:

Theory

						Scheme	of Assessmer	nt (Marks)		
Board of Study				Prog		End Semeste	Total Marks			
	Cous e Code	Course Title	Class/Ho me Assignm ent 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Semi nar one (SA)	Class Activit y any one (CAT)	Class Attendanc e (AT)	Total Marks (CA+CT+ SA+CAT +AT)	Assess ment (ESA)	(PRA+ ESA)
AEC	0SDG 102	Sustaina ble Develop ment Goal	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

0SDG102.1Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.

Арр	proximate Hours
Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes	Laborat	Classroom Instruction	Self
(SOs)	ory	(CI)	Learning
	Instruct		(SL)
	ion		
	(LI)		
SO1.1Understand about Sustainable		Unit-1.0 Introduction to	
Development		Sustainable Development	Different
			SDG goals
SO1.2 Understand the Need and		1.1 Need and Importance of Sustainable	details and
Importance of SDGs		Development	its
SO1.3 Understand the historical		1.2 Historical & Policy perspectives of	importance
evolution of SDGs		Sustainable Development	P
		1.3 Sustainable Development: World and	
SO1.4 Gain knowledge of SDGs		Ladia Development. Wond and	
Different goals and their importance		India Perspective	
		1.4 Introduction to 17 SDGs	
SO1. 5 Explain the Challenges &		1.5 Specific learning objectives for	
strategies of attaining SDGs in		different SDGs	
countries		1.6 Challenges & strategies of attaining	
		SDGs in developed and developing	
		nations	
		nauons	

a. Assignments:

Overview of SDGs, Sustainable Consumption and Production, Details of 17 SDGs

b. Other Activities (Specify):

Note down the different challenges in our state and district to achieve SDG

0SDG102.2: Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability and measuring.

-rr	-
Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
 SO2.1 Explain Sustainable Development SO2.2 Understand the NEP-2020 and SDG SO2.3 Discuss higher Education role to achieve SDGs SO2.4 Explain how education for Sustainable Development SO2.5 Explain the measuring techniques for Sustainability 		 Unit-2.0 Special focus on SDG 4- Quality Education and Lifelong Learning: 2.1 Focus of NEP-2020 on SDG 2.2 Education for Sustainable Development (ESD): 2.3 Berlin Declaration 2021 on ESD 2.4 Integration of ESD in curriculum and textbooks 2.5 Tools, Systems, and Innovation for Sustainability 2.6 Measuring Sustainability: How do we measure sustainability 	 NEP2020 objectives and concept for SDGs Concept ,Tools and techniques for measuring sustainabilit y

c. Assignments:

Education role to achieve SDGs, The role of education in Sustainable Development, Measuring techniques of sustainability, Sustainability Indicators

d. Other Activities (Specify): Seminar and group discussion on ESD and measuring sustainability Millennium Development Goals (MDGs)

0SDG102.3:Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.

Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
 SO3.1 Understand current economic issues in the context of the global sustainable development debate. SO3.2 Outline of health, hygiene and water sanitation issues. SO3.3 Discuss the renewable energy resources and its importance in present scenario SO3.4 Explain the importance of sustainable production and consumption SO3.5 Explain the problems and solution in rural and urban areas. 		 Unit-3.0 Understanding the SDGs 3.1 Circular economy (basic model of reuse, recycle, and reduce) 3.2 Rural & urban Problems & Challenges 3.3 Sustainable production and consumption 3.4 Renewable energy 3.5 Health & Hygiene, water , sanitation & water management 3.6 Waste Management 	 Water treatment and manageme nt practices. Non renewable energy resources.

Smart cities

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e. Assignments:

Ecofriendly energy resources importance, types of waste and its management, Urban Problems & Challenges

Other Activities (Specify):

Visit of waste water treatment plant, Visit of water treatment process.

0SDG102.4Develop skills to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.

Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes (SOs)	Laborat ory	Classroom Instruction (CI)	lf Learning (SL)
	Instruct		
	ion		

	(LI)		
SO4.1 Understand environmental		Unit-4.0 Climate Change, Energy and	
sustainability is crucial in reducing the		Sustainable Development	1
impacts of climate change			Agreement
SO4.2 Discuss sources of amission of		4.1 The greenhouse effect: Causes and	on Climate
SO4.2 Discuss causes of emission of GHGs and its consequences		Consequences	Trade and
SO4.3 Explain how climate change		4.2 Climate Change: A Threat to	Sustainabilit
and sustainable development both play a role in shaping the human and		Sustainable Development	y Carbon
environmental factors of the world.		4.3 Adaptation to Current and Future	Credit,
SO4.4 Explain the importance of		Climate Regimes	carbon trading
sustainable production and		4.4 The consequences: crop failure	U
consumption		4.5 Solutions technology and lifestyle	Kyoto Protocol
SO4. 5 Climate change is disrupting		changes	FIOLOCOI
national economies and affecting lives and livelihoods, especially for the most vulnerable and its mitigation.		4.6 Mitigating Climate Change	

f. Assignments:

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Urban Sustainability and Climate Change, Sustainable Development Policies, Agreement on Climate Change, Trade and Sustainability, Resilient cities – What makes a city sustainable, green, and resilient

Other Activities (Specify):

0SDG102.5Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes.

Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes	Laboratory	Classroom Instruction	Self Learning
(SOs)	Instruction	(CI)	(SL)
	(LI)		
SO4.1 Understand the relevance and the		Unit-5.0 Sustainable Business	
concept of sustainability and the global		Practices:	
initiatives in this direction		5.1 Corporate Social Responsibility	Local to the
SO4.2 Understand role of Corporations		5.2 Sustainable products and services	Global: Can
and Ecological Sustainability.		5.3 Business and Environment	Sustainable
SO4.3 Explain role of CSR in		5.4 Corporations and Ecological	Development
Sustainability.		Sustainability	Work
SO4.4 Understand the SD challenge for		5.5 Life Cycle Assessment:	
companies, their responsibility and their		LCA Overview and	
potentials for action		Application	
SO4.5 Discuss the role of world		5.6 World peace and justice:	
government for world justice and peace		• United nations goals for peace	
		and justice	
		World Government for peace	

g. Assignments:

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Consumption Patterns and Lifestyles, Company Perspectives for Environmental Sustainability, An Introduction to Economic Growth

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class	Sessional	Self	Total hour
	Lecture	Work	Learning	(Cl+SW+S
	(Cl)	(SW)	(Sl)	1)
0SDG102.1: Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.	6	1	1	8
0SDG102.2: Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability.	6	1	1	8
0SDG102.3: Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.	6	1	1	8
0SDG102.4 Develop skills to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.	6	1	1	8

0SDG102.5: Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes.	6	1	1	8
Total Hours	30	5	5	40

Suggestion for End Semester Assessment

Suggested Specification Table(For ESA)

СО	Unit Titles	Mark	Total		
		R	U	Α	Marks
CO-1	Need and Importance of Sustainable Development	03	01	01	05
CO-2	Education for Sustainable Development (ESD): Tools, Systems, and Innovation for Sustainability	02	06	02	10
CO-3	Discuss the sustainable production and consumption	03	07	05	15
CO-4	How Climate Change may be Threat to Sustainable Development	-	10	05	15
CO-5	Role of Corporations and Ecological Sustainability	05			
	Total	11	26	13	50

Legend: R: Remember, U: Understand, A: Apply A: Analyse E:Evaluate C:Create

The end of semester assessment for Sustainable Development Goals will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

- 1. Improved Lecture
- 2. Tutorial
- 3. Case Method
- 4. Group Discussion
- 5. Role Play
- 6. Visit to industry, water treatment plant
- 7. Demonstration
- 8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook, Twitter,Whatsapp,Mobile,Onlinesources)
- 9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No	Title	Author	Publisher	Edition & Vear
1	The Economics of Sustainable Development: The Case of India (Natural Resource Management and Policy)"	Surender Kumar and Shunsuke Managi	Springer Switzerland	2009
2	Corporate Social Responsibility in Developing and Emerging Markets	<u>Onyeka Osuji</u>	Cambridge	New Edition June 2022
3	Smart Cities for Sustainable Development	<u>Ram Kumar</u> <u>Mishra, Ch Lakshmi</u> <u>Kumari, Sandeep</u> <u>Chachra, P.S. Janaki</u> <u>Krishna</u>	Springer Switzerland	March 2022
4	Sustainable Development: Linking Economy, Society, Environment	Tracey Strange and Anne Bayley		
5	Management Of Resources For Sustainable Devpt	Sushma Goyal	The Orient Blackswan	2016
6	Energy, Environment and Sustainable Development: Issues and Policies	S. Ramaswamy Sathis G. Kumar	Regal Publications	2009
7	The New Map: Energy, Climate, and the Clash of Nations	Daniel Yergin	Penguin Press	September 2015
8	Contributions of Education for Sustainable Development (ESD) to Quality Education:	Laurie, R., Nonoyama- Tarumi, Y., Mckeown, R., & Hopkins, C.	A Synthesis of Research. Jour nal of Education for Sustainable Development, 10(2), 226– 242.	2016
9	Sustainable Results in Development: Using the SDGs for Shared Results and Impact	OECD	OECD Publishing, Paris	2019
10	Development Discourse and Global History from colonialism to the sustainable development goals	Ziai, Aram	Routledge, London & New York	2016
11	Sustainable Development Goals An Indian Perspective,	Hazra, Somnath., Bhukta, Anindya	Springer Switzerland	2020
12	Environmental Ecology, Biodiversity and Climate Change	HM Saxena	Rawat Publication	January 2021
13	https://www.un.org/sustainabledevelopm	ent/		
14	https://www.aiu.ac.in/documents/AIU_Pu	ublications/UN-SDG goal	ls	
15	https://www.unesco.org/en/education-sus	stainable-development		

16	https://onlinecourses.nptel.ac.in/noc23_hs57/preview
17	ttps://www.iau-hesd.net/news/5180-berlin-declaration-education-sustainable development-adopted- unesco-esd-conference-17-19

Curriculum Development Team

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COs, POs and PSOs Mapping

Course Code : 0SDG102

Course Title: Sustainable Development Goals (SDGs)

					Р	rogra	Program Specific Outcome									
	PO1	PO 2	PO 3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
Course Outcomes	kno wle dge	Pro ble m anal ysis	Desi gn/ dev elop men t of solu tion s	Con duct inve stig atio ns of com plex pro ble ms	Mo der n tool usa ge	Th e en gin eer an d soc iet y	Envi ron ment and susta inabi lity:	Ethi cs	Indi vidu al and tea m wor k:	Co mm unic atio n:	Proje ct mana geme nt and finan ce:	Life- long learni ng	The ability to apply technical & engineeri ng knowledg e to mitigate the conseque nces of global warming	Ability to understan d the Different SD Goals and their significanc e	Ability to understa nd the latest Technolo gy to achieve SD	Ability to use the research based innovativ e knowled ge for SDGs
CO1: Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.	1	1	1	2	3	2	3	2	2	1	3	2	2	3	3	1

CO2: Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Develop skills to understand attitudes on individuals, society and their role	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2

regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.														
CO5: Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1-Low,2-Medium, 3-High

Course Curriculum Map:

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO1: Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 Introduction to Sustainable Development: 1.1,1.2,1.3,1.4,1.5,1.6,1.7,	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO2: Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Special focus on SDG 4-Quality Education and Lifelong Learning: 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	As mentioned in page number 17to 25
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO3: Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Understanding the SDGs: 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO4: Develop skills to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	Unit-4 : Climate Change, Energy and Sustainable Development 4.1, 4.2,4.3,4.4,4.5,4.6,4.7
PO1,2,3,4,5,6	CO5: Describe the steps of the	SO5.1	Unit 5: Sustainable Business Practices, LCA
7,8,9,10,11,12	design thinking methodology	SO5.2	and World peace and justice
PSO 1,2, 3, 4, 5	and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values- based education for sustainable development in educational programmes and processes	SO5.3 SO5.4 SO5.5	5.1,5.2,5.3,5.4,5.5,5.6

Program Name	Bachelor of Science B.Sc. (Biotechnology)									
Semester	Ι									
Course Code:	0SSD101									
Course title:	Communication Skills	Curriculum Developer: Mr. Dhirendra Mishra, Teaching Associate								
Pre-requisite:	Students should have basic knowledge of Communication Skills									
Rationale:	Communication today is very important both in the business world and in private life. Successful communication helps us better understand people and situations. It helps us overcome diversities, build trust and respect, and create conditions for sharing creative ideas and solving problems.									
Course Outcomes (COs):	 CO1-0SSD101.1: To enhance the Speaking Skills of confidence in themselves CO2-0SSD101.2: To develop the leadership skills, impressive Resume. CO3-0SSD101.3: To improve the presentation skil CO4-0SSD101.4: To focus on improving the funda CO5-0SSD101.5: To make them aware of the Ind Writers 	of the students in such a way where they will be able to communicate effectively with immense self public speaking skills and social skills in students along with the basic knowledge of how to make an ls of the students that plays a pivotal role in building and shaping the career of the students mental grammar of the students in order to bring accuracy while speaking and writing. ian Culture and English Language by imbibing the dramas and poetry of some famous Indian English								

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=2:0:0)
AEC	0SSD101	Communication Skills	2	0	1	3	6	2

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

 Nate:
 SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course of

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
				Progressive Assessment (PRA)					
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
AEC	0SSD101	Communication Skills	15	20	10	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students	Approximate Hours					
are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory						
Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their	Item	Cl	LI	SW	SL	Total
mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the	Approx.	08	00	01	05	14
course's conclusion	Hrs					

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)		
CO1-0SSD101.1: To enhance the Speaking Skills of the students in such a way where they will be	SO1.1 Anytime we're trying to get people to think of us a certain way, it's an act of self presentation. Generally speaking, we work to present ourselves		Unit 1 Self Grooming, Basic Etiquettes and Presentation Skills CI1.1 Self Introduction	SL1.1 The Role of Education in Life, The Importance of English in Today's World		
able to communicate effectively with immense self confidence in themselves	SO1.2 Generally, oral presentation is public speaking, either individually or as a group, the aim of which is to providing information entertain, persuade the audience, or educate		CI 1.2 Oral Presentation	SL1.2 Dressing and Grooming Etiquettes (Male and Female)		
	SO1.3 Understands the role of education in life by oral presentation		CI 1.3 The Role of Education in Life,			
	SO1.4 Understands the importance of English in today's life by oral presentation		CI 1.4 The Importance of English in Today's World and Necessity of Uniform in a College			
	SO1.5 Be a professionally refined person. Project a confident image by being well groomed. Building up a good self-image.		CI 1.5 Dressing and Grooming Etiquettes	SL1.3 Importance of Body Language (Gesture, Posture, Facial Expressions & Sign Language, etc.)		
	SO1.6 The most effective communication occurs when the importance of body language in teaching is acknowledged. When these nonverbal cues are in sync with our verbal ones, it creates communication synergy.		Cl1.6 Importance of Body Language	SL1.4 Role Plays (Hospital Scene, Interaction in the Classroom and Travelling by Train).		
	SO1.7 Role play has helped 'enhance active listening skills, social problem solving skills and demonstration of emotional empathy'''		Cl1.7 Role Plays.	SL1.5 Students will self practice to improve their Interviews skills.		
	SO1.8 Getting insight into the candidate's rational knowledge, quick thinking, communication skills and creativity. Verifying if a candidate is a right fit for the company culture and work ethic		Cl1.8 Interviews and their Kinds			

Suggested Sessional Work	SW1.1 Assignments	Make practice on self introduction				
(SW):anyone	SW1.2Mini Project	Write some role play to improve speaking skills and developing self confidence				
	SW1.3 Other Activities (Specify)	Attend some publics and socials activities or program to improve self onfidence				

				Item		Cl LI		SW SL		Tota
				Appro	ox.Hrs	06	00	01	03	10
Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	l	Self Le	Self Learning (SL)				
CO2-0SSD101.2: To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Pesume	SO2.1 Skill development: It helps individuals develop important skills such as communication, critical thinking, problem- solving, and collaboration.		Unit-II Confidence Building and Interview Skills. Cl2.1 Group Discussion. I of Covid-19 on mental hea	Skills mpact alth,	SL2.1 steps ar on ment	Read nd proc tal heal	the (ess(Im th	Group npact o	Discu: of Covi	ssion d-19
impressive resume.	SO2.2 Understand The Impact of Social Media on Our Lives.		CI2.2 The Impact of Media on Our Lives an Pros and Cons of Technolo							
	SO2.3 Know the process and kinds of interviews.		CI2.3 Interviews and Kinds	their	SL2.2 Read the question which mostly asks during an interview?					
	SO2.4 Understand about Debate and their importance.		CI2.4 Debate (Should the of Plastic Be Banned?,	ne Use	. SL2.3 practice	Debat to imp	e stu vrove t	idents heir ski	will ills.	self
	SO2.5 Know the importance of career.		CI2.5 Should Parents I Which Career Their Ch Will Pursue?	Decide nildren						
	SO2.6 Understand about Artificial Intelligence Useful or Dangerous?		CI2.6 Is Artificial Intell Useful or Dangerous?	igence						

Suggested Sessional	SW2.1 Assignments	Write steps of interview.					
Work (SW):anyone	SW2.2Mini Project	Write the steppes of Group Discussion					
	SW2.3 Other Activities (Specify)	Some class activities for improvement of team work.					

Item	Cl	LI	SW	SL	Total	
Approx.Hrs	07	00	01	03	11	

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning(SL)
		Instruction(LI)	(CI)	
CO3-0SSD101.3: To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of	SO3.1 Speech/ Anchoring (Occasional Speech, Valedictory Speech, Patriotic Speech),.		Unit-III Public Speaking Skills and Conversational Skills. CI 3.1 Speech/ Anchoring	SL3.1 Take chance for Speech and Anchoring to improve public speaking skills.
the students	SO3.2 The students will identify words and/or phrases related to the topic. The students will draw inferences relying on the context. The students will express themselves fluently. The students will express themselves with acceptable accuracy		CI 3.2 Occasional Speech	SL3.2 Pros and Cons of Online teaching
	SO3.3 The students will identify words and/or phrases related to the topic. The students will draw inferences relying on the context. The students will express themselves fluently. The students will express themselves with acceptable accuracy		CI 3.3 Valedictory Speech	SL3.3 Conversational Topics (Inquiry at bank, Airport, Station and Hospitals).
	SO3.4 The students will identify words and/or phrases related to the topic. The students will draw inferences relying on the context. The students will express themselves fluently. The students will express themselves with acceptable accuracy		CI 3.4 Patriotic Speech	
	SO3.5 Extemporaneous speech has many benefits for both the speaker and the audience For The Speaker.		CI 3.5 Extempore	
	SO3.6 Understands the pros and cons of online teaching.SO3.7 UnderstandstheEnvironment		CI 3.6 Pros and Cons of Online teaching, CI3.7 Environment Conservation	
	Conservation and Education of a Girl Child		and Education of a Girl Child	

Suggested Sessional	SW3.1 Assignments	Write key features of Anchoring
Work (SW): anyone	SW3.2 Mini Project	Inquiry at bank.
	SW3.3 Other Activities (Specify)	Occasional Speech

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	00	01	03	9

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
0SSD101CO4: To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing.	SO4.1 Prepositions (Place, Time and Direction),		Unit-IV Functional Grammar and Vocabulary Building: CI4.1 1Prepositions	SL4.1 Learn about appropriate use of preposition
Speaking and writing.	SO4.2 Understand the uses of present tense. SO4.3 Understand the uses of present tense.		CI4.2 Tenses (Present tense) CI4.13 Tenses (Past tense)	SL4.2 Learn tenses and their use
	SO4.4 Understand the uses of present tense.		CI4.4 Tenses (Future tense)	
	SO4.5 Know the uses of active voice		CI4.5 Voice (Active - Passive voice)	
	SO4.6 Know the uses of Passive voice.		CI4.6 Modals	

Suggested Sessional	SW4.1 Assignments	Write structure of Tense.
Work (SW): anyone	SW4.2 Mini Project	Write the uses of Prepositions (Place, Time and Direction),
	SW1.3 Other Activities (Specify)	Uses of tense

			Item	Cl	LI	SW	SL	Total	
			Approx.Hrs	03	00	01	03	7	
Course Outcome (CO)	SessionOutcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)			Self- Learning(SL)			
CO5-0SSD101.5: To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry	SO5.1 The Axe- R.K. Narayan to know the importance and values of trees.		Unit-V India English & Hind CI5.1 The Axe-	n Wri li - R.K. I	iting Naray	in /an	SL5 Read Axe	. 1 I the	story
of some famous Indian English Writers	SO5.2 By reading The Night of the Scorpion- Nissim Ezekiel, the student will understand the Indian culture and English language.		CI5.2 The Night of the Scorpion- Nissim Ezekiel			SL5.2 Read the lession the night of the scorpion.			
	SO5.3 The Portrait of a Lady - Khushwant Singh.		CI5.3 The Portr Khushwant Singh	ait of	a La	dy -	SL5. Lea khus	.3 rn hwant s	about ingh.

Suggested Sessional	SW5.1 Assignments	Write about R.K.Narayan
Work (SW): anyone	SW5.2 Mini Project	Make a list of Indian Dramas.
	SW5.3 Other Activities (Specify)	Find out some you tube videos based on Indian poet.

Course duration (in hours) to attain Course Outcomes:

Course Title: Communication Skills Course Code: 0SSD101 **Course Outcomes(COs)** Self-Learning **Total Hours** Laboratory Sessional work Class lecture (**CI**) **Instruction(LI)** (SL) (**SW**) (Li+CI+SL+SW) To enhance the Speaking Skills of the 8 0 5 14 CO1-0SSD101.1: 1 students in such a way where they will be able to communicate effectively with immense self confidence in themselves 0 **CO2-0SSD101.2:** To develop the leadership skills, public 6 3 1 10 speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume. 7 3 **CO3-0SSD101.3:** To improve the presentation skills of the 0 11 1 students that plays a pivotal role in building and shaping the career of the students **CO4-0SSD101.4:** To focus on improving the fundamental 6 0 2 1 9 grammar of the students in order to bring accuracy while speaking and writing. 7 3 0 3 **CO5-0SSD101.5:** To make them aware of the Indian Culture 1 and English Language by imbibing the dramas and poetry of some famous Indian English Writers 30 **Total Hours** 00 16 05 51

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Communication Skills

Course Code: 0SSD101

Course Outcomes		Marks I	Distribution	n	
	Α	An	Е	С	Total Marks
CO1-0SSD101.1: To enhance the Speaking Skills of the students in such a way where they will be able to communicate effectively with immense self confidence in themselves	2	1	1	1	5
CO2-0SSD101.2: To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume.	2	4	2	2	10
CO3-0SSD101.3: To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of the students	3	5	5	2	15
CO4-0SSD101.4: To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing.	2	3	3	2	10
CO5-0SSD101.5: To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry of some famous Indian English Writers	5	4	1	0	10
Total Marks	14	17	12	07	50

Legend: A, Apply; An, Analyze; E, Evaluate; C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Dr. Meenu Pandey: Communication Skills, NiraliPraksahan.
2	Dr. Neeta Sharma: Communication Skills, Satya Prakashan.
3	A. J. Thomson & A. V. Martinet: A Practical English Grammar, Oxford University Press
4	K.P. Thakur: A Practical Guide to English Grammar, Bharti Bhawan Publishers & Distributors
5	Wilfred Funk: Six Weeks to Words of Power, W.R. Goyal Publishers and Distributors.
6	Grant Taylor: English Conversation Practise, Tata McGraw Hill Education Private Limited.

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Industrial Visit.
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

Program Name: B. Sc.Biotechnology Semester:I Semester Course Title: Communication Skills Course Code: 0SSD101

CO)/PO/PSO	Mapping							
Course Outcome (Cos)		Program Outcomes (POs)				Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	
CO1-0SSD101.1: To enhance the Speaking Skills of the students in such a way where they will be able to communicate effectively with immense self confidence in themselves	2	-	-	1	2	2	2	1	
CO2-0SSD101.2: To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume.	-	-	-	-	-	1	1	2	
CO3-0SSD101.3: To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of the students	-	1	1	1	-	1	1	1	
CO4-0SSD101.4: To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing.	-	1	1	-	2	1	1	3	
CO5-0SSD101.5: To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry of some famous Indian English Writers	1	1	1	-	_	1	3	2	

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
PO 1,2,3,4,5	CO1-0SSD101.1: To enhance the Speaking	SO1.1 SO1.2		1.1,1.2,1.3,1.4,1.5	1SL-1,2,3
	Skills of the students in such a way where they	SO1.3 SO1.4		1.6,1.7,1.8	
PSO 1,2,3	will be able to communicate effectively with	SO1.5 SO1.6			
	immense self confidence in themselves	SO1.7 SO1.8			
PO 1,2,3,4,5	CO2-0SSD101.2: To develop the leadership	SO2.1 SO2.2		2.1, 2.2, 2.3, 2.4,	2SL-1,2,3
	skills, public speaking skills and social skills in	SO2.3 SO2.4		2.5, 2.6,	
PSO 1,2,3	students along with the basic knowledge of how	SO2.5 SO2.6			
	to make an impressive Resume.				
PO 1,2,3,4,5	CO3-0SSD101.3: To improve the	SO3.1 SO3.2		3.1,3.2,3.3,3.4,3.5	3SL-1,2,3
	presentation skills of the students that plays a	SO3.3 SO3.4		3.6,3.7	
PSO 1,2,3	pivotal role in building and shaping the career of	SO3.5 SO3.6			
	the students	SO3.7			
PO 1,2,3,4,5	CO4-0SSD101.4: To focus on improving the	SO4.1 SO4.2		4.1,4.2,4.3,4.4,4.5	4SL-1,2
	fundamental grammar of the students in order to	SO4.3 SO4.4		4.6,	
PSO 1,2,3	bring accuracy while speaking and writing.	SO4.5 SO4.6			
PO 1,2,3,4,5	CO5-0SSD101.5: To make them aware of the	SO5.1 SO5.2		5.1,5.2,5.3,	5SL-1,2,3
	Indian Culture and English Language by imbibing	SO5.3			
PSO 1,2,3	the dramas and poetry of some famous Indian				
	English Writers				

Program Name	Bachelor of Science (B.Sc.)- Biotechnology					
Semester	Ш					
Course Code:	01BT201					
Course title:	Molecular biology and diagnostic techniques Curriculum Developer: Shaily Mishra, Assistant Professor					
Pre-requisite:	Students should have basic knowledge of biology, biochemistry of nucleic acids, immune system related biological processes.					
Rationale:	The paper on Molecular biology and diagnostic techniques in a B.Sc. Biotechnology program provides students with an understanding of the basic principles and clinical significance of laboratory testing in the field of molecular diagnostics. Students will gain insights about the basic principles of DNA replication and how to perform basic molecular diagnostic techniques and their applications in the identification of genetic diseases and diseases caused by microorganisms.					
Course Outcomes (COs):	 CO1-01BT201.1: Understand the basic structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism. CO2-01BT201.2: Students are able to understand the chemical and molecular processes that occur in and between cells. CO3-01BT201.3: Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes. CO4-01BT201.4: Demonstrate an understanding of basic molecular diagnostic techniques. CO5-01BT201.5: Apply molecular diagnostic techniques to the identification and diagnosis of diseases. 					

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)
Major	01BT201	Molecular Biology and Diagnostic Techniques	4	4	1	3	12	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

						Sch	eme of Assessme	ent (Marks)		
						Progressive Ass	essment (PRA)			
Board of Study Couse Code	e Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Class Activity (CAT)	Seminar (SA)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
Major	01BT201	Molecular biology and diagnostic techniques	15	20	05	05	05	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)	-		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major	01BT201-L	Molecular biology and diagnostic techniques	35	5	5	5	50	50	100

Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session **Approximate Hours** levels, which students are anticipated to accomplish through various modes of instruction Item Cl SW SL Total including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self LI 12 06 01 03 Approx.Hrs 22 Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT201.1: Understand	SO1.1	LI1.1	Unit-1 DNA structure and	SL1.1
the basic structure of DNA	Learn about DNA as genetic	Preparation of solutions	replication	Study experiments that proves
and RNA modes of DNA	material	for Molecular biology	CI1.1 DNA as genetic material,	DNA as genetic material
replication and its damage		experiments.		
and repair mechanism				
and repair meenamsm.	SO1 2 Understand the structure of		CT1 2 Structure of DNA	
	DNA			
	SO1.3 Study about different forms		CI1.3 Types of DNA	
	of DNA			
	SO1.4 Understand the experimental	LI1.2 DNA isolation	CI1.4 Semi conservative nature of DNA	SL1.2 Understand the role of
	proof of semi conservative DNA	from different sources	replication	proteins and enzymes in DNA
	replication.			replication
	SO1.5 Role of replicon and	LI1.2 RNA isolation	CI1.5 Replicon and DNA polymerases	
	polymerases in prokaryotes	from different sources	in prokaryotes	
	SO1.6 Role of replicon and		CI1.6 Replicon and DNA polymerases	
	polymerases in eukaryotes		in eukaryotes	
	SO1.7 Study the process of		CI1.7Replication of DNA in	
	replication in prokaryotes		prokaryotes	
	SO1.8 Role of telomere in		CI1.8 Telomere and end replication	
	termination of replication		problem	
	SO1.8 Study the process of		CI1.8 Replication of DNA in	
	replication in eukaryotes		eukaryotes	
	SO1.10 Understand the rolling		CI1.10 Rolling circle replication	
	circle replication			
	SO1.11 Study the causes and types		CI1.11 DNA damage	SL1.3 Study about various factors
	of DNA damage			responsible for DNA Damage
	SO1.12 DNA repair mechanism		CI1.12 DNA repair	

Suggested Sessional Work	SW1.1 Assignments	Describe in detail the function of machinery involved in DNA replication.
(SW):anyone	SW1.2Mini Project	Diagrammatic representation of repair mechanism of damaged DNA.
	SW1.3 Other Activities (Specify)	Search research papers related to DNA damage.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate Hours						
levels, which students are anticipated to accomplish through various modes of instruction including							
Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning		Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs),		Approx.Hrs	12	06	01	03	22
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-01BT201.2: Students are able to understand the chemical and molecular processes that occur in and between cells.	SO2.1 Understand the structure of RNA	LI2.1 Isolation of bacterial plasmid and their separation to confirm the coiling.	Unit-2 Transcription CI2.1 RNA structure	SL2.1 Function of different types of RNA.
	SO2.2 Types of RNA		CI2.2 Types of RNA	
	SO2.3 Study the role of RNA polymerase enzyme in transcription	LI2.2 Agarose gel electrophoresis	CI2.3 Transcription in prokaryotes: Prokaryotic RNA polymerase	SL2.2 Study the interaction of DNA and proteins.
	different promoters	electrophoresis	C12.4 Role of signa factor and promoter	
	SO2.5 Understand the mechanism of transcription in prokaryotes		CI2.5 Initiation, elongation and termination of RNA chains in prokaryotes	
	SO2.6 Study the role of RNA polymerase enzyme in eukaryotes		CI2.6 Transcription in eukaryotes: Eukaryotic RNA polymerases,	SL2.3 Understand the role of regulatory proteins.
	SO2.7 Study the role of transcription factors, promoters and enhancers		CI2.7 Transcription factors, promoters, enhancers	
	SO2.8 Understand the mechanism of DNA replication in prokaryotes		CI2.8 Mechanism of transcription in eukaryotes	
	SO2.9 Learn about RNA processing		Cl2.9 RNA splicing and processing	
	SO2.10 Understand about post- transcriptional changes in precursor RNA		CI2.10 Post-transcriptional modifications in different types of precursor RNA	
	SO2.11 Types of RNA processing		CI2.11 Types of RNA splicing of precursor RNA	
	SO2.12 Learn about the mechanism of RNA splicing		CI2.12 RNA Splicing mechanism	

Suggested Sessional Work	SW1.1 Assignments	Differentiate between structure of RNA polymerase in prokaryotes and eukaryotes.			
(SW):anyone	SW1.2Mini Project	Diagrammatic representation of mechanism of different types of RNA splicing.			
	SW1.3 Other Activities (Specify)	Make a PowerPoint presentation on mechanism of transcription in prokaryotes.			

Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session **Approximate Hours** levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning Cl SW Item LI SL Total 12 06 01 04 23 (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), Approx.Hrs culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion. Laboratory Self-Learning (SL) **Course outcome (CO)** Session Outcomes (SOs) **Class room Instruction (CI)** Instruction (LI) LI3.1Demonstration of CO3-01BT201.3: SO3.1 Study about genetic SL4.1 Structure of protein Gain **Unit-3 Translation & Gene Expression** AMES test CI3.1Genetic code and its characteristics (primary, secondary and code knowledge about the protein tertiary) synthesis mechanism and regulation of gene expression in prokaryotes. SL4.2Role of protein in **SO3.2**Study the role of ribosome in LI3.2Kirby-Bauver CI3.2Prokaryotic translation: ribosome (disc-diffusion translation. method structure and assembly, biological activities. method) to study antibiotic sensitivity of a bacterial culture SO3.3Role CI3.3Charging of tRNA, aminoacyl of charging LI3.3 Demonstration of of aminoacyl tRNA in translation reverse mutation for tRNA synthetases carcinogenicity **SO3.4** Structure and function of CI3.4 Polycistronic and monocistronic mRNA mRNA **SO3.5** Steps involved in process of CI3.5 Mechanism SL4.3Understand the role of of initiation. protein synthesis in prokaryotes elongation termination of molecular chaperones and polypeptides **SO3.6** Steps involved in process of CI3.6 Mechanism of initiation. SL4.3Understand the role of protein synthesis in eukaryotes elongation and termination molecular chaperones of polypeptides **SO3.7** CI3.7Post-translational modifications of **SL4.4** Study the role of regulatory Post-translational modifications proteins in gene regulation. proteins CI3.8 Types of Post-translational SO3.8 Learn about types of posttranslational modifications modifications of proteins SO3.9 Understand the mechanism CI3.9 Mechanism of protein of protein modifications modifications CI3.10 Regulation of gene expression in SO3.10 Understand the gene regulation mechanism in bacteria prokaryotes. **CI3.11** Operon concept in prokaryotes SO3.11 Learn about operon concept SO3.12 Understand the regulation CI3.12 Lac and Trp operon in of different operon in prokaryotes prokarvotes Describe the importance of post translation modification of proteins. SW3.1 Assignments **Suggested Sessional Work** SW3.2Mini Project Diagrammatic representation of *lac* and *trp* operon. (SW):anyone Draw a chart of genetic code and watch you tube videos of models of protein structures. SW3.3 Other Activities (Specify)

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session ApproximateHours levels, which students are anticipated to accomplish through various modes of instruction including Item Cl SW SL Total Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning LI 12 06 01 04 Approx.Hrs 23 (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-01BT201.4: Demonstrate	SO4.1	LI4.1	Unit-4	SL4.1 Study different molecular
an understanding of basic	Understand about molecular	A kit-based detection of a	Molecular Diagnostics	techniques
molecular diagnostic techniques.	diagnostic techniques.	microbial infection (Widal test).	Techniques-I	
			CI4.1 Introduction to molecular	
			Diagnostics	
	SO4.2 Explain PCR and DNA sequencing	LI4.2 Demonstration of PCR	CI4.2 PCR and its applications	SL4.2 Gain insights of DNA replication mechanism
	SO4.3 Learn about the function	LI4.2 Demonstration of Gel	CI4.3 Types of PCR	
	of different types of PCR	Doc		
	SO4.4 Application of DNA		CI4.4 DNA sequencing and its	
	sequencing		method	
	SO4.5 Different types of DNA		CI4.5 Types of DNA	
	sequencing methods		sequencing	
	SO4.6 Understand difference		CI4.6 Blotting Techniques-	SL4.3 Learn about DNA,RNA
	among different blotting		Southern Blotting	and protein
	technique			
	SO4.7 Concept of Blotting		CI4.7 Northern Blotting	
	Techniques			
	SO4.8 Applications of blotting		CI4.8 Southern Blotting	
	techniques		~~~~	
	SO4.9 Demonstrate about the		CI4.9 Diagnosis of genetic	SL4.4 Study about molecular
	diagnosis of genetic diseases.		diseases,	basis of genetic diseases.
	SO4.10 Methods of detection of		CI4.10 Detection of mutation in	
	mutations in DNA		DINA.	
	SU4.11 Illustration of Flow		CI4.11 Flow cytometry and its	
	SO4 12 Illustration of call		applications	
	sorting		applications	
	sorung		applications	

Suggested Sessional Work	SW4.1 Assignments	Differentiate between different blotting techniques used in molecular biology.
(SW): anyone	SW4.2 Mini Project	Diagrammatic representation of PCR and DNA sequencing methods.
	SW4.3 Other Activities (Specify)	Find out some you tube videos related to detection of genetic diseases and mutation in DNA.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session ApproximateHours levels, which students are anticipated to accomplish through various modes of instruction including SW Item Cl LI SL Total Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning Approx.Hrs 12 06 01 03 22 (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-01BT201.5: Apply	SO5.1	LI5.1	Unit-5	SL5.1
molecular diagnostic techniques	Describe the techniques for	Perform immune-diagnostic	Molecular Diagnostics	Study about effect of different
to the identification and	testing microbial susceptibility	test (Typhoid, Malaria).	Techniques-II	antibiotics
diagnosis of diseases.			CI5.1 Susceptibility tests-	on microbial cell
			Micro-dilution and macro-	
			dilution broth procedures	
	SO5.2 Learn about types and		CI5.2 Diffusion test	
	applications of susceptibility test		procedures.	
	SO5.2 Study the tests for	LI5.2 Demonstration of ELISA	CI5.3 Tests for bactericidal	SL5.2 List out antibiotics that
	bactericidal activity.		activity	have bactericidal effect
	SO5.2 Understand the application	LI5.3 Perform immune-	CI5.4 Application of	
	of bactericidal activity	diagnostic test (Dengue).	bactericidal activity	
	SO5.3 Elucidate enzyme immuno		CI5.5 Enzyme Immuno assay	SL5.3 Learn about role of
	assay technique			enzyme-substrate complex in
				immunological diagnostics.
	SO5.2 Recognize the application		C15.6 Applications of enzyme	
	of enzyme in immunodiagnostic		immunoassays in diagnostic	
	tests		microbiology	
	SO5.2 Learn about		CI5.7 Immunodiagnostic tests	
	Immunodiagnostic tests			
	SO5.2 Understand the application		CI5.8 Application of	
	of immunodiagnostic tests		immunodiagnostic tests	
	SO5.4 Explain different immune		CI5.9 Immuno florescence	
	assays techniques			
	SO5.10 Applications of Immuno		CI5.10 Applications of	
	florescence		Immuno florescence	
	SUS.II Learn about		CI5.11 Radioimmunoassay	
	Radioimmunoassay			
	SO5.12 Understand the		CI5.12 Applications of	
	applications of		Radioimmunoassay	
	Radioimmunoassay			

Suggested Sessional Work	SW5.1 Assignments	Draw a ray diagram to show different immuno assay methods used in molecular diagnostics.		
(SW): anyone	SW5.2 Mini Project Make a power point presentation on immune fluorescence.			
	SW5.3 Other Activities	Search research paper on microbial susceptibility test.		
	(Specify)			
Course duration (in hours) to attain Course Outcomes:

Course Title: Molecular biology and diagnostic techniques

Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-01BT201.1: Understand the basic structure of DNA and	12	6	01	03	22
RNA, modes of DNA replication and its damage and repair					
mechanism.					
CO2-01BT201.2: Students are able to understand the chemical	12	6	01	03	22
and molecular processes that occur in and between cells.					
CO3-01BT201.3: Gain knowledge about the protein synthesis	12	6	01	04	23
mechanism and regulation of gene expression in prokaryotes.					
CO4-01BT201.4: Demonstrate an understanding of basic	12	6	01	04	23
molecular diagnostic techniques.					
CO5-01BT201.5: Apply molecular diagnostic techniques to the	12	6	01	03	22
identification and diagnosis of diseases.					
Total Hours	60	30	05	17	112

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Molecular biology and diagnostic techniques

Course Outcomes		Marks Distribution					
	Α	An	Ε	С	Total Marks		
CO1-01BT201.1: Understand the basic structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism.	2	1	1	0	4		
CO2-01BT201.2: Students are able to understand the chemical and molecular processes that occur in and between cells.	2	4	2	0	08		
CO3-01BT201.3: Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes.	3	5	4	1	13		
CO4-01BT201.4: Demonstrate an understanding of basic molecular diagnostic techniques.	2	3	3	2	10		
CO5-01BT201.5: Apply molecular diagnostic techniques to the identification and diagnosis of diseases.	4	4	2	2	12		
Total Marks	13	17	12	05	47		

(a) Books:

S.No.	Title/Author/Publisher details
1	Genes V by Benjamin Lewin, Oxford University Press, New York, 1994.
2	Gene IX, Benjamin Lewin Oxford University Press, New York, 2006.
3	Principles of Genetics, Snustad and Simmons, Seventh Edition, John Wiley and Sons,
	Inc.,2015.
4	Molecular Cell Biology, Lodish et.al., W. H. Freeman and Company, Eighth Edition, 2016.
5	Genomes 5 by T.A. Brown, John Wiley and sons (Asia)PTE LTD, New York, Fifth Edition2023
6	Genes V by Benjamin Lewin, Oxford University Press, New York, 1994.

(b) Online Resources:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Industrial plant of fermentation industries
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biotechnology Semester: II Semester

	CO/PO Mapping														
Course Outcome		Program Outcomes (POs)				Progra	Program Specific Outcomes (PSOs)								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-01BT201.1: Understand the basic structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism.	-	-	-	-	2	2	3	-	3	3	3	3	2	2	1
CO2-01BT201.2: Students are able to understand the chemical and molecular processes that occur in and between cells.	-	-	-	-	-	-	3	-	3	2	3	3	2	1	2
CO3-01BT201.3: Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes.	-	-	-	-	-	-	3	-	3	1	3	3	1	1	3
CO4-01BT201.4: Demonstrate an understanding of basic molecular diagnostic techniques.	-	-	-	-	2	2	3	3	-	1	3	3	1	1	3
CO5-01BT201.5: Apply molecular diagnostic techniques to the identification and diagnosis of diseases.	-	-	-	-	-	2	3	3	-	2	3	3	1	3	2

Course Title: Molecular biology and diagnostic techniques

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
No.			Instruction (LI)	Instruction (CI)	
PO 1,2,3,4,5, 6,	CO1-01BT201.1: Understand the basic	SO1.1 SO1.2	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5,	1SL-1,2,3
7, 8, 9 10, 11, 12	structure of DNA and RNA, modes of DNA	SO1.3 SO1.4		1.6,1.7,1.8,1.9,1.10,	
	replication and its damage and repair	SO1.5 SO1.6		1.11,1.12	
PSO 1,2,3	mechanism.	SO1.7 SO1,8			
		SO1.9 SO1.10			
		SO1.11 SO1.12			
PO 1,2,3,4,5, 6,		SO2.1 SO2.2	2.1, 2.2, 2.3,	2.1,2.2,2.3,2.4,2.5,2.6,	2SL-1,2,3
7, 8, 9 10, 11, 12		SO2.3 SO2.4		2.7,2.8,2.9,2.10,2.11,	
	CO2-01B1201.2: Students are able to	SO2.5 SO2.6		2.12	
PSO 1,2,3	processes that occur in and between cells	SO2.7 SO2.8			
	processes that occur in and between cens.	SO2.9 SO2.10			
		SO2.11 SO2.12			
PO 1,2,3,4,5, 6,		SO3.1 SO3.2	3.1,3.2,3.3	3.1,3.2,3.3,3.4,3.5,	3SL-1,2,3,4
7, 8, 9 10, 11, 12		SO3.3 SO3.4		3.6,3.7,3.8,3.9,3.10,	
	CO3-01B1201.3: Gain knowledge about the	SO3.5 SO3.6		3.11,3.12	
PSO 1,2,3	gone expression in prokervotes	SO3.7 SO3.8			
	gene expression in prokaryotes.	SO3.9 SO3.10			
		SO3.11 SO3.12			
PO 1,2,3,4,5, 6,		SO4.1 SO4.2	4.1,4.2,4.3	4.1,4.2,4.3,4.4, 4.5,	4SL-1,2,3
7, 8, 9 10, 11, 12		SO4.3 SO4.4		4.6.4.7,4.8,4.9,4.10,	
	CO4-01B1201.4: Demonstrate an	SO4.5 SO4.6		4.11,4.12	
PSO 1,2,3	techniques	SO4.7 SO4.8			
	teeninques.	SO4.9 SO4.10			
		SO4.11 SO4.12			
PO 1,2,3,4,5, 6,	CO5-01BT201.5: Apply molecular diagnostic	SO5.1 SO5.2	5.1,5.2,5.3	5.1,5.2,5.3,5.4,5.5,	5SL-1,2,3
7, 8, 9 10, 11, 12	techniques to the identification and diagnosis of	SO5.3 SO5.4		5.6,5.7,5.8,5.9,5.10,	
	diseases.	SO5.5 SO5.6		5.11,5.12	
PSO 1,2,3		SO5.7 SO5.8			
		SO5.9 SO5.10			
		SO5.11 SO5.12			

Program Name	Bachelor of Science (Hons.) Biotechnology						
Semester	П	Π					
CourseCode:	02BC201						
Coursetitle:	Bioenergetics and Metabolism	Curriculum Developer: Mrs. Pratima Mishra, Guest Faculty					
Pre-requisite:	Students should have basic knowledge of Biomolecules, Biochemistry and Chemistry						
Rationale:	The Bioenergetics and Metabolism course in a B.Sc. (Hons.) Biotechnology program is essential for understanding how organisms acquire, transform, and utilize energy at the molecular level. It provides foundational knowledge crucial for optimizing biotechnological processes like fermentation and metabolic engineering. Understanding metabolic pathways and energy transformations is vital in developing biotechnological solutions for healthcare, such as metabolic disorders and drug metabolism studies. The course's interdisciplinary approach integrates biology, chemistry, and physics, fostering critical thinking and preparing graduates for diverse careers in biotechnology, research, and innovation in a rapidly evolving field. Top of Form						
Course Outcomes (COs):	CO1-02BC201.1: Understanding of the components of biological systems i.e. enzymes, vitamins and minerals CO2-02BC201.2: Learning in-depth information regarding the Key elements of Bioenergetics and metabolism CO3-02BC201.3: Recognize various concepts related the carbohydrate metabolism and biological significance. CO4- 02BC201.4: Assess various concepts related the lipid, fatty acid and amino acid metabolism and its significance CO5-02BC201.5: Appraise the relationship between purine and pyrimidine metabolism and its biological significance.						

Scheme of Studies:

					ırs/Week)			
Board of Study	Course Code	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)
Minor	02BC201	Bioenergetics and Metabolism	4	4	1	5	14	4+2=6
Legends:	<i>nds:</i> CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);							

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

					Sch	eme of Assessme	ent (Marks)		
					Progressive Asso	essment (PRA)			
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02BC201	Bioenergetics and Metabolism	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessn	nent (Marks)		
					Progressive As	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02BC201-L	Bioenergetics and Metabolism	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and	ApproximateHours						
session levels, which students are anticipated to accomplish through various modes of			-				
instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional		Item	Cl	LI	SW	SL	Total
Work (SW), and Self Learning (SL). As the course progresses, students should showcase		Approx.Hrs	15	10	01	05	31
their mastery of Session Outcomes (SOs), culminating in the overall achievement of							
Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-02BC201.1: Understanding of the components of biological systems i.e. enzymes, vitamins and minerals	SO1.1 Define and Describe concept and Nomenclature of Enzymes	LI1.1 Determination of enzyme activity	Unit 1 CI1.1 Enzymes: Nomenclature	SL1.1 Search various reference books and study material to start the learning
	SO1.2 Describe about classification of enzyme	LI1.2 Identification of enzyme	CI1.2 Enzyme Classification	SL1.2 Check the properties of enzymes
	SO1.3 Explain about characteristics of enzyme		CI1.3 Characteristics	SL1.3 Learn about various categories of enzymes
	SO1.4 Describe factors affecting enzyme activity	LI1.3 To study the effect of temp. of enzyme activity	CI1.4 Factors affecting enzyme activity	SL1.4 Enlist the structure and properties of different vitamins
	SO1.5 Study the mechanism of enzyme		CI1.5 Mechanism of enzyme action	
	SO1.6 Study MM equation		CI1.6 MM Equation	
	SO1.7 Describe enzyme specificity	LI1.5 To study the effect of pH of enzyme activity	CI1.7 Enzyme specificity	
	SO1.8 Assess application of enzyme		CI1.8 Application of Enzyme	SL1.5 Enlist the structure and properties of different minerals
	SO1.9 Describe concept and types of vitamins		CI1.9 Vitamins: Introduction, types	
	SO1.10 Describe structure and sources of vitamins		CI1.10 Structure, Sources,	
	SO1.11 Describe function and deficiency of vitamins		CI1.11 Function and deficiencies of water soluble vitamins.	
	SO1.12 Describe function and deficiency of vitamins		CI1.12 Function and deficiencies of fat-soluble vitamins	
	SO1.13 Assess the concept and types of minerals		CI1.13 Minerals: Introduction, types,	
	SO1.14 Assess Function and deficiencies of nutrients		CI1.14 Function and deficiencies of macro nutrients	
	SO1.15 Assess Function and deficiencies of nutrients		CI1.15 Function and deficiencies of micro nutrients	

Suggested Sessional Work	SW1.1 Assignments	Describe in detail classification, characteristics and biological significance of enzyme.
(SW):anyone	SW1.2Mini Project	Prepare a chart on vitamins and minerals.
	SW1.3 Other Activities (Specify)	Collect the data about biological role of vitamins/minerals and their deficiencies.

				Item		Cl	LIS	SW	SL	Total
				Appro	ox.Hrs	09	00 ()1	05	15
Course	Session Outcomes	Laboratory Instruction (LI)	Classroom Instruction		Self L	earnin	g (SL)			
Outcome (CO)	(SOs)		(CI)							
CO2-02BC201.2:	SO2.1 Assess the concept of		Unit-II		SL2.1	Enlist	the	: (differ	rent
Learning in-depth	bioenergetics and metabolism		CI2.1 Bioenergetics	and	compo	nents of	f bioen	ergeti	cs	
information regarding			metabolism: Basic conce	epts						
the Key elements of										
Bioenergetics and										
metabolism										
	SO2.2 Explain about first law		CI2.2 First law	of	SL2.2	Asses	s biolo	gical	role	of
	of thermodynamics		thermodynamics		thermo	odynan	nics			
	SO2.3 Explain about second		CI2.3 second law	of	SL2.3	Learn	abou	ıt r	ole	of
	law of thermodynamics		thermodynamics		thermo	odynan	nics in 1	netał	olisn	n
	SO2.4 Explain about high		CI2.4 High en	nergy	SL2.4	Learn	stru	icture	e a	and
	energy phosphor		phosphate compound	ds	function	on of N	TPs			
	compounds									
	SO2.5 Describe the role of		CI2.5 role of ATP		SL2.5	colle	ction of	of da	ta ab	out
	ATP				interm	ediary	metabo	lism		
	SO2.6 Describe role of ATP		CI2.6 structural basis	s of						
	hydrolysis pathway		free energy ch	nange						
			during hydrolysis of	ATP						
	SO2.7 Describe biological		CI2.7 ATP and its ro	ole in						
	role of ATP		biological system.							
	SO2.8 Explain hydrolysis of		CI2.8 hydrolysis of AT	ГР						
	ATP									
	SO2.9 Explain ATP and		CI2.9 ATP and Energy	7						
	energy									

Suggested Sessional	SW2.1 Assignments	Describe in detail bioenergetics and their biological role.
Work (SW) :anyone	SW2.2 Mini Project	Explain the mechanism of energy transfer in biological system.
	SW2.3 Other Activities (Specify)	Write an article on error of metabolism.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	04	01	05	22

Course Outcome (CO)	Durse Outcome (CO)Session Outcomes(SOs)Laboratory Instruction(LI)Class room Instruction (CI)		Self-Learning (SL)		
CO3-02BC201.3: various concepts re carbohydrate metabo biological significance.	Recognize lated the blism and	SO3.1 Explain the concept and components of carbohydrate metabolism	SL3.1 Quantitative estimation of carbohydrate	Unit-III CI3.1 Carbohydrate metabolism	SL3.1 Read about various pathways of carbohydrate metabolism
		SO3.2 Assessing the structure and mechanism of gycolysis	SL3.2 Qualitative estimation of carbohydrate	CI3.2 Glycolysis	SL3.2 Collect the information about various enzymes involved in carbohydrate metabolism
		SO3.3 Assessing the structure and mechanism of pyruvate activation		CI3.3 activation of pyruvate	SL3.3 Collect the information about various energy balances of carbohydrate metabolism.
		SO3.4 Assessing mechanism of Glycogenesis		CI3.4 Glycogenesis	
		SO3.5 Describe about mechanism of Glycogenolysis		CI3.5 Glycogenolysis	
		SO3.6 Assessing the role of Gluconeogenesis		CI3.6 Gluconeogenesis	SL3.4 Collect information about inborn errors of carbohydrate metabolism
		SO3.7 Describe about role of Pentose Phosphate Pathway SO3.8 Assessing mechanism of		CI3.7 Pentose phosphate pathway CI3.8 Kreb's cycle	SL3.5 Study about regulation of carbohydrate metabolism
		Kreb's cycle SO3.9 Assessing mechanism of Electron transport Chain SO3 10 Assessing mechanism of		CI3.9 Electron transport Chain	
		ATP synthesis SO3.11 Assessing mechanism of oxidative phosphorylation SO3.12 Assessing mechanism of		CI3.11 Oxidative phosphorylation CI3.12 ATP Generation	
Suggested Sessional Work (SW): anyone	SW3.1 A SW3.2 N	ATP generation Assignments Mini Project Desc	cribe in detail about ca cribe the role of carbol	 rbohydrate catabolism nydrate metabolism in biolog	ical system.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	08	01	05	26

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
CO4- 02BC201.4: Assess various concepts related the lipid, fatty acid and amino acid metabolism and its significance	SO4.1 Exploring the concept of lipids biosynthesis		Unit-IV CI4.1 Lipids biosynthesis	SL4.1 Read about various pathways of lipid metabolism
	SO4.2 Assessing role of lipid and fatty acid biosynthesis	LI4.1 Quantitative estimation of amino acid	CI4.2 Biosynthesis of lipids and fatty acids	SL4.2 Collect the information about various enzymes involved in lipid metabolism
	SO4.3 Explaining the triglycerol biosynthesis		CI4.3 Biosynthesis of triglycerol	
	SO4.4 Explaining the role of phosphor-lipid biosynthesis	LI4.2 Perform Folin Lowry method of protein estimation	CI4.4 Biosynthesis of phospholipids	
	SO4.5 Evaluate role of lipid catabolism	LI4.3 Qualitative estimation of amino acid	CI4.5 Lipid catabolism	
	SO4.6 Describe the impact of lipid degradation		CI4.6 Degradation of Lipids	SL4.3 Collect information about inborn errors of lipid metabolism
	SO4.7 Describe the impact of fatty acid oxidation	LI4.4 Calcium Sulphate method of protein estimation	CI4.7 oxidation of unsaturated, saturated fatty acids	
	SO4.8 Describe the impact of fatty acid oxidation		CI4.8 oxidation of even and odd chain fatty acids	
	SO4.9 Elaborate the concept of amino acid metabolism		CI4.9 Amino acid metabolism:	SL4.4 Read various pathways of amino acid metabolism
	SO4.10 Explain the mechanism of amino acid biosynthesis		CI4.10 Biosynthetic families of amino acids: Outlines	SL4.5 Collect information of inborn errors of amino acid metabolism
	SO4.11 Explain the mechanism of amino acid catabolism		CI4.11 Catabolism of amino acids	
	SO4.12 Assessing the urea cycle		CI4.12 urea cycle	

Suggested Sessional	SW4.1 Assignments	Describe in detail about lipid and fatty acid metabolism
Work (SW): anyone	SW4.2 Mini Project	Describe the role of amino acid metabolism in biological system.
	SW4.3 Other Activities (Specify)	Prepare a model for explaining the lipid and amino acid metabolism.

			Item	Cl LI SW SL Tota
			Approx.Hrs	12 08 01 05 26
Course Outcome	SessionOutcomes(SOs)	LaboratoryIns	Classroom Instruction(CI)	Self-
(CO)		truction(LI)		Learning(SL)
CO5-02BC201.5: Appraise the relationship between purine and pyrimidine metabolism and its biological significance.	SO5.1 Define the concept of nucleotide metabolism	LI5.1 Quantitative estimation of DNA	Unit-V CI5.1 Nucleotide metabolism	SL4.1 Read about various pathways of nucleotide metabolism
	SO5.2 Able to execute role of purine biosynthesis	LI5.2 Qualitative estimation of DNA	CI5.2 Biosynthesis of purines nucleotides by denovo pathway	SL4.2 Collecttheinformationaboutvariousenzymesinvolved in nucleotidemetabolism
	SO5.3 Apply the role of pyrimidine biosynthesis	LI5.3 Quantitative estimation of RNA	CI5.3 Biosynthesis of pyrimidine nucleotides by denovo pathway	SL4.3 Collect information about inborn errors of nucleotide metabolism
	SO5.4 Evaluate the role of purine biosynthesis	LI5.4 Qualitative estimation of RNA	CI5.4 Biosynthesis of purines nucleotides by salvage pathway	
	SO5.5 Assess the role of pyrimidine biosynthesis		CI5.5 Biosynthesis of pyrimidine nucleotides by salvage pathway	SL4.4 Study about regulation of nucleotide metabolism
	SO5.6 Apply the role of purine nucleotide degradation		CI5.6 Degradation of purine nucleotides	SL4.5 Compare denovo and salvage pathways
	SO5.7 Explore about pyrimidine nucleotide degradation		CI5.7 Degradation of pyrimidine nucleotides	
	SO5.8 Explore about Errors of metabolism		CI5.8 Errors of metabolism	
	SO5.9 Revision Class		CI5.9 Revision Class	
	SO5.10 Revision Class		CI5.10 Revision Class	
	SO5.11 Revision Class		CI5.11 Revision Class	
	SO5.12 Revision Class		CI5.12 Revision Class	

Suggested Sessional	SW5.1 Assignments	Explain general mechanism of denovo and salvage pathways.
Work (SW): anyone	SW5.2 Mini Project	Describe the various components nucleotide metabolism
	SW5.3 Other Activities (Specify)	Prepare one model for showing nucleotide metabolism

Course duration (in hours) to attain Course Outcomes:

Course Title: Bioenergetics and Metabolism			Course Code:02BC201				
Course Outcomes(COs)	Class lecture	Laboratory Instruction(LI)	Self-Learning	Sessional work	Total Hours		
	(CI)		(SL)	(3W)			
CO1-02BC201.1: Understanding of the components of	15	10	5	1	31		
biological systems i.e. enzymes, vitamins and minerals							
CO2-02BC201.2: Learning in-depth information regarding the	9	0	5	1	15		
Key elements of Bioenergetics and metabolism.							
CO3-02BC201.3: Recognize various concepts related the	12	4	5	1	22		
carbohydrate metabolism and biological significance.							
CO4- 02BC201.4: Assess various concepts related the lipid,	12	8	5	1	26		
fatty acid and amino acid metabolism and its significance							
CO5-02BC201.5: Appraise the relationship between purine and	12	8	5	1	26		
pyrimidine metabolism and its biological significance.							
Total Hours	60	30	25	05	120		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Bioenergetics and Metabolism

Course Code:02BC201

Course Outcomes		Marks Distribution			
	Α	An	Ε	С	Total Marks
CO1-02BC201.1: Understanding of the components of biological systems i.e. enzymes, vitamins and	2	1	1	1	5
minerals					
CO2-02BC201.2: Learning in-depth information regarding the Key elements of Bioenergetics and	2	4	2	2	10
metabolism.					
CO3-02BC201.3: Recognize various concepts related the carbohydrate metabolism and biological	3	5	5	2	15
significance.					
CO4- 02BC201.4: Assess various concepts related the lipid, fatty acid and amino acid metabolism and its	2	3	3	2	10
significance					
CO5-02BC201.5: Appraise the relationship between purine and pyrimidine metabolism and its biological	5	4	1	0	10
significance.					
Total Marks	14	17	12	07	50

(a) Books:

S.No.	Title/Author/Publisher details
1	Biochemistry by G. Zubey.
2	Biochemistry, D. Freifilder, W.H. Freeman & Company.
3	Harper's Biochemistry, Murray et al., Mc Graw Hill.
4	Principles of Biochemistry, Lehininger, Nelson and Cox.
5	Clinical Biochemistry by MN Chaterji and Rana Shinde

(b) Online Resources:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Hons Biotechnology

Semester: I Semester

Course Title: Bioenergetics and Metabolism **Course Code:** 02BC201

Course Outcome (Cos)		Program Outcomes (POs)								Program Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02BC201.1: Understanding of the	1	2	2	2	3	3	2	3	3	1	2	3	2	2	3
components of biological systems i.e.															
enzymes, vitamins and minerals															
CO2-02BC201.2: Learning in-depth	1	2	1	1	2	2	2	2	2	2	2	2	2	3	2
information regarding the Key elements of															
Bioenergetics and metabolism.															
CO3-02BC201.3: Recognize various concepts	1	2	2	2	1	2	1	1	2	1	2	2	1	2	2
related the carbohydrate metabolism and															
biological significance.															
CO4- 02BC201.4: Assess various concepts	1	1	2	1	2	3	2	2	3	2	1	3	1	2	3
related the lipid, fatty acid and amino acid															
metabolism and its significance															
CO5-02BC201.5: Appraise the relationship between purine and pyrimidine metabolism and its biological significance.	1	2	2	1	1	3	1	1	3	2	2	3	1	2	3

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
PO 1,2,3,4,5, 6,	CO1-02BC201.1: Understanding of the	SO1.1 SO1.2	1.1,1.2,1.3,1.4,1.5,	1.1,1.2,1.3,1.4,1.5,	1SL-1,2,3,4,5
7,8,9,10,11, 12	components of biological systems i.e. enzymes,	SO1.3 SO1.4		1.6, 1.7, 1.8, 1.9,	
	vitamins and minerals	SO1.5 SO1.6		1.10, 1.11, 1.12,	
PSO 1,2,3		SO1.7 SO1.8		1.13, 1.14, 1.15	
		SO1.9 SO1.10			
		SO1.11 SO1.12			
		SO1.13 SO1.14			
		SO1.15			
PO 1,2,3,4,5, 6,	CO2-02BC201.2: Learning in-depth information	SO2.1 SO2.2		2.1, 2.2, 2.3, 2.4,	2SL-1,2,3,4,5
7,8,9,10,11, 12	regarding the Key elements of Bioenergetics	SO2.3 SO2.4		2.5, 2.6, 2.7, 2.8,	
	and metabolism.	SO2.5 SO2.6		2.9	
PSO 1,2,3		SO2.7 SO2.8			
		SO2.9			
PO 1,2,3,4,5, 6,	CO3-02BC201.3: Recognize various concepts	SO3.1 SO3.2	3.1,3.2	3.1,3.2,3.3,3.4,3.5,	3SL-1,2,3,4,5
7,8,9,10,11, 12	related the carbohydrate metabolism and	SO3.3 SO3.4		3.6, 3.7, 3.8, 3.9,	
	biological significance.	SO3.5 SO3.6		3.10, 3.11, 3.12	
PSO 1,2,3		SO3.7 SO3.8			
		SO3.9 SO3.10			
		SO3.11 SO3.12			
PO 1,2,3,4,5, 6,	CO4- 02BC201.4: Assess various concepts	SO4.1 SO4.2	4.1,4.2,4.3,4.4	4.1,4.2,4.3,4.4,	4SL-1,2,3,4,5
7,8,9,10,11, 12	related the lipid, fatty acid and amino acid	SO4.3 SO4.4		4.5, 4.6,4.7, 4.8,	
	metabolism and its significance	SO4.5 SO4.6		4.9, 4.10, 4.11,	
PSO 1,2,3		SO4.7 SO4.8		4.12	
		SO4.9 SO4.10			
		SO4.11 SO4.12			
PO 1,2,3,4,5, 6,	CO5-02BC201.5: Appraise the relationship	SO5.1 SO5.2	5.1,5.2,5.3, 5.4	5.1,5.2,5.3,5.4,5.5,	5SL-1,2,3,4,5
7,8,9,10,11, 12	between purine and pyrimidine metabolism and	SO5.3 SO5.4		5.6, 5.7, 5.8, 5.9,	
	its biological significance.	SO5.5 SO5.6		5.10, 5.11, 5.12	
PSO 1,2,3		SO5.7 SO5.8			
		SO5.9 SO5.10			
		SO5.11 SO5.12			

Program Name	B.Sc. (HONOURS) BIOTECHNOLOGY	B.Sc. (HONOURS) BIOTECHNOLOGY						
Semester	II nd							
CourseCode:	02MB201							
Coursetitle:	MICROBIAL PHYSIOLOGY	WICROBIAL PHYSIOLOGY Curriculum Developer: Mr. Vivek Kumar Agnihotri, Assistant Professor						
Pre-requisite:	Prerequisites for studying microbial physiology include a strong foundation in microbiology, biochemistry, molecular biology, and laboratory skills, encompassing an understanding of microbial growth, metabolism, genetics, and cellular processes.							
Rationale:	The study of microbial physiology provides insights into the fundamental processes governing microorganisms' growth, metabolism, and behavior, which is essential for various applications in biotechnology, medicine, and environmental science.							
CourseOutcomes (COs):	CO1-02MB201.1: Understand the nutritional requirements of microorganisms and classify them based on carbon, energy, and electron sources. CO2-02MB201.2: Analyze growth curves and interpret mathematical expressions of microbial growth. CO3-02MB201.3: explores microbial growth temperature ranges, classification, and adaptations, pH ranges, and adaptations, oxygen concentration effects. CO4-02MB201.4: Understand the diversity of photosynthetic pigments and their roles in phototrophic metabolism. CO55-02MB201.5: Understand the various pathways involved in microbial energetics and their significance in energy metabolism							

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	(L:T:P=4:0:2)		
Minor	02MB201	Microbial Physiology	4	4	1	2	11	4+2=6		

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note:
 SU has to be planned and performed under the centinuous guidence and feedback of teacher to achieve course of

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)			
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02MB201	Microbial Physiology	15	20	5	5	5	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02MB201-L	Microbial Physiology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session	Approxin	nateHours					
levels, which students are anticipated to accomplish through various modes of instruction including	-						
Classroom Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning		Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs),		Approx.Hrs	12	06	01	02	21
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-02MB201.1: Understand the nutritional requirements of microorganisms and	SO1.1 Explain the importance of nutritional classification in understanding microbial metabolism and ecology.	LI1.1 Basics of media	CI1.1 Introduction to Microbial Nutritional Classification	SL1.1 Remember taxonomical classification of archaea and bacteria
classify them based on carbon, energy, and electron sources	CI1.2 Classify microorganisms based on their carbon source preferences	LI1.2 Perform Sterilization Technique	CI1.3 Carbon Sources in Microbial Nutrition	SL1.2 Learn classification of microorganism
	SO1.2 Know about Energy Sources in Microbial Nutrition	LI1.3 preparation of different carbons sources	CI1.4 Energy Sources in Microbial Nutrition	
	SO1.3 Know about Electron Sources in Microbial Nutrition		CI1.5 Electron Sources in Microbial Nutrition	
	SO1.4 Know about Chemo lithotrophic Metabolism		CI1.6 Chemo lithotrophic Metabolism	
	SO1.5 Understand the Physiological Groups of Aerobic Chemolithotrophs		CI1.7 Physiological Groups of Aerobic Chemolithotrophs	
	SO1.6 Understand the Physiological Groups of Anaerobic Chemolithotrophs		CI1.8 Physiological Groups of Anaerobic Chemolithotrophs	
	SO1.7 Know about Hydrogen- Oxidizing Bacteria		CI1.9 Hydrogen-Oxidizing Bacteria	
	SO1.8 Know about Methanogens		CI1.10 Methanogens	
	SO1.9 Understand Classification of Microorganisms Based on Nutritional Preferences		CI1.11 Classification of Microorganisms Based on Nutritional Preferences	
	SO1.10KnowaboutAdaptationsofMicroorganismstoDifferent Environmental Conditions		CI1.12 Adaptations of Microorganisms to Different Environmental Conditions	
	SO1.11 Understand Integration and Application of Concepts		CI1.13 Integration and Application of Concepts	

Suggested Sessional Work	SW1.1 Assignments	Summarizes the Environmental Adaptations of Hydrogen-Oxidizing Bacteria
(SW): anyone	SW1.2 Mini Project	To demonstrate chemo lithotrophic metabolism in microbial cultures.
	SW1.3 Other Activities (Specify)	Students will conduct a research project on nitrogen metabolism in microorganisms and its ecological implications.

				Item		Cl	LI	SW	SL	Total
				Appro	ox.Hrs	12	4	1	2	19
Course Outcome (CO)	SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction (CI)		Self-Le	earning	g (SL)		
CO2- 02MB201.2Analyze growth curves and interpret mathematical	SO2.1 Understand the fundamental concepts and definitions related to the growth and development of microorganisms.	LI2.1 Discuss how to analyze growth rate of microbial population.	CI2.1 Fundamental of and definitions related growth and developm microorganisms.	to the ent of	SL2.1 grov	Contra wth me	ast th dia	e prep	paratio	n of
expressions of microbial growth.	SO2.2 Analyze the phases of microbial growth and their significance in microbial physiology and ecology.	LI2.2 analyze growth rate of microbial population.	CI2.2 Phases of m growth and their signific microbial physiology ecology.	ance in and	SL2.2 exp	Recall ression	of gro	ma owth ki	athema netics	atical
	SO2.3 Interpret growth curves and mathematical expressions of microbial growth to assess growth kinetics.		CI2.3 Growth curves mathematical expression microbial growth to assess kinetics.	s and ons of s growth						
	SO2.4 Evaluate the influence of environmental factors on microbial growth and development.		CI2.4 Influence environmental factors microbial growth development.	of on and						
	SO2.5 Explain the mechanisms of group translocation, including the phosphotransferase system, and its role in microbial metabolism.		CI2.5 Mechanisms of translocation, including phosphotransferase syste its role in microbial metable	group g the m, and oolism.						
	SO2.6 Differentiate between various types of membrane transport processes, such as symport, antiport, and uniport.		CI2.6 Various type membrane transport pr such as symport, antipo uniport.	s of ocesses, ort, and						
	SO2.7 Define and compare electrogenic and electro-neutral transport mechanisms in microorganisms.		CI2.7 Electrogenic and neutral transport mechan microorganisms.	electro- isms in						
	SO2.8 Apply knowledge of microbial growth and transport processes to solve practical problems in microbiology and biotechnology.		CI2.8 Microbial grow transport processes to practical problems microbiology and biotechn	th and solve in nology.						
	SO2.9 Understand the mechanism of group translocation and its significance in microbial metabolism.		CI2.9 Mechanism of translocation and its sign in microbial metabolism.	group						

SO2.10 Describe the components and regulation of the phosphotransferase system in bacteria.	CI2.10 The components and regulation of the phosphotransferase system in bacteria.	
SO2.11 Students will differentiate between symport, antiport, and uniport mechanisms of membrane transport.	CI2.11 Symport, antiport, and uniport mechanisms of membrane transport.	
SO2.12 Students will analyze the physiological roles of membrane transport processes in nutrient uptake, osmoregulation, and signal transduction in microorganisms.	CI2.12 Physiological roles of membrane transport processes in nutrient uptake, osmoregulation, and signal transduction in microorganisms.	

Suggested Sessional	SW2.1 Assignments	Describe the phases of microbial growth, including lag phase, exponential phase, stationary
Work (SW): anyone		phase, and death phase.
	SW2.2 Mini Project	calculate growth parameters such as growth rate, generation time, and doubling time based
		on experimental data.
	SW2.3 Other Activities (Specify)	

			Itor	m	Cl	TT	SW	SI	Total
					12	DI O	1	<u>5</u> 2	24
			Ap	prox.Hrs	12	ð		2	24
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction	Self	Self-Learning(SL)				
			(CI)						
CO3-02MB201.3explores	SO3.1 Know about Temperature	LI3.1 Determination of pH	CI3.1 Temperature	and SL3	.1 Practi	ce		Trans	port
microbial growth temperature	and Microbial Growth	of Microbial Media.	Microbial Growth	Me	chanism				
ranges, classification, and	SO3.2 Know about pH and	LI3.2 Effect of	CI3.2 pH and Micro	obial SL3	.2 Learn	F	Radiatio	n	and
adaptations, pH ranges, and	Microbial Adaptation	Temperature of microbial	Adaptation	Pre	ssure		effect		on
adaptations, oxygen concentration	_	growth.	-	Mi	croorgan	isms			
effects.	SO3.3 Know about Oxygen	LI3.3 Effect of	CI3.3 Oxygen						
and apply problem-solving skills in	Concentration and Microbial	nutrients of microbial	Concentration and Micro	obial					
biological analyses.	Metabolism	growth.	Metabolism						
	SO3.4 Learn Metabolite	LI3.4 Calculation of	CI3.4 Metabolite Trans	sport					
	Transport Across Membranes	TDP	Across Membranes	-					
	SO3.5 Describe Active		CI3.5 Active Trans	sport					
	Transport Mechanisms		Mechanisms	-					
	SO3.6 Know about Radiation		CI3.6 Radiation	and					
	and Pressure Effects on		Pressure Effects	on					
	Microorganisms		Microorganisms						
	SO3.7 Explain the mechanisms		CI3.7 Mechanisms	of					
	of metabolite transport across		metabolite transport ac	cross					
	microbial cell membranes,		microbial cell membra	anes,					
	including passive diffusion		including passive diffu	ision					
	and facilitated diffusion.		and facilitated diffusion.						

SO3	3.8 Know about the factors	CI3.8 The factors	
	influencing the rate of	influencing the rate of	
	metabolite transport and	metabolite transport and	
	predict the transport	predict the transport	
	mechanisms under different	mechanisms under different	
	conditions.	conditions.	
SO3	3.9 Differentiate between	CI3.9 Primary active and	
	primary active and secondary	secondary active transport	
	active transport mechanisms	mechanisms and describe	
	and describe their molecular	their molecular mechanisms.	
	mechanisms.		
SO3	3.10 Know the effects of	CI3.10 Effects of radiation	
	radiation and pressure on	and pressure on microbial	
	microbial growth, survival,	growth, survival, and DNA	
	and DNA damage.	damage.	
SO3	3.11 Learn microbial	CI3.11 Microbial adaptations	
	adaptations to extreme	to extreme environmental	
	environmental conditions,	conditions, including	
	including mechanisms of	mechanisms of radiation	
	radiation resistance and	resistance and barophilic	
	barophilic adaptations.	adaptations.	
SO3	3.12 Learn adaptations of	CI3.12 Adaptations of	
	microorganisms to varying	microorganisms to varying	
	oxygen levels, including	oxygen levels, including	
	aerotolerance mechanisms	aerotolerance mechanisms	
	and anaerobic metabolism	and anaerobic metabolism	
	pathways	pathways	

Suggested Sessional	SW3.1 Assignments	Write about microorganism adaptation.
Work (SW): anyone	SW3.2 Mini Project	
	SW3.3 Other	Search and find the effects of radiation and pressure on microbial growth.
	Activities (Specify)	

			Item	Cl	LI	SW	SL	Total
			Approx.Hrs	12	6	1	2	21
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-L	earn	ing(SI	J)	
CO4-	SO4.1 Know abou	LI4.1 To isolate and	CI4.1 Introduction to	SL4.1	Lea	arn teo	chniqu	ues
02MB201.4: Understand	Photosynthesis	analyze photosynthetic	Photosynthesis	of	chro	matog	raphy	
the diversity of		pigments from plant leaves						
photosynthetic pigments		using chromatography.						

and their roles in	SO4.2 Learn anoxygenic and	LI4.2 To measure the	CI4.2 Anoxygenic and	SL4.2 Recall two
phototrophic metabolism.	Oxygenic Photosynthesis	rate of oxygen evolution	Oxygenic Photosynthesis	phtosystem
		during photosynthesis		
		using an oxygen electrode.		
	SO4.3 Know about Two	LI4.3 To measure the	CI4.3 Two Photosystems	
	Photosystems Concept	rate of oxygen evolution.	Concept	
	SO4.4 Students will know		CI4.4 Photosynthetic Pigments	
	about Photosynthetic Pigments		and Photophosphorylation	
	and Photophosphorylation			
	SO4.5 Understand Physiology		CI4.5 Physiology of Bacterial	
	of Bacterial Photosynthesis		Photosynthesis	
	SO4.6 Know about Carbon		CI4.6 Carbon Dioxide Fixation	
	Dioxide Fixation and the Calvin		and the Calvin Cycle	
	Cycle			
	SO4.7 Know about		CI4.7 Crassulacean Acid	
	Crassulacean Acid Metabolism		Metabolism (CAM) Plants	
	(CAM) Plants			
	SO4.8 Learn Photorespiration		CI4.8 Photorespiration and	
	and Compensation Point		Compensation Point	
	SO4.9 Understand the		CI4.9 Photosynthetic Efficiency	
	Photosynthetic Efficiency and		and Environmental Factors	
	Environmental Factors			
	SO4.10 Know about Nitrogen		CI4.10 Nitrogen Fixation	
	Fixation and Photosynthesis		and Photosynthesis	
	SO4.11 Understand the		CI4.11 Biotechnological	
	Biotechnological Applications		Applications of Photosynthesis	
	of Photosynthesis			
	SO4.12 Know about future		CI4.12 Future Directions	
	Directions in Photosynthesis		in Photosynthesis Research	
	Research			

Suggested Sessional	SW4.1 Assignments	Write about CAM
Work (SW): anyone	SW4.2 Mini Project	
	SW4.3 Other	Search and learn via YouTube how to extract chlorophyll
	Activities (Specify)	

		Item Cl I					SL	Total
				Approx.Hrs 12	6	1	2	21
Course Outcome		SessionOutcomes(SOs)	LaboratoryInstructio	ClassroomInstructio		Self	_	
(CO)			n(LI)	n(LI) n(CI) Lear				
CO55-02MB201.5: T	Го	SO5.1 Introduction to Microb	ial LI5.1 measure	CI5.1 Introduction to	SL5	1 Lear	'n	
measure the rate	of oxygen	Energetics	nitrogen fixation activity	Microbial Energetics	ferm	entatio	on pat	hway in
evolution	during	C C	in nitrogen-fixing		micr	obes	•	•
photosynthesis us	sing an	SO5.2 The Entner-Doudoro	off bacteria using the	CI5.2 The Entner-	SL5	.2 Cla	ssify	electron
oxygen electrode.		(ED) Pathway	acetylene reduction	Doudoroff (ED) Pathway	trans	sport		
			assay.					
		SO5.3 The Glyoxylate Cycle		CI5.3 The Glyoxylate				
				Cycle				
		SO5.4 Mitochondrial and Bacter	ial LI5.2 To measure	CI5.4 Mitochondrial and				
		Electron Transport	ATP production in	Bacterial Electron				
		SO5 5 Former totion Dethurous	microbial fermentation	I ransport				
		SU5.5 Fermentation Pathways	In pathways using a luciferase based assay	CI5.5 Fermentation				
	SO5.6 Nitrogon Eiving Microbes: LI5.3 Demonstrate CI5.6 Nitrogon Eiving							
		Rhizobium	fermentor	Microbes: Rhizobium	Ś			
		SO5.7 Nitrogen-Fixing Microbe	es:	CI5.7 Nitrogen-Fixing				
		Azotobacter		Microbes: Azotobacter				
		SO5.8 Describe Properties	of	CI5.8 Properties of				
		Nitrogenase and Hydrogenase		Nitrogenase and				
				Hydrogenase				
		SO5.9 Explain the Nif Gene at	nd	CI5.9 The Nif Gene and				
		Regulation of Nitrogen Fixation		Regulation of Nitrogen				
			-	Fixation				
		SO5.10 Compare t	he	CI5.10 Inorganic and				
		Mitra and Firstian	lar	Molecular Nitrogen				
		Nitrogen Fixation	ha	Fixation				
		subway of Nitrate Reduction	nd	and Ammonium				
		Ammonium Assimilation		Assimilation				
		SO5.12 Integration a	nd	CI5.12 Integration and				
	Applications of Nitrogen Applications of Nitrogen							
		Metabolism		Metabolism				
Suggested Sessional	SW5.1 Ass	ignments	Write about application of nitro	ogen metabolism				
Work (SW): anyone	SW5.2 Mir	ni Project	<u> </u>					
	SW5.3 Oth	er Activities (Specify)	Try to learn Ed pathway					

Course Title: Microbial physiology

Course Code:02MB201

Course Outcomes (COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction (LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-02MB201.1: Understand the nutritional requirements	12	6	2	1	21
of microorganisms and classify them based on carbon,					
energy, and electron sources.					
CO2-02MB201.2Analyse growth curves and interpret	12	4	2	1	19
mathematical expressions of microbial growth.					
CO3-02MB201.3 explores microbial growth temperature	12	8	2	1	24
ranges, classification, and adaptations, pH ranges, and					
adaptations, oxygen concentration effects.					
CO4-02MB201.4: Understand the diversity of	12	6	2	1	21
photosynthetic pigments and their roles in phototrophic					
metabolism.					
CO55-02MB201.5: Understand the various pathways	12	6	2	1	21
involved in microbial energetics and their significance in					
energy metabolism.					
Total Hours	60	30	10	05	105

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Microbial physiology

Course Code:02MB201

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-02MB201.1: Understand the nutritional requirements of microorganisms and classify them	02	03	04	1	10
based on carbon, energy, and electron sources.					
CO2-02MB201.2Analyze growth curves and interpret mathematical expressions of microbial	03	04	02	1	10
growth.					
CO3-02MB201.3 explores microbial growth temperature ranges, classification, and adaptations,	02	05	02	1	10
pH ranges, and adaptations, oxygen concentration effects.					
CO4-02MB201.4: Understand the diversity of photosynthetic pigments and their roles in	02	05	02	1	10
phototrophic metabolism.					
CO55-02MB201.5: Understand the various pathways involved in microbial energetics and their	03	04	03	1	11
significance in energy metabolism.					
Total Marks	12	21	13	05	51

(a) Books:

S.No.	Title/Author/Publisher details	
1	Microbial Physiology: Unity and Diversity (ASM Books) 1st Edition	Ann M. Stevens (Author), Jayna L. Ditty (Author), Rebecca E.
	Parales (Author), Susan M. Merkel (Author) 2024	
2	MICROBIAL PHYSIOLOGY WILL MORGAN Amazon 2024	
3	Microbial Physiology S Meena Kumari MJP Publishers	2007

(b) Online Resources:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Research lab (BSL-1)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

Program Name: B.Sc. Biotechnology Semester:IInd Sem Course Title: Microbial physiology Course Code: 02MB201

	CO/PO/PSO Mapping														
Course Outcome (Cos)					Ι	Program	Outcom	es (POs))				Program Specific		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	POQ	PO10	PO11	PO12		PSO2	505) PSO3
CO1-02MB201.1: Understand the nutritional requirements of microorganisms and classify them based on carbon, energy, and electron sources.	-	-	-	1	2	2	1	-	1	2	2	3	3	3	1
CO2-02MB201.2 Analyze growth curves and interpret mathematical expressions of microbial growth.	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
CO3-02MB201.3 explores microbial growth temperature ranges, classification, and adaptations, pH ranges, and adaptations, oxygen concentration effects.	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
CO4-02MB201.4: Understand the diversity of photosynthetic pigments and their roles in phototrophic metabolism.	-	1	1	-	2	2	2	3	-	1	-	-	1	2	3
CO55-02MB201.5: Understand the various pathways involved in microbial energetics and their significance in energy metabolism.	1	1	1	-	-	2	3	3	1	2	2	2	1	-	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs &	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning
PSOs No.			Instruction (LI)		(SL)
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO1-02MB201.1: Understand the nutritional requirements of microorganisms and classify them based on carbon, energy, and electron sources.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	IL 1 IL 2 IL 3	1.1,1.2,1.3,1.4,1.5,1.6.1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO2-02MB201.2 Analyze growth curves and interpret mathematical expressions of microbial growth.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5,2.6,2.7,2.8,2.9,2.10, 2.11,2.12	IL 1 IL 2	2.1, 2.2, 2.3, 2.4,2.5,2.6,2.7,2.8,2.9,2.10, 2.11,2.12	2SL-1,2
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO3-02MB201.3 explores microbial growth temperature ranges, classification, and adaptations, pH ranges, and adaptations, oxygen concentration effects.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6, .7,3.8,3.9,3.10,.311,3.12	IL 1 IL 2 IL 3 IL 4	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9, 3.10,3.11,3.12	3SL-1,2
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO4-02MB201.4: Understand the diversity of photosynthetic pigments and their roles in phototrophic metabolism.	SO4.1 SO4.2 SO4.3 SO4.4,SO 4.5,SO4.6, SO4.7, SO4.8, SO 4.9, SO4.10 SO4.11 SO4.12	IL 1 IL 2 IL 3	4.1,4.2,4.3,4.4,4.5,4.6, 4.7, 4.8 ,4.9, 4.10,4.11, 4.12	4SL-1,2
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO55-02MB201.5: Understand the various pathways involved in microbial energetics and their significance in energy metabolism.	SO5.1 SO5.2 SO5.3 SO5.4,SO5.5, SO5.6, SO5.7, SO5.8, SO5.9, SO5.10, SO5.11, SO5.12	IL 1 IL 2 IL 3	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12	5SL-1,2

Program Name	Bachelor of Science (Hons.) Biotechnology							
Semester	П							
CourseCode:	03BC201							
Coursetitle:	Bioenergetics and Metabolism	Curriculum Developer: Mrs. Pratima Mishra, Guest Faculty						
Pre-requisite:	Students should have basic knowledge of Biomolecules, Biochemistry and Chemistry							
Rationale:	The Bioenergetics and Metabolism course in a transform, and utilize energy at the molecular like fermentation and metabolic engineering biotechnological solutions for healthcare, such integrates biology, chemistry, and physics, fost and innovation in a rapidly evolving field.Top of	The Bioenergetics and Metabolism course in a B.Sc. (Hons.) Biotechnology program is essential for understanding how organisms acquire, transform, and utilize energy at the molecular level. It provides foundational knowledge crucial for optimizing biotechnological processes like fermentation and metabolic engineering. Understanding metabolic pathways and energy transformations is vital in developing biotechnological solutions for healthcare, such as metabolic disorders and drug metabolism studies. The course's interdisciplinary approach integrates biology, chemistry, and physics, fostering critical thinking and preparing graduates for diverse careers in biotechnology, research, and innovation in a rapidly evolving field Top of Form						
Course Outcomes (COs):	CO1-03BC201.1: Understanding of the componen CO2-03BC201.2: Learning in-depth information re CO3-03BC201.3: Recognize various concepts relat CO4- 03BC201.4: Assess various concepts related CO5-03BC201.5: Appraise the relationship betwee	ts of biological systems i.e. enzymes, vitamins and minerals garding the Key elements of Bioenergetics and metabolism ed the carbohydrate metabolism and biological significance. the lipid, fatty acid and amino acid metabolism and its significance en purine and pyrimidine metabolism and its biological significance.						

Scheme of Studies:

					ırs/Week)				
Board of Study	Course Code	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)	
Generic Elective	03BC201	Bioenergetics and Metabolism	3	2	1	5	11	3+1=4	

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

					Scł	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03BC201	Bioenergetics and Metabolism	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)	-		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03BC201-L	Bioenergetics and Metabolism	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and	ApproximateHours						
session levels, which students are anticipated to accomplish through various modes of				-			
instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional		Item	Cl	LI	SW	SL	Total
Work (SW), and Self Learning (SL). As the course progresses, students should showcase		Approx.Hrs	13	6	01	05	25
their mastery of Session Outcomes (SOs), culminating in the overall achievement of							
Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-03BC201.1: Understanding of the components of biological systems i.e. enzymes, vitamins and minerals	SO1.1 Define and Describe concept and Nomenclature of Enzymes	LI1.1 Determination of enzyme activity	Unit 1 CI1.1 Enzymes: Nomenclature	SL1.1 Search various reference books and study material to start the learning
	SO1.2 Describe about classification of enzyme	LI1.2 Identification of enzyme	CI1.2 Enzyme Classification	SL1.2 Check the properties of enzymes
	SO1.3 Explain about characteristics of enzyme		CI1.3 Characteristics	SL1.3 Learn about various categories of enzymes
	SO1.4 Describe factors affecting enzyme activity		CI1.4 Factors affecting enzyme activity	SL1.4 Enlist the structure and properties of different vitamins
	SO1.5 Study the mechanism of enzyme		CI1.5 Mechanism of enzyme action	
	SO1.6 Study MM equation		CI1.6 MM Equation	
	SO1.7 Describe enzyme specificity		CI1.7 Enzyme specificity	
	SO1.8 Assess application of enzyme		CI1.8 Application of Enzyme	SL1.5 Enlist the structure and properties of different minerals
	SO1.9 Describe concept and types of vitamins		CI1.9 Vitamins: Introduction, types	
	SO1.10 Describe structure and sources of vitamins		CI1.10 Structure, Sources,	
	SO1.11 Describe function and deficiency of vitamins		CI1.11 Function and deficiencies of water soluble vitamins.	
	SO1.12 Describe function and deficiency of vitamins		CI1.12 Function and deficiencies of fat-soluble vitamins	
	SO1.13 Assess types Function and deficiencies of nutrients		CI1.13 Minerals: Introduction, types, Function and deficiencies of micro and macro nutrients	

Suggested Sessional Work	SW1.1 Assignments	Describe in detail classification, characteristics and biological significance of enzyme.					
(SW):anyone	SW1.2Mini Project	Prepare a chart on vitamins and minerals.					
	SW1.3 Other Activities (Specify)	Collect the data about biological role of vitamins/minerals and their deficiencies.					

				Item		Cl	LI	SW	SL	Total
				Appr	ox.Hrs	06	00	01	05	12
Course	Session Outcomes	Laboratory Instruction (LI)	Classroom Instruction		Self L	earnin	g (SL)		
Outcome (CO)	(SOs)		(CI)							
CO2-03BC201.2:	SO2.1 Assess the concept of		Unit-II		SL2.1	Enlist	tl	he	differ	ent
Learning in-depth	bioenergetics and metabolism		CI2.1 Bioenergetics	and	compo	nents o	f bioe	nerge	tics	
information regarding			metabolism: Basic conce	epts						
the Key elements of										
Bioenergetics and										
metabolism										
	SO2.2 Explain about first law		CI2.2 First law	of	SL2.2	Asses	s bio	logica	l role	of
	of thermodynamics		thermodynamics		thermo	odynan	nics			
	SO2.3 Explain about second		CI2.3 second law	of	SL2.3	Learn	ab	out	role	of
	law of thermodynamics		thermodynamics		thermo	odynan	nics ir	n meta	bolisn	1
	SO2.4 Explain about high		CI2.4 High e	nergy	SL2.4	Learn	st	ructu	re a	and
	energy phosphor compounds		phosphate compoun	ds	function	on of N	TPs			
	SO2.5 Describe the role of		CI2.5 structural basi	s of	SL2.5	colle	ction	of d	ata ab	out
	ATP hydrolysis pathway		free energy cl	hange	interm	ediary	metal	oolisn	1	
	5 5 1 5		during hydrolysis of	ATP		5				
			role of ATP							
	SO2.6 Describe biological		CI2.6 ATP and its ro	ole in						
	role of ATP		biological system.							
Suggested Sessional	SW2.1 Assignments	Describe in detail bioener	getics and their biological	l role.						
Work (SW) :anyone	SW2.2 Mini Project	Explain the mechanism of	nism of energy transfer in biological system.							
· · · -	SW2.3 Other Activities (Speci	fy) Write an article on error of	of metabolism.							

				Item		Cl	LI	SW	SL	Total
				Appro	ox.Hrs	10	02	01	05	18
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	1	Self-Lear	rning (SL)		<u>.</u>	
CO3-03BC201.3: Recognize various concepts related the carbohydrate metabolism and biological significance.	SO3.1 Explain the concept and components of carbohydrate metabolism	SL3.1 Quantitative estimation of carbohydrate	Unit-III CI3.1 Carbohydrate metabolism		SL3.1 Re of carboh	ad abo ydrate	out va metab	rious olism	pathw	ays
	SO3.2 Assessing the structure and mechanism of gycolysis		CI3.2 Glycolysis		SL3.2 Co various carbohyd	ollect the enzymate me	ne inf nes taboli	ormati invol sm	ion ab lved	out in
	SO3.3 Assessing the structure and mechanism of pyruvate activation		CI3.3 activation of pyruvate		SL3.3 Co various carbohyd	ollect the energy of the energ	ne inf gy etaboli	ormati balan sm.	ion ab ces	out of
	SO3.4 Assessing mechanism of Glycogenesis		CI3.4 Glycogenesis							
	SO3.5 Describe about mechanism of Glycogenolysis		CI3.5 Glycogenolysis	5						
	SO3.6 Assessing the role of Gluconeogenesis		CI3.6 Gluconeogenes	sis	SL3.4 Co inborn metabolis	ollect errors	infor of	matior carl	n ab bohydr	out ate
	SO3.7 Describe about role of Pentose Phosphate Pathway		CI3.7 Pentose phosp pathway	hate	SL3.5 Stu carbohyd	udy abo rate me	out reg taboli	ulatio sm	n of	
	SO3.8 Assessing mechanism of Kreb's cycle		CI3.8 Kreb's cycle							
	SO3.9 Assessing mechanism of Electron transport Chain		CI3.9 Electron transp Chain	ort						
	SO3.10 Assessing ATP synthesis oxidative phosphorylation		CI3.10 ATP synthesis Oxidative phosphorylati	and ion						

Suggested Sessional	SW3.1 Assignments	Describe in detail about carbohydrate catabolism
Work (SW): anyone	SW3.2 Mini Project	Describe the role of carbohydrate metabolism in biological system.
	SW3.3 Other	Prepare a model for explaining the carbohydrate metabolism.
	Activities (Specify)	

				Item	Cl	LI	SW	SL	Total
				Approx.Hrs	10	05	01	05	21
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruc	tion(CI)	Self-Le	earnii	ng(SL))	
CO4- 03BC201.4: Assess various concepts related the lipid, fatty acid and amino acid metabolism and its significance	SO4.1 Exploring the concept of lipids biosynthesis		Unit-IV CI4.1 Lipids bios	ynthesis	SL4.1 F pathway	Read /s of li	abou pid me	ıt taboli:	various sm
	SO4.2 Assessing role of lipid and fatty acid biosynthesis	LI4.1 Quantitative estimation of a mino acid	CI4.2 Biosynthesi and fatty acids	s of lipids	SL4.2 C about v in lipid	Collect arious metab	the enzyr olism	infoi nes ir	rmation wolved
	SO4.3 Explaining the triglycerol biosynthesis		CI4.3 Biosynthesi triglycerol	s of					
	SO4.4 Explaining the role of phosphor-lipid biosynthesis	LI4.2 Perform Folin Lowry method of protein estimation	CI4.4 Biosynthesi phospholipids	s of					
	SO4.5 Evaluate role of lipid catabolism		CI4.5 Lipid catab	olism					
	SO4.6 Describe the impact of lipid degradation		CI4.6 Degradation	n of Lipids	SL4.3 (inborn e	Collect errors (inforr of lipid	nation metal	about oolism
	SO4.7 Describe the impact of fatty acid oxidation		CI4.7 oxidation of saturated fatty acids	f unsaturated,					
	SO4.8 Describe the impact of fatty acid oxidation		CI4.8 oxidation of odd chain fatty acid	f even and s					
	SO4.9 Elaborate the concept of amino acid metabolism		CI4.9 Amino acid Biosynthetic familie acids: Outlines	metabolism: es of amino	SL4.4 F amino a	Read v cid me	arious etabolis	pathv sm	vays of
	SO4.10 Explain the amino acid catabolism and Urea cycle		CI4.10 Catabolism acids, urea cycle	of amino	SL4.5 (errors of	Collect amino	informa acid me	tion o etabolis	f inborn sm

Suggested Sessional	SW4.1 Assignments	Describe in detail about lipid and fatty acid metabolism
Work (SW): anyone	SW4.2 Mini Project	Describe the role of amino acid metabolism in biological system.
	SW4.3 Other Activities (Specify)	Prepare a model for explaining the lipid and amino acid metabolism.

			Item	Cl	LI	SW	SL	Total
			Approx.Hrs	06	02	01	05	14
Course Outcome	SessionOutcomes(SOs)	LaboratoryIns	Classroom Instruction(CI)	-	Self]-		
(CO)		truction(LI)		Lea	arnin	g(SL)		
CO5-03BC201.5: Appraise the relationship between purine and pyrimidine metabolism and its biological significance.	SO5.1 Define the concept of nucleotide metabolism	LI5.1 Quantitative estimation of DNA	Unit-V CI5.1 Nucleotide metabolism	SL4.1 variou nucle	l Rea us otide	ad pathwa metabo	abo ays olism	out of
	SO5.2 Able to execute role of purine biosynthesis		CI5.2 Biosynthesis of purines nucleotides by denovo pathway	SL4 infor vario invo meta	.2 Col rmatic ous lved abolisi	llect on in nue m	th abou nzyme cleotid	e it es e
	SO5.3 Apply the role of pyrimidine biosynthesis		CI5.3 Biosynthesis of pyrimidine nucleotides by denovo pathway	SL4 infor inbox nucle	.3 Col rmatic rn eotide	llect on errors e metab	abou s c olism	ıt of
	SO5.4 Evaluate the role of purine biosynthesis		CI5.4 Biosynthesis of purines nucleotides by salvage pathway					
	SO5.5 Assess the role of pyrimidine biosynthesis		CI5.5 Biosynthesis of pyrimidine nucleotides by salvage pathway	SL4. regul meta	.4 Stu lation abolisi	dy of nuo m	abou cleotid	it e
	SO5.6 Apply the role of purine and pyrimidine nucleotide degradation		CI5.6 Degradation of purine and pyrimidine nucleotides	ine SL4.5 Compare denovo and salvage pathways				

Suggested Sessional	SW5.1 Assignments	Explain general mechanism of denovo and salvage pathways.
Work (SW): anyoneSW5.2 Mini ProjectDesc		Describe the various components nucleotide metabolism
	SW5.3 Other Activities (Specify)	Prepare one model for showing nucleotide metabolism

Course duration (in hours) to attain Course Outcomes:

Course Title: Bioenergetics and Metabolism			Course Code:03BC201				
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)		
CO1-03BC201.1: Understanding of the components of	13	6	5	1	25		
biological systems i.e. enzymes, vitamins and minerals							
CO2-03BC201.2: Learning in-depth information regarding the	6	0	5	1	12		
Key elements of Bioenergetics and metabolism.							
CO3-03BC201.3: Recognize various concepts related the	10	2	5	1	18		
carbohydrate metabolism and biological significance.							
CO4- 03BC201.4: Assess various concepts related the lipid,	10	5	5	1	21		
fatty acid and amino acid metabolism and its significance							
CO5-03BC201.5: Appraise the relationship between purine and	6	2	5	1	14		
pyrimidine metabolism and its biological significance.							
Total Hours	45	15	25	05	90		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Bioenergetics and Metabolism

Course Code:03BC201

Course Outcomes		Marks Distribution			
		An	Ε	С	Total Marks
CO1-03BC201.1: Understanding of the components of biological systems i.e. enzymes, vitamins and	2	1	1	1	5
minerals					
CO2-03BC201.2: Learning in-depth information regarding the Key elements of Bioenergetics and	2	4	2	2	10
metabolism.					
CO3-03BC201.3: Recognize various concepts related the carbohydrate metabolism and biological	3	5	5	2	15
significance.					
CO4- 03BC201.4: Assess various concepts related the lipid, fatty acid and amino acid metabolism and its	2	3	3	2	10
significance					
CO5-03BC201.5: Appraise the relationship between purine and pyrimidine metabolism and its biological		4	1	0	10
significance.					
Total Marks	14	17	12	07	50

(a) Books:

S.No.	Title/Author/Publisher details
1	Biochemistry by G. Zubey.
2	Biochemistry, D. Freifilder, W.H. Freeman & Company.
3	Harper's Biochemistry, Murray et al., Mc Graw Hill.
4	Principles of Biochemistry, Lehininger, Nelson and Cox.
5	Clinical Biochemistry by MN Chaterji and Rana Shinde

(b) Online Resources:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming
CO, PO and PSO Mapping

Program Name: B.Sc. Hons Biotechnology Semester: I Semester Course Title: Bioenergetics and Metabolism Course Code: 03BC201

Course Outcome (Cos)					Prog	gram O	utcom	es (PO	s)				Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-03BC201.1: Understanding of the	1	2	2	2	3	3	2	3	3	1	2	3	2	2	3
components of biological systems i.e.															
enzymes, vitamins and minerals															
CO2-03BC201.2: Learning in-depth	1	2	1	1	2	2	2	2	2	2	2	2	2	3	2
information regarding the Key elements of															
Bioenergetics and metabolism.															
CO3-03BC201.3: Recognize various concepts	1	2	2	2	1	2	1	1	2	1	2	2	1	2	2
related the carbohydrate metabolism and															
biological significance.															
CO4- 03BC201.4: Assess various concepts	1	1	2	1	2	3	2	2	3	2	1	3	1	2	3
related the lipid, fatty acid and amino acid															
metabolism and its significance															
CO5-03BC201.5: Appraise the relationship	1	2	2	1	1	3	1	1	3	2	2	3	1	2	3
between purine and pyrimidine metabolism															
and its biological significance.															

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (L1)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO1-03BC201.1: Understanding of the components of biological systems i.e. enzymes, vitamins and minerals	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12 SO1.13	1.1,1.2,1.3,	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13,	1SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO2-03BC201.2: Learning in-depth information regarding the Key elements of Bioenergetics and metabolism.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6		2.1, 2.2, 2.3, 2.4, 2.5, 2.6,	2SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO3-03BC201.3: Recognize various concepts related the carbohydrate metabolism and biological significance.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10	3.1,	3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8, 3.9, 3.10,	3SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO4- 03BC201.4: Assess various concepts related the lipid, fatty acid and amino acid metabolism and its significance	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10	4.1,4.2	4.1,4.2,4.3,4.4, 4.5, 4.6,4.7, 4.8, 4.9, 4.10,	4SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO5-03BC201.5: Appraise the relationship between purine and pyrimidine metabolism and its biological significance.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	5.1,	5.1,5.2,5.3,5.4,5.5, 5.6	5SL-1,2,3,4,5

Program Name	B.Sc. (HONOURS) BIOTECHNOLOGY	·						
Semester	II							
CourseCode:	03MB201							
Coursetitle:	MICROBIAL PHYSIOLOGY	Curriculum Developer: Mr. Vivek Kumar Agnihotri, Assistant Professor						
Pre-requisite:	Prerequisites for studying microbial physiology include a strong foundation in microbiology, biochemistry, molecular biology, and laboratory skills, encompassing an understanding of microbial growth, metabolism, genetics, and cellular processes.							
Rationale:	The study of microbial physiology provides insights into the fundamental processes governing microorganisms' growth, metabolism, and behavior, which is essential for various applications in biotechnology, medicine, and environmental science.							
CourseOutcomes (COs):	 CO1-03MB201.1: Understand the nutritional sources. CO2-03MB201.2: Analyze growth curves and CO3-03MB201.3: explores microbial growth concentration effects. CO4-03MB201.4: Understand the diversity of CO55-03MB201.5: Understand the various path 	requirements of microorganisms and classify them based on carbon, energy, and electron interpret mathematical expressions of microbial growth. In temperature ranges, classification, and adaptations, pH ranges, and adaptations, oxygen photosynthetic pigments and their roles in phototrophic metabolism.						

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	(L:T:P=3:0:1)	
Generic Elective	03MB201-L	Microbial Physiology	3	2	1	2	8	3+1=4	

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Progressive As				
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03MB201-L	Microbial Physiology	15	20	5	5	5	50	100

Scheme of Assessment: Practical

					S	cheme of Assess	nent (Marks)		
					-				
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03MB201-L	Microbial Physiology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the	ApproximateHours						
course and session levels, which students are anticipated to accomplish through		T 4	Cl	тт	CW	CI	Tatal
various modes of instruction including Classroom Instruction (CI). Laboratory		Item	CI	LI	3 W	SL	Total
Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course		Approx.Hrs	09	04	01	02	16
progresses, students should showcase their mastery of Session Outcomes (SOs),							
culminating in the overall achievement of Course Outcomes (COs) upon the							
course's conclusion.							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-03MB201.1: Understand the nutritional requirements of microorganisms and classify them based on	SO1.1 Explain the importance of nutritional classification in understanding microbial metabolism and ecology.	LI1.1 Basics of media preparation of different carbons sources	CI1.1 Introduction to Microbial Nutritional Classification	SL1.1 Remember taxonomical classification of archaea and bacteria
carbon, energy, and electron sources.	CI1.2 Classify microorganisms based on their carbon source preferences	LI1.2 Perform Sterilization Technique	CI1.3 Carbon Sources in Microbial Nutrition	SL1.2 Learn classification of microorganism
	SO1.2 Know about Energy Sources in Microbial Nutrition		CI1.4 Energy Sources in Microbial Nutrition	
	SO1.3 Understand the Physiological Groups of Aerobic Chemolithotrophs		CI1.5 Physiological Groups of Aerobic Chemolithotrophs	
	SO1.4 Understand the Physiological Groups of Anaerobic Chemolithotrophs		CI1.6 Physiological Groups of Anaerobic Chemolithotrophs	
	SO1.5 Understand Classification of Microorganisms Based on Nutritional Preferences		CI1.7 Classification of Microorganisms Based on Nutritional Preferences	
	SO1.6 Know about Adaptations of Microorganisms to Different Environmental Conditions		CI1.8 Adaptations of Microorganisms to Different Environmental Conditions	
	SO1.7 Understand Integration and Application of Concepts		CI1.9 Integration and Application of Concepts	

Suggested Sessional Work	SW1.1 Assignments	Summarizes the Environmental Adaptations of Hydrogen-Oxidizing Bacteria					
(SW): anyone	SW1.2 Mini Project	To demonstrate chemo lithotrophic metabolism in microbial cultures.					
	SW1.3 Other Activities (Specify)	Students will conduct a research project on nitrogen metabolism in microorganisms and its ecological implications.					

				Item Cl LI SW SL			SL	Total		
				Appro	ox.Hrs	9	2	1	2	14
Course	SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction		Self-Le	earning	g (SL)		
Outcome			(CI)			·				
(CO)										
CO2-	SO2.1 Understand the fundamental	LI2.1 Discuss how to	CI2.1 Fundamental c	oncepts	SL2.1	Contra	st th	e prep	oaratio	n of
03MB201.2Analyze	concepts and definitions related to the	analyze growth rate of	and definitions related	to the	gro	wth me	dia			
growth curves and	growth and development of	microbial population.	growth and developme	ent of	_					
interpret	microorganisms.		microorganisms.							
mathematical	SO2.2 Analyze the phases of		CI2.2 Phases of m	icrobial	SL2.2	Recall		m	athema	tical
expressions of	microbial growth and their significance		growth and their signific	ance in	exp	ression	of gro	owth k	inetics	
microbial growth.	in microbial physiology and ecology.		microbial physiology	and						
			ecology.	•						
	SO2.3 Interpret growth curves and		C12.3 Growth curves	and f						
	growth to assess growth kinetics		mainematical expression	ns of						
	growin to assess growin kinetics.		kinetics	growin						
	SO2.4 Evaluate the influence of		CI2.4 Influence	of						
	environmental factors on microbial		environmental factors	on						
	growth and development.		microbial growth	and						
	5		development.							
	SO2.5 Explain the mechanisms of		CI2.5 Mechanisms of	group						
	group translocation, including the		translocation, including	g the						
	phosphotransferase system, and its role		phosphotransferase system	n, and						
	in microbial metabolism.		its role in microbial metab	olism.						
	SO2.6 Differentiate between various		CI2.6 Various types	s of						
	types of membrane transport processes,		membrane transport pro	ocesses,						
	such as symport, antiport, and uniport.		such as symport, antipo	ort, and						
	SO27 Define and commons		Uniport.	-1						
	so2.7 Define and compare		CI2.7 Electrogenic and	electro-						
	transport mechanisms in		microorganisms							
	microorganisms		interoorganisiis.							
	SO2.8 Apply knowledge of microbial		CI2.8 Microbial grow	th and						
	growth and transport processes to solve		transport processes to	solve						
	practical problems in microbiology and		practical problems	in						
	biotechnology.		microbiology and biotechn	ology.						
	SO2.9 Understand the mechanism of		CI2.9 Mechanism of	group						
	group translocation and its significance		translocation and its sign	ificance						
	in microbial metabolism.		in microbial metabolism.							

Suggested Sessional Work	SW2.1 Assignments	Describe the phases of microbial growth, including lag phase, exponential phase, stationary phase, and death phase.
(SW): anyone	SW2.2 Mini Project	calculate growth parameters such as growth rate, generation time, and doubling time based on experimental data.
	SW2.3 Other Activities (Specify)	

Item	Cl	LI	SW	SL	Total
Approx.Hrs	9	2	1	2	14

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction	Self-Learning(SL)
CO3-03MB201.3explores microbial growth temperature	SO3.1 Know about Temperature and Microbial Growth	LI3.1 Determination of pH of Microbial Media.	CI3.1 Temperature and Microbial Growth	SL3.1 Practice Transport Mechanism
ranges, classification, and adaptations, pH ranges, and adaptations, oxygen concentration	SO3.2 Know about pH and Microbial Adaptation		CI3.2 pH and Microbial Adaptation	SL3.2 Learn Radiation and Pressure effect on Microorganisms
effects. and apply problem-solving skills in biological analyses.	SO3.3 Know about Oxygen Concentration and Microbial Metabolism		CI3.3 Oxygen Concentration and Microbial Metabolism	
	SO3.4 Learn Metabolite Transport Across Membranes		CI3.4 Metabolite Transport Across Membranes	
	SO3.5 Describe Active Transport Mechanisms		CI3.5 Active Transport Mechanisms	
	SO3.6 Know about Radiation and Pressure Effects on Microorganisms		CI3.6 Radiation and Pressure Effects on Microorganisms	
	SO3.7 Explain the mechanisms of metabolite transport across microbial cell membranes, including passive diffusion and facilitated diffusion.		CI3.7 Mechanisms of metabolite transport across microbial cell membranes, including passive diffusion and facilitated diffusion.	
	SO3.8 Know about the factors influencing the rate of metabolite transport and predict the transport mechanisms under different conditions.		CI3.8 The factors influencing the rate of metabolite transport and predict the transport mechanisms under different conditions.	
	SO3.9 Differentiate between primary active and secondary active transport mechanisms and describe their molecular mechanisms.		CI3.9 Primary active and secondary active transport mechanisms and describe their molecular mechanisms.	

Suggested Sessional	SW3.1 Assignments	Write about microorganism adaptation.
Work (SW): anyone	SW3.2 Mini Project	
	SW3.3 Other	Search and find the effects of radiation and pressure on microbial growth.
	Activities (Specify)	

Item	Cl	LI	SW	SL	Total
Approx.Hrs	9	4	1	2	16

Course Outcome (CO) Session Outcomes(SOs)		Laboratory	Classroom Instruction(CI)	Self-Learning(SL)		
		Instruction(LI)				
CO4-	SO4.1 Know about	LI4.1 To isolate and	CI4.1 Introduction to	SL4.1 Learn techniques		
03MB201.4: Understand	Photosynthesis	analyze photosynthetic	Photosynthesis	of chromatography		
the diversity of		pigments from plant leaves				
photosynthetic pigments		using chromatography.				
and their roles in	SO4.2 Learn anoxygenic and	LI4.2 To measure the	CI4.2 Anoxygenic and	SL4.2 Recall two		
phototrophic metabolism.	Oxygenic Photosynthesis	rate of oxygen evolution	Oxygenic Photosynthesis	phtosystem		
		during photosynthesis				
		using an oxygen electrode.				
	SO4.3 Know about Two		CI4.3 Two Photosystems			
	Photosystems Concept		Concept			
	SO4.4 Students will know		CI4.4 Photosynthetic Pigments			
	about Photosynthetic Pigments		and Photophosphorylation			
	and Photophosphorylation					
	SO4.5 Understand Physiology		CI4.5 Physiology of Bacterial			
	of Bacterial Photosynthesis		Photosynthesis			
	SO4.6 Know about Carbon		CI4.6 Carbon Dioxide Fixation			
	Dioxide Fixation and the Calvin		and the Calvin Cycle			
	Cycle					
	SO4.7 Know about		CI4.7 Crassulacean Acid			
	Crassulacean Acid Metabolism		Metabolism (CAM) Plants			
	(CAM) Plants					
	SO4.8 Learn Photorespiration		CI4.8 Photorespiration and			
	and Compensation Point		Compensation Point			
	SU4.9 Understand the		CI4.9 Photosynthetic Efficiency			
	Photosynthetic Efficiency and		and Environmental Factors			
	Environmental Factors					

Suggested Sessional	SW4.1 Assignments	Write about CAM
Work (SW): anyone	SW4.2 Mini Project	
	SW4.3 Other	Search and learn via YouTube how to extract chlorophyll
	Activities (Specify)	

Item	Cl	LI	SW	SL	Total	
Approx.Hrs	9	3	1	2	15	

Course Outcome		Session Autcomes(SAs)	I aboratoryInstructio	ClassroomInstructio	Solf
		SessionOutcomes(SOS)		classi oonninsti uctio	L comping(SL)
(00)			II(L1)	II(CI)	Learning(SL)
CO55-03MB201.5: T	0	SO5.1 Introduction to Microb	bial LI5.1 o measure	CI5.1 Introduction to	SL5.1Learn
measure the rate of	of oxygen	Energetics	nitrogen fixation activity	Microbial Energetics	fermentation pathway in
evolution	during		in nitrogen-fixing		microbes
photosynthesis us	sing an	SO5.2 The Entner-Doudoro	off bacteria using the	CI5.2 The Entner-	SL5.2 Classify electron
oxygen electrode.		(ED) Pathway	acetylene reduction	Doudoroff (ED) Pathway	transport
			assay.		-
		SO5.3 The Glyoxylate Cycle		CI5.3 The Glyoxylate	
				Cycle	
		SO5.4 Mitochondrial and Bacter	rial LI5.2 To measure	CI5.4 Mitochondrial and	
		Electron Transport	ATP production in	Bacterial Electron	
		L.	microbial fermentation	Transport	
		SO5.5 Fermentation Pathways	in pathways using a	CI5.5 Fermentation	
		Microbes	luciferase-based assay.	Pathways in Microbes	
		SO5.6 Nitrogen-Fixing Microb	es:	CI5.6 Nitrogen-Fixing	
		Rhizobium		Microbes: Rhizobium	
		SO5.7 Nitrogen-Fixing Microb	es:	CI5.7 Nitrogen-Fixing	
		Azotobacter		Microbes: Azotobacter	
		SO5.8 Describe Properties	of	CI5.8 Properties of	
		Nitrogenase and Hydrogenase		Nitrogenase and	
				Hydrogenase	
		SO5.9 Explain the Nif Gene a	ınd	CI5.9 The Nif Gene and	
		Regulation of Nitrogen Fixation		Regulation of Nitrogen	
				Fixation	
Suggested Sessional	SW5.1 Ass	signments	Write about application of nitro	ogen metabolism	
Work (SW): anyone	SW5.2 Min	ni Project	<u> </u>	Y	
× <i>* *</i>	SW5.3 Oth	er Activities (Specify)	Try to learn Ed pathway		

Course Title: Microbial physiology

Course Code:03MB201

Course Outcomes (COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction (LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-03MB201.1: Understand the nutritional requirements	9	4	2	1	16
of microorganisms and classify them based on carbon,					
energy, and electron sources.					
CO2-03MB201.2Analyse growth curves and interpret	9	2	2	1	14
mathematical expressions of microbial growth.					
CO3-03MB201.3 explores microbial growth temperature	9	2	2	1	14
ranges, classification, and adaptations, pH ranges, and					
adaptations, oxygen concentration effects.					
CO4-03MB201.4: Understand the diversity of	9	4	2	1	16
photosynthetic pigments and their roles in phototrophic					
metabolism.					
CO55-03MB201.5: Understand the various pathways	9	3	2	1	15
involved in microbial energetics and their significance in					
energy metabolism.					
Total Hours	45	15	10	05	75

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Microbial physiology

Course Code:03MB201

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-03MB201.1: Understand the nutritional requirements of microorganisms and classify them	02	03	04	1	10
based on carbon, energy, and electron sources.					
CO2-03MB201.2Analyze growth curves and interprets mathematical expressions of microbial	03	04	02	1	10
growth.					
CO3-03MB201.3 explores microbial growth temperature ranges, classification, and adaptations,	02	05	02	1	10
pH ranges, and adaptations, oxygen concentration effects.					
CO4-03MB201.4: Understand the diversity of photosynthetic pigments and their roles in	02	05	02	1	10
phototrophic metabolism.					
CO55-03MB201.5: Understand the various pathways involved in microbial energetics and their	03	04	03	1	11
significance in energy metabolism.					
Total Marks	12	21	13	05	51

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details	
1	Microbial Physiology: Unity and Diversity (ASM Books) 1st Edition	Ann M. Stevens (Author), Jayna L. Ditty (Author), Rebecca E.
	Parales (Author), Susan M. Merkel (Author) 2024	
2	MICROBIAL PHYSIOLOGY WILL MORGAN Amazon 2024	
3	Microbial Physiology S Meena Kumari MJP Publishers	2007

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Research lab (BSL-1)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

Program Name: B.Sc. Biotechnology Semester: II Semester Course Title: Microbial physiology Course Code: 03MB201

CO/PO/PSO Mapping															
Course Outcome (Cos)		Program Outcomes (POs)								Prog	Program Specific				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-03MB201.1: Understand the nutritional requirements of microorganisms and classify them based on carbon energy and electron sources	-	-	-	1	2	2	1	-	1	2	2	3	3	3	1
CO2-03MB201.2 Analyze growth curves and interpret mathematical expressions of microbial growth.	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
CO3-03MB201.3 explores microbial growth temperature ranges, classification, and adaptations, pH ranges, and adaptations, oxygen concentration effects.	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
CO4-03MB201.4: Understand the diversity of photosynthetic pigments and their roles in phototrophic metabolism.	-	1	1	-	2	2	2	3	-	1	-	-	1	2	3
CO55-03MB201.5: Understand the various pathways involved in microbial energetics and their significance in energy metabolism.	1	1	1	-	-	2	3	3	1	2	2	2	1	-	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs &	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning (SL)
PSOs No.			Instruction (LI)		
PO	CO1-03MB201.1:	SO1.1 SO1.2 SO1.3	1.1,1.2,	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9,	
1,2,3,4,5, 6,	Understand the nutritional	SO1.4 SO1.5 SO1.6			
7,8,9,10,11,	requirements of	SO1.7 SO1.8 SO1.9			161 1 2 2
12	microorganisms and classify				15L-1,2,5
	them based on carbon,				
PSO 1,2,3	energy, and electron sources.				
РО	CO2-03MB201.2 Analyze	SO2.1 SO2.2 SO2.3	2.1,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9,	
1,2,3,4,5, 6,	growth curves and interpret	SO2.4 SO2.5 SO2.6			
7.8.9.10.11.	mathematical expressions of	SO2.7 SO2.8 SO2.9			
12	microbial growth.				2SL-1,2
	6				
PSO 1,2,3					
PO	CO3-03MB201.3 explores	SO3.1 SO3.2 SO3.3	3.1	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9,	
1,2,3,4,5, 6,	microbial growth	SO3.4 SO3.5 SO3.6			
7,8,9,10,11,	temperature ranges,	SO3.7 SO3.8 SO3.9			
12	classification, and				3SL-1,2
	adaptations, pH ranges, and				
PSO 1,2,3	adaptations, oxygen				
	concentration effects.				
PO	CO4-03MB201.4:	SO4.1 SO4.2 SO4.3	4.1,4.2	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9,	
1,2,3,4,5, 6,	Understand the diversity of	SO4.4 SO4.5 SO4.6			
7,8,9,10,11,	photosynthetic pigments and	SO4.7 SO4.8 SO4.9			AST 1 2
12	their roles in phototrophic				451-1,2
	metabolism.				
PSO 1,2,3					
PO	CO55-03MB201.5:	SO5.1 SO5.2 SO5.3	5.1,5.2	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	
1,2,3,4,5, 6,	Understand the various	SO5.4 SO5.5 SO5.6			
7,8,9,10,11,	pathways involved in	SO5.7 SO5.8 S05.9			5SI -1 2
12	microbial energetics and				561-194
	their significance in energy				
PSO 1,2,3	metabolism.				

Course Code:	0IKS201
Course Title:	Indian Knowledge System
Pre- requisite:	Creating awareness among the youths about the true history and past rich
	culture of India.

Rationale: India has very rich and versatile knowledge system and cultural heritage since antiquity. The Indian Knowledge systems was developed on life science, medical science, literature, drama, art, music, dance, astronomy, mathematics, architecture (Sthapatyaveda), chemistry, aeronautics etc, during ancient period. In this basic course, a special attention is given to the ancient and historical perspective of ideas occurrence in the ancient society, and implication to the concept of material world and religious, social and cultural beliefs. On the closer examination, religion, culture and science have appeared epistemological very rigidly connected in the Indian Knowledge System. This land of Bharat Bhumi has provided invaluable knowledge stuff to the society and the world in all sphere of life.

Course Outcomes:

- **CO- 0IKS201. 1:** To understand the ancient civilization, Indian Knowledge Systems, Concept of Panch Mahabhuta, Origin of name Bharat Varsha, Ancient Rivers, Ancient Universities and ancient agriculture.
- **CO- 0IKS201.II:** Students will have the ability to learn about ancient books, Religious places, basic concept of Indian dance, music and arts, and fundamental aspects of Sangeeta and Natyashashtra etc.
- CO- 0IKS201.III: Student will be able to gain knowledge on Vedic Science, Astronomy, Astrovastu, Vedic Mathematics, Aeronautics, Metallurgy, Nakhatras, Panchang, Concept of Zero, Pi and point etc.
- **CO- I0IKS201. IV:** Understanding on ancient Engineering, Science and Technology, Town Planning, Temple architecture, Chemistry and Metallurgy, Metal manufacturing etc.
- **CO- I0IKS201. V:** Student will able to understand about the Life, Nature and Health through basic concept of Ayurveda andYoga, Traditional Medicinal Systems, Ethnomedicine, Nature conservation, World Heritage Sites etc.

Category	Cours	Course	Scheme of studies(Hours/Week)			Total		
of Course	e	Title	CI	LI	SW	SL	Total Study Hours	Credits
	Code						CI+LI+SW+SL	(C)
AEC	0IKS2	Indian	2		1	1	4	2
	01	Knowledge						
		System						

Scheme of Studies:

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Session Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Proposed examination scheme (Marking) as per the recommendation of University Grant Commission (UGC) for Under Graduate Courses in Fundamentals of Indian Knowledge Systems 2022-23 onwards

S.	Category of		Component	s of Marks		Total
No.	Course/Subject	Semester End Examination (External	Mid Term exam (Internal)	Assignment (Internal)	Practical Exam (Internal)	
1	Only Theory					
	Subject Course					
2	Subject/ Course					
	with theory and					
	Practical					
3	Subject/ Course					
	only Practical					

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

0IKS201. 1. To understand Indian Civilization and Indian Knowledge Systems

	Approximate Hours
Item	Approximate Hours
CI	6
LI	
\mathbf{SW}	2
SL	1
Total	9

Session Outcomes (SOs)	Laboratory	Class room Instruction (CI)	Self Learning

	Instruction		(SL)
	(LI)		
SO 1.1. Understand Overview		Unit-1. Indian Civilization	Golden era of
of Indian Knowledge		and Indian Knowledge	ancient India
Systems (IKS)		Systems	
SO 1.2. Understand		1.1.Overview of Indian	
Classification of		Knowledge Systems	
Ancient IKS texts		(IKS)	
SO 1.3. Understand		1.2 Classification of Ancient	
Introduction to Panch		IKS texts	
Mahabhutas (Earth,		1.3 Introduction to Panch	
Water, Fire, Sky and		Mahabhutas (Earth,	
Air)		Water, Fire, Sky and Air)	
SO 1.4. Understand Origin of		1.4 Origin of the name	
the name Bharatvarsha:		Bharatvarsha: the Land of	
the Land of Natural		Natural Endowments	
Endowments		1.5 Rivers of ancient India	
SO 1.5. Understand Rivers of		(The Ganga, Yamuna,	
ancient India (The		Godawari, Saraswati,	
Ganga, Yamuna,		Narmada, Sindhu and	
Godawari, Saraswati,		Kaveri)	
Narmada, Sindhu and		1.6 Agriculture system in	
Kaveri)		ancient India, Ancient	
SO 1.6. Understand Ancient		Universities: Takshashila	
Agriculture and ancient		and Nalanda, Gurukul	
Universities:		system	
Takshashila and			
Nalanda, Gurukul			
system			

a. Assignments:

i. Concepts of Panch Mahabhuta, Classification of ancient texts, origin of ancient rivers

b. Mini Project:

- i. Ancient Universities: Takshashila and Nalanda,
- c. Other Activities (Specify):

0IKS201.2: Students will have the ability to apply the knowledge gained about Indian Art, Literature and Religious Places

	Approximate Hours
Item	Approximate Hours
CI	6
LI	
SW	2
SL	1
Total	9

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 2.1. Understand the Ancient		Unit-2. Indian Art,	1. Indian Art,
Indian Books: Vedas,		Literature and Religious	Music and
Puranas, Shastras,		Places	Dance
Upanishads, Mahakavyas		2.1. Ancient Indian	
(Ramayana &		Books: Vedas, Puranas,	
Mahabharata), Smrities,		Shastras, Upanishads,	
Samhitas		Mahakavyas (Ramayana &	
SO 2.2. Understand the		Mahabharata), Smrities,	
Religious places: Puries,		Samhitas	
Dhams, Jyotiralinga,		2.2. Religious places:	
Shaktipeeths, Kumbha		Puries, Dhams,	
Mela		Jyotiralinga, Shaktipeeths,	
SO 2.3. Understand the		Kumbha Mela	
Legendary places of		2.3. Legendary places of	
Madhya Pradesh: Ujjain,		Madhya Pradesh: Ujjain,	
Chitrakoot, Omkareshwar,		Chitrakoot, Omkareshwar,	
Bharhut, Maihar		Bharhut, Maihar	
SO 2.4. Understand the Basic		2.4. Basic concept of	
concept of Indian Art,		Indian Art, Music and	
Music and Dance, Indian		Dance, Indian Musical	
Musical Instruments		Instruments	
SO 2.5. Understand the		2.5. Fundamental aspects	
Fundamental aspects of		of Sangeeta and Natya	
Sangeeta and Natya shastra		shastra	
SO 2.6. Understand the different		2.6. Different schools of	
schools of music, dance		music, dance and painting	
and painting in different		in different regions of	
regions of India		India	

a. Assignments:

i. Visit of Chitrakoot, Maihar and Bharhuta

b. Mini Project:

ii. Kumbhmela, Story of Ramayana and Mahabharata

c. Other Activities (Specify):

0IKS201. 3: Student will be able to understand Ancient Science, Astronomy and Vedic Mathematics

	Approximate Hours
Item	Approximate Hours
CI	6
LI	
SW	2
SL	1
Total	9

Session Outcomes (SOs)	Laboratory	Class room Instruction (CI)	Self Learning
	Instruction		(SL)
	(LI)		
SO 3.1. Understand Vedic		Unit-3. Ancient Science,	1. Ancient
Cosmology		Astronomy, Mathematics	Science,
SO 3.2. Understand the		3.1. Vedic Cosmology	Astronomy
Astronomy, Astrovastu,		3.2. Astronomy, Astrovastu,	and Vedic
Vedang Jyotish,		Vedang Jyotish,	Mathematic
Nakshatras, Navagraha,		Nakshatras, Navagraha,	S
Rashis, Vastushastra and		Rashis, Vastushastra and	
their related plants		their related plants	
SO 3.3. Understand the Time		3.3. Time and Calendar,	
and Calendar, Panchang		Panchang	
SO 3.4. Understand the Concept		3.4. Concept of Zero, Point,	
of Zero, Point, Pi -number		Pi -number system,	
system, Pythagoras		Pythagoras	
SO 3.5. Understand the Vedic		3.5. Vedic Mathematics,	
Mathematics, Vimana-		Vimana-Aeronautics,	
Aeronautics, Basic idea of		Basic idea of planetary	
planetary model of		model of Aryabhatta	
Aryabhatta		3.6. Varanamala of Hindi	
SO 3.6. Understand the		language based on	
Varanamala of Hindi		classification of sounds	
language based on		on the basis of their	
classification of sounds on		origin, Basic purpose of	

the basis of their origin,	science of Vyakarana.	
Basic purpose of science of		
Vyakarana		

a. Assignments:

1. Varanamala of Hindi language based on classification of sounds on the basis of their origin

b. Mini Project:

- 1. Nakshatras, Navagraha and their related plants
- c. Other Activities (Specify):

0IKS201. 4: Understand the Engineering, Technology and Architecture

	Approximate mours
Item	Approximate Hours
CI	6
LI	
SW	2
SL	1
Total	9

Session Outcomes (SOs)	Laboratory	Class room Instruction (CI)	Self Learning
	Instruction		(SL)
	(LI)		
SO 4.1. Understand the		Unit-4. Engineering,	2. Ancient
Engineering Science and		Technology and	Science,
Technology in Vedic and		Architecture	Astronomy
Post Vedic Era		4.1.Engineering Science and	and Vedic
SO 4.2. Understand the Town		Technology in Vedic and	Mathematic
and Home planning,		Post Vedic Era	S
Sthapatyaveda		4.2.Town and Home	
SO 4.3. Understand the		planning, Sthapatyaveda	
Chemistry and Metallurgy		4.3.Chemistry and	
as gleaned from		Metallurgy as gleaned	
archeological artifacts		from archeological	
SO 4.4. Understand the		artifacts	
Chemistry of Dyes,		4.4 Chemistry of Dyes,	
Pigments used in Paintings,		Pigments used in	
Fabrics, Potteries and Glass		Paintings, Fabrics,	
SO 4.5. Understand the Temple		Potteries and Glass	
Architecture: Khajuraho,		4.5.Temple Architecture:	

Approximate Hours

Sanchi Stupa, Chonsath	Khajuraho, Sanchi Stupa,	
Yogini temple	Chonsath Yogini temple	
SO 4.6. Understand the Mining	4.6.Mining and manufacture	
and manufacture in India of	in India of Iron, Copper,	
Iron, Copper, Gold from	Gold from ancient times	
ancient times		

a. Assignments:

i. Varanamala of Hindi language based on classification of sounds on the basis of their origin

b. Mini Project:

i. Nakshatras, Navagraha and their related plants

c. Other Activities (Specify):

0IKS201. 5: Understand about the Life, Nature and Health

	Approximate Hours
Item	Approximate Hours
CI	6
LI	
SW	2
SL	1
Total	9

Session Outcomes (SOs)	Laboratory	Class room Instruction (CI)	Self Learning
	Instruction		(SL)
	(LI)		
SO 5.1. Understand the		Unit-5. Life, Nature and	1. Concept of
Fundamentals of Ayurveda		Health	Ayurveda
(Charaka & Shushruta) and		5.1.Fundamentals of	and Yoga
Yogic Science (Patanjali),		Ayurveda (Charaka &	2. Traditional
Ritucharya and Dinacharya		Shushruta) and Yogic	system of
SO 5.2. Understand the		Science (Patanjali),	Indian
Traditional system of		Ritucharya and	medicines
Indian medicines		Dinacharya	3. Ethnobotan
(Ayurveda, Siddha, Unani		5.2. Traditional system of	y and
and Homoeopathy)		Indian medicines	Ethnomedic
SO 5.3. Understand		(Ayurveda, Siddha,	ines of
Fundamentals of		Unani and Homoeopathy)	India
Ethnobotany and		5.3.Fundamentals of	4. World
Ethnomedicines of India		Ethnobotany and	Heritage

SO 5.4. Understand the Nature	Ethnomedicines of India	Sites
Conservation in Indian	5.4.Nature Conservation in	
ancient texts	Indian ancient texts	
SO 5.5. Understand the	5.5 Introduction to Plant	
Introduction to Plant	Science in	
Science in Vrikshayurveda	Vrikshayurveda	
SO 5.6. Understand the World	5.6.World Heritage Sites of	
Heritage Sites of Madhya	Madhya Pradesh:	
Pradesh: Bhimbetka,	Bhimbetka, Sanchi,	
Sanchi, Khajuraho	Khajuraho	

- a. Assignments:
 - i. Visit to world Heritage Site Khajuraho
- b. Mini Project:
 - i. Ritucharya and Dincharya, Ethnomedicinal plants
- c. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class	Sessional	Self	Total hour
	Lecture	Work (SW)	Learning	(Cl+SW+Sl)
	(Cl)		(Sl)	
0IKS201. 1: To understand Indian	6	2	1	9
Civilization and Indian Knowledge				
Systems				
0IKS201. 2: Students will have the ability	6	2	1	9
to apply the knowledge gained about				
Indian Art, Literature and Religious Places				
0IKS201. 3: Student will be able to	6	2	1	9
understand the Ancient Science,				
Astronomy and Vedic Mathematics				
0IKS201. 4: Understand the Engineering,	6	2	1	9
Technology and Architecture				
0IKS201. 5: Understand about the Life,	6	2	1	9
Nature and Health				
Total	30	10	5	45

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

СО	Unit Titles	Marks Distribution			Total
		R	U	Α	Marks
CO 1	Indian Civilization and Indian Knowledge Systems	2	5	1	8

CO 2	Indian Art, Literature and Religious Places	2	6	2	8
CO 3	Ancient Science, Astronomy and Vedic	2	6	5	13
	Mathematics				
CO 4	Engineering, Technology and Architecture	2	4	4	10
CO 5	Life, Nature and Health	2	5	2	9
	Total	10	26	14	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Indian Knowledge Systems** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course teacher for above tasks. Teacher can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

- 1. Improved Lecture
- 2. Tutorial
- 3. Case Method
- 4. Group Discussion
- 5. Role Play
- 6. Visit to Religious places, World Heritage Sites
- 7. Demonstration
- 8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
- 9. Brainstorming

Suggested Learning Resources: (a) Books:

S.	Title	Author	Publisher	Edition
No.				& Year
1	An Introduction of Indian	Mahadevan, B.;	Prentice Hall of India.	2022
	Knowledge Systems: Concept	Bhat V. R. and		
	and Applications	Pavana, Nagendra R.		
		Ν.		
2	Indian Knowledge Systems:	Kapoor, Kapil and	D.K. Print World Ltd	2005
	Vol. I and II.	Singh, A. K.		
3	Science of Ancient Hindus:	Kumar, Alok	Create pace	2014
	Unlocking Nature in Pursuit		Independent Publishing	
	of Salvation			
4	A History of Agriculture in	Randhava, M.S.	ICAR, New Delhi	1980
	India			
5	Panch Mahabhuta,	Yogcharya, Jnan	Yog Satsang Ashram	2021

		Dev		
6	The Indian Rivers	Singh, Dhruv Sen	Springer	2018
7	The Wonder That Was India	Basam, Arthue Llewllyn	Sidgwick & Jackson	1954
8	Ancient Cities, Sacred Skies: Cosmic Geometries and City Planning in Ancient India	Malville, J. MacKim & Gujaral, Lalit M.	IGNCA & Aryan Books International, New Delhi	2000
9	The Natya Shastra of Bharat Muni	Jha, Narendra	Innovative Imprint, Delhi	2023
10	Astronomy in India: A Historical Perspective	Padmanabhan, Thanu	Indian National Science Academy, New Delhi & Springer (India).	2010
11	<i>History of Astronomy in India</i> 2 nd Ed.	Sen, S.N. and Shukla, K.S.	INSA New Delhi	2001
12	History of Indian Astronomy A Handbook	Ramasubramanian, K.; Sule, Aniket and Vahia, Mayank	Science and Heritage Initiative, I.I.T. Mumbai and Tata Institute of Fundamental Research, Mumbai	2016
13	Indian Mathematics and Astronomy: Some Landmarks	Rao, Balachandra S.	Jnana Deep Publications, Bangalore, 3 rd Edition	. 2004
14	Vedic Mathematics and Science in Vedas	Rao, Balachandra S.	Navakarnataka Publications, Bengaluru	2019
15	A History of Hindu Chemistry	Ray, Acharya Prafulla Chandra	Repbl Shaibya Prakashan Bibhag, Centenary Edition, Kolkata	1902
16	<i>Early Indian Architecture:</i> <i>Cities and City Gates</i>	Coomeraswamy, Anand	Munciram Manoharlal Publishers	2002
17	Theory and Practices of Temple Architecture in Medieval India: Bhojas samrangasutradhar and the Bhojpur Line Drawings	Hardy, Adams	Dev Publishers & Distributors.	2015
18	Indian Science and Technology in Eighteenth Century	Dharmpal	Academy of Gandhian Studies, Hyderabad.	1971
19	Science in India: A Historical Perspective	Subbarayappa, B.V.	Rupa New Delhi	2013
20	Fine Arts & Technical	Mishra, Shiv	Krishnadas Academy,	1982

	Sciences in Ancient India with	Shankar	Varanasi	
	special reference to			
	Someswvara's Manasollasa			
21	Fundamental Principles of	Lad, Vasant D.	The Ayurvedic Press,	2002
	Ayurveda, Volume One		Alboquerque, New	
			Mexico.	
22	Charak Samhita,	Pandey, Kashinath	Vidya Bhawan,	
	Chaukhamba	and Chaturvedi	Varanasi	
		Gorakhnath		
23	Ayurveda: The Science of	Lad, Vasant D.	Lotus Press: Santa Fe	1984
	Self-Healing			
24	Ayurveda: Life, Health and	Svoboda, Robert E	Penguin: London	1992
	Longevit			
25	Plants in the Indian Puranas	Sensarma, P.	Naya Prokash, Calcutta	1989
26	Indian Cultural Heritage	Singh, L. K.	Gyan Publishing	2008
	Perspective for Tourism		House, Delhi	
27	Glimpses of Indian	Jain, S.K.	Oxford & IBH	1981
	Ethnobotany		Publishing Company	
			Private Limited, New	
			Delhi	
28	Manual of Ethnobotany	Jain, S.K.	Scientific Publishers,	2010
			Jodhpur	

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Cos, POs and PSOs Mapping

Programme Title: B.Sc. (Hons.) Biotechnology

Course Code: 0IKS201

Course Title: Indian Knowledge System

	Program Outcomes										Program Specific Outcome				
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO-1: To understand the ancient civilization, Indian Knowledge Systems, Concept of Panch Mahabhuta, Origin of name Bharat Varsha, Ancient Rivers, Ancient Universities and ancient agriculture.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO-2: Students will have the ability to learn about ancient books, Religious places, basic concept of Indian dance, music and arts, and fundamental aspects of Sangeeta and Natyashashtra etc.	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
CO3: Student will be able to gain knowledge on Vedic Science, Astronomy, Astrovastu, Vedic Mathematics, Aeronautics, Metallurgy, Nakhatras, Panchang, Concept of Zero, Pi and point etc.	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
CO- 4: Understanding on ancient Engineering, Science and Technology, Town Planning, Temple architecture, Chemistry and Metallurgy, Metal manufacturing etc.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO- 5: Student will able to understand about the Life, Nature and Health through basic concept of Ayurveda andYoga, Traditional Medicinal Systems, Ethnomedicine, Nature conservation, World Heritage Sites atc	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Classroom Instruction(CI) Instruction (LI)		Self Learning (SL)
					(~_)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO-1: To understand the ancient civilization, Indian Knowledge Systems, Concept of Panch Mahabhuta, Origin of name Bharat Varsha, Ancient Rivers, Ancient Universities and ancient agriculture.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1: Indian Civilization and Indian Knowledge Systems 1.1,1.2,1.3,1.4,1.5,1.6	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO-2: Students will have the ability to learn about ancient books, Religious places, basic concept of Indian dance, music and arts, and fundamental aspects of Sangeeta and Natyashashtra etc.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2: Indian Art, Literature and Religious Places 2.1,2.2,2.3,2.4,2.5,2.6	As mentioned
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO3: Student will be able to gain knowledge on Vedic Science, Astronomy, Astrovastu, Vedic Mathematics, Aeronautics, Metallurgy, Nakhatras, Panchang, Concept of Zero, Pi and point etc.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3: Ancient Science, Astronomy and Vedic Mathematics 3.1, 3.2,3.3,3.4,3.5,3.6	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO- 4: Understanding on ancient Engineering, Science and Technology, Town Planning, Temple architecture, Chemistry and Metallurgy, Metal manufacturing etc.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: Engineering, Technology and Architecture 4.1, 4.2,4.3,4.4,4.5,4.6	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO- 5: Student will able to understand about the Life, Nature and Health through basic concept of Ayurveda andYoga, Traditional Medicinal Systems, Ethnomedicine, Nature conservation, World Heritage Sites etc.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit 5: Life, Nature and Health 5.1,5.2,5.3,5.4,5.5,5.6	

Course Code:	0EVS202
Course Title:	Environmental Education
Pre-requisite:	To study this course, the student must have a knowledge about the environmental components, pollution, biodiversity, and ecosystem at senior secondary, Class 12 th level.
Rationale:	The students studying Environmental Science should possess foundational understanding about environment and its components. They should also know the importance of ecosystems in our surroundings.

Course Outcomes:

OEVS202.1:To understand various aspects of life forms, ecological processes, and the impacts on them by the human during Anthropocene era.

OEVS202.2:To build capabilities to identify relevant environmental issues, analyze the various underlying causes, evaluate the practices and policies, and develop framework to make inform decisions.

0EVS202.3:To develop empathy for all life forms, awareness, and responsibility towards environmental protection and naturepreservation.

0EVS202.4: To develop the critical thinking for shaping strategies such as; scientific, social. economic. administrative & legal. environmental protection, conservation of biodiversity. environmental equity and sustainabled evelopment.

0EVS202.5: To prepare for the competitiveexams.

Scheme of Studies:

Board			Scheme of s				e of studies(Hours/Week)		
ofStudy	CourseC ode	CourseTitle	Cl	LI	SW	SL	Total StudyHours(CI+LI +SW+SL)	(C)	
AEC	0EVS202	Environmental Science	2	0	1	1	5	2	

Legend: CI:ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.,Lecture(L)andTutorial (T)andothers),

LI:LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop, field or other locations using different instructional strategies)

SW: Sessional Work(includesassignment, seminar, miniprojectetc.),

SL:SelfLearning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacherto ensureoutcomeofLearning.

Scheme of Assessment:

Theory

						Schem	e of Assessmen	t (Marks)		
Board of	Couse	Course		Progressive Assessment (PRA)						Total Marks
Study	Code	Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Semina r one (SA)	Class Activit y any one (CAT)	Class Attendanc e (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ ESA)
AEC	OEV S202	Environ mental Science	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

0EVS202.1:To understand various aspects of life forms, ecological

processes, and the impacts on them by the human during Anthropocene era.

~	pproximate mours
Item	AppX Hrs.
Cl	08
LI	0
SW	1
SL	2
Total	11

Approximate Hours

Session Outcomes	Laboratory	ClassroomInstruction	Self-Learning
(SOs)	Instruction	(Cl)	(SL)
SO1.1Know multidisciplinary nature of environmental science. SO1.2 Learn about the natural resources. SO1.3Know the problems associated with land resource. SO1.4Learn the conservation of resources. SO1.5 Know alternative energy resources.		Unit-1EnvironmentandNatural Resources:1.11.1The Multidisciplinary natureof environmental studies.1.2Scope and Importance of Environmental studies1.3Componentsof Environment: Atmosphere, Hydrosphere, Lithosphere, and Biosphere.1.4Brief account1.4Brief accountof Natural Resources and associated problems1.5Land Resource1.6Water Resource1.7Energy Resource1.8ConceptOrceptSustainability and Development	i. What is environme ntal Science? ii. What are resources?

a. Assignments:

- i. Write the definition and causes of soil erosion.
- **ii.** Define desertification and write its causes.
- iii. Describe structure of atmosphere.
- iv. Explain lithosphere.

OEVS202.2: To build capabilities to identify relevant environmental issues, analyze the various underlying causes, evaluate the practices and policies, and develop framework to make inform decisions.

Approximate Hours					
Item	AppXHrs				
Cl	05				
LI	0				
SW	2				
SL	2				
Total	09				

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SessionOutcomes	LaboratoryInstruction	ClassroomInstruction	Self-Learning	
(SOs)	(LI)	(CI)	(SL)	
(SOs) SO2.1Understand the concept of ecosystem. SO2.2Learn the structure of ecosystem. SO2.3Know the function of ecosystem. SO2.4Describe the structure of forest ecosystem. SO2.5 Learn about biodiversity and its conservation.	(LI)	(CI)Unit-2Biomes,EcosystemandBiodiversity2.12.1MajorBiomes: Tropical, Temperate, Forest, Grassland, Desert, Tundra, Wetland, Estuarine and Marine2.2Ecosystem: Structure 2.32.3Function and types 2.4 their Preservation & Restoration2.5Biodiversity and its	(SL) i.What is biotic and abiotic components of environment ? ii. What are interactions?	
		conservation practices.		

a. Assignments:

- i. What do you mean by ecosystem? Describe the structure of ecosystem.
- ii. Give a brief classification of ecosystem.
- iii. Write the function of an ecosystem.
- iv. Define biodiversity write strategies of biodiversity conservation.

b. MiniProject:

Visit to various ecosystem and study biotic and abiotic ecosystem.

0EVS202.3: To develop empathy for all life forms, awareness, and responsibility towards environmental protection and nature preservation.

Approximate Hours

Item	AppXHrs		
Cl	07		
LI	0		
SW	02		
SL	2		
Total	11		

SessionOutcomes	LaboratoryInstruction	ClassroomInstruction	Self-
(SOs)	(LI)	(CI)	Learning (SL)
SO3.1 . Learn about pollution		Unit-3:Environmental	i. What is
and its sources.		Pollution, Management	pollution basic
		and Social Issues:	introduction?
SO3.2Know the sources of			ii. What is
different pollutant.		3.2 Pollution: Types,	pollutant?
		Control measures,	
SO3.3Understand the law &		Management and	
legislation related to		associated problems.	
environment.		3.3 Environmental Law and	
SO2 Algorithm control of		Legislation: Protection	
pollution		and conservation Acts.	
		& Program	
3.1 SO3. 5 Describe the role		3.5 Environmental	
of information		Movements,	
technology in		communication and public	
environment and human		awareness Program.	
health.		3.6 National and International	
		organizations related to	
		and monitoring	
		3.7 Role of information	
		technology in	
		environment and human	
		health.	

a. Assignments:

- i. Write an essay on air pollution.
- ii. What do you mean by acid rain write its causes and effects.
- iii. Describe the effects of water pollution.
- iv. How soil pollution can be control?
- v. Describe the role of information technology in environment and human health.
- vi. Mention some national and international organizations related to environment conservation and monitoring.

b. Other Activities (Specify):

Visit to different polluted sites and study the source of pollution and their effects.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class	Sessional	Self-	Total hour
	Lecture	Work	Learning	(CI+SW+SI)
	(CI)	(SW)	(SI)	
0EVS202.1: To understand various aspects				
of life forms, ecological	08	1	С	11
processes, and the impacts on them by the	08	Т	2	11
human during Anthropocene era.				
0EVS202.2: To build capabilities to identify relevant				
environmental issues, analyze the various				
underlying causes, evaluate the practices and	05	2	2	09
policies, and develop framework to make inform				
decisions.				
0EVS202.3: To develop empathy for all life forms,				
awareness, and responsibility towards	07	2	2	11
environmental protection and nature preservation.				
Total Hours				
	20	05	06	31

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

СО	UnitTitles	MarksDistribution			Total
		R	U	Α	Marks
CO-1	Environment and Natural Resources:	03	01	01	05
CO-2	Biomes, Ecosystem and Biodiversity	02	06	02	10
CO-3	Environmental Pollution, Management and Social Issues	03	07	05	15
	Total	11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

Theendofsemesterassessmentfor Fundamental of Environmental Sciencewillbeheldwith written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wiseteachers for above tasks. Teachers can also design different tasks as per requirement, for endsemesterassessment.

Suggested Instructional/Implementation Strategies:

- 1. Improved Lecture
- 2. Tutorial
- 3. CaseMethod
- 4. GroupDiscussion
- 5. RolePlay
- 6. Visit to cement plant
- 7. Demonstration
- 8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Face book, Twitter, Online sources)
- 9. Brainstorming

Suggested Learning Resources:

(a)	Books:			
S.	Title	Author	Publisher	Edition&Year
No.				
1	Ecology; Environment Science and Conservation	Singh; J.S., Singh S.P. and Gupta, S. R	S. Chand publishing, New Delhi.	2018
2	Perspectives in Environmental Studies	Kaushik, Anubha, Kaushik, C.P.	New age International Publishers	2018
3	A Textbook of Environmental Studies	Asthana, D. K Asthana Meera	S. C1iand.Publishing, New Delhi	2007
4	Environmental Law and Policy in India: Cases, Material & Status	Divan, S. and Rosenkranz, A	Oxford University Press, India	2002

Program name	Bachelor of Science (B.Sc.)- Biotechnology					
Semester	III					
Course Code:	01BT301					
Course title:	Bioanalytical Tools and Techniques	Developer: Mrs. Keerti Samdariya, Assistant Professor				
Pre-requisite:	Students should have basic knowledge of biochemical and analytical techniques.					
Rationale:	The paper on "Bioanalytical Tools and Techniques" in the B.Sc. (Hons) Biotechnology program allow an understanding of the working principle and application of numerous tools like spectroscopy, chromatography, and gel electrophoresis. Techniques like DNA microarray will advance the knowledge of research related to molecular biology, gene regulation					
Course Outcomes (COs):	 CO1-01BT301.1: Recognize the finer points of microscopy. CO2-01BT301.2: Recognize the differences between colorimetry, fluorescence, UV visible spectroscopy, and centrifugation. CO3-01BT301.3: Calculate the Rf value from a chromatogram to study paper, ion exchange, and affinity chromatography apart. CO4-01BT301.4: Understand the working principle and application of electrophoresis CO5-01BT301.5: Learn the essential ideas behind the isolation of DNA and nanotechnology. 					

Scheme of Studies:

			Scheme ofstudies (Hours/Week)						
Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)	
MAJOR	01BT301	Bioanalytical Tools and Techniques	4	4	1	2	11	4+2=6	

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial(T) and others);

LI: Laboratory Instruction(Includes Practical performances in laboratory workshop, field or other instructional strategies);

SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
				Class Test				End	Total Marks
Board of	Course	Course Title	Class/Home	2	Seminar one	Class Attendance	Total Marks	Semester	
Study	Code	Course Thie	Assignment	(2 best out				Assessment	
			5 number	of 3)	(SA)	(AT)	(CA+CT+SA+AT)	(ESA)	(PRA+ ESA)
			3 marks each	10 marks		(111)			
			(CA)	each (CT)					
		Bioanalytical							
MAJOR	01BT301	Tools and	15	20	10	5	50	50	100
		Techniques							

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)					
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MAJOR	01BT301-L	Bioanalytical Tools and Techniques	35	5	5	5	50	50	100

Course-Curriculum:

Approximate Hours

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	02	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-01BT301.1:	SO 1.1: Attain Good	LI1.1: Demonstration of	CI 1.1: Introduction to Analysis:	SL1.1: Difference among the
Understand the concept	Laboratory Practice	working of the microscope	Concept of Good Laboratory Practice	various spectrophotometer
of microscopy.		in the lab	and Quality Management	
	SO 1.2: Discuss the Working	LI1.2: Demonstration of	CI 1.2: Discuss the Working	SL1.3: Principle of different
	principle of Simple	working of the	principle of Simple microscopy	spectroscopy
	microscopy	Spectrometer		
	SO 1.3: Discuss the Working	LI1.3: Demonstration of	CI 1.3: Discuss the Working	
	principle of phase contrast	working of the TEM and	principle of phase contrast	
	microscopy	SEM	microscopy	
	SO 1.4: Discuss the Working		CI 1.4: Discuss the Working	
	principle of fluorescence		principle of fluorescence microscopy	
	microscopy			
	SO 1.5: Discuss working		CI 1.5: Discuss working principle	
	principle Electron		Electron microscopy (TEM and	
	microscopy (TEM and SEM)		SEM)	
	SO 1.6: Understand the		CI 1.6: Spectroscopy: Lambert Beer's	
	Spectroscopy:		Law, principle, instrumentation	
	SO 1.7: Understand		CI 1.7: principle	
	principle, of spectroscopy			
	SO 1.8: Understand instrume-		CI 1.8: instrumentation	
	ntation of spectroscopy			
	SO 1.9: Application of UV,		CI 1.9: Application of UV, visible,	
	visible, Spectroscopy		Spectroscopy	
	SO 1.10: Application of IR		CI 1.10: Application of IR Spectroscopy	
	Spectroscopy in research			
	SO 1.11: Application of		CI 1.11: Application of NMR	
	NMR Spectroscopy		Spectroscopy	
	SO 1.12: Application of		CI 1.12: Application of Spectroscopy	
	Spectroscopy in research			

Suggested Sessional	SW1.1 Assignments	Explain in details about good laboratory practices
Work (SW): anyone	SW1.2 Mini Project	Ray diagram of all microscope you studied with neat labelling. And their applications
	SW1.3 Other Activities (Specify)	Find out the literature discussing about the advancement of spectrophotometer.
Course-Curriculum:

Approximate Hours

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	02	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT301.2: -Recognize the	SO2.1: Learn about Principle	LI2.1: Demonstration	CI 2.1: Principle of absorption	SL2.1: fluorimetry and
differences between colorimetry,	of absorption	of working of		colorimetry
fluorescence, and UV visible		cholorimeter		
spectroscopy				
	SO2.2: Learn about the law	LI2.2: Demonstration	CI 2.2: law of absorption	SL2.2: cell fractionation
	of absorption.	of working of		techniques
		centrifuge		
	SO2.3: Learn about		CI 2.3: Principle of fluorimetry	
	fluorimetry			
	SO2.4: Learn about		CI 2.4: Principle of colorimetry	
	colorimetry			
	SO2.5: Learn about		CI 2.5: spectrophotometry	
	spectrophotometry			
	SO2.6: Learn about visible		CI 2.6: visible spectrophotometry.	
	spectrophotometry			
	SO2. /: Learn about, infrared		CI 2. /: infrared spectrophotometry	
	spectrophotometry			
	SO2.8: Learn about, UV		CI 2.8: UV spectrophotometry	
	spectrophotometry		CL2.0. Contrifuention	
	SO2.9: Learn abou		CI 2.9: Centrifugation	
	SO2 10: Learn shout call	I I2 2 isolation of sub	CI 2 10: cell fractionation techniques	
	SO2.10: Learn about cen	callular organallas and	CI 2.10: cen fractionation techniques,	
	fractionation techniques.	particles		
	SO2.11: study the isolation		CI 2.11: isolation of sub-cellular	
	of sub-cellular organelles		organelles and particles	
	SO2.12: Learn application of		CI 2.12: application of centrifugation	
	centrifugation			

Suggested Sessional	SW1.1 Assignments	Important precautions while working with centrifugation
Work (SW): anyone	SW1.2 Mini Project	Prepare the poster evaluating different spectrophotometry
	SW1.3 Other Activities (Specify)	Find out the videos discussing about the different spectrophotometry

Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	02	21
Appiox. his	12	00	01	02	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT301.3: Calculate the	SO 3.1: Introduction and concept of	LI 3.1: Thin layer	CI 3.1: Introduction and concept of	3.1: Study the fundamentals
Rf value from a chromatogram to	chromatographic techniques	chromatography	chromatographic techniques	of various chromatography
study paper, ion exchange, and				
affinity chromatography apart				
	SO 3.2:Read the principle behind the	LI 3.2: Paper	CI 3.2: principle of	3.2: Boost your knowledge
	various chromatographic techniques	chromatography	chromatography	for application of
				chromatographic techniques
	SO 3.3: Apply practical application	LI 3.3: Column	CI 3.3: absorption chromatography	
	of Chromatography.	chromatography		
	SO 3.4: Explain paper		CI 3.4: Paper chromatography,	
	chromatography.			
	SO 3.5: Explain thin layer		CI 3.5: thin layer chromatography,	
	chromatography.			
	SO 3.6: Explain column		CI 3.6: column chromatography	
	chromatography			
	SO 3.7: Explain, gel chromatography.		CI 3.7: silica gel	
	SO 3.8: Explain gel filtration		CI 3.8: silica and gel filtration	
	chromatography.			
	SO 3.9: Explain affinity		CI 3.9: affinity chromatography	
	chromatography.			
	SO 3.10: Explain ion exchange		CI 3.10: Ion exchange	
	chromatography.		chromatography	
	SO 3.11: Explain gas		CI 3.11: gas chromatography	
	chromatography.			
	SO 3.12: Explain HPLC		CI 3.12: HPLC	

Suggested Sessional Work	Assignments:	What are the materials used as bead in different chromatography machine; explain in details
(SW): anyone	Mini Project:	Make a poster explaining the principle of separation of ion exchange chromatography
	Other Activities (Specify):	Watch animation on explaining the functionality of HPLC and Gas chromatography

Course-Curriculum:

Approximate Hours

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	02	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT301.4: Understand the working principle and application of electrophoresis in real world	SO4.1 Understanding the basic concept ofelectrophoresis	LI 4.1: DNA gel electrophoresis and DNA separation	CI 4.1: Concept and basic principle of electrophoresis	4.1: Enhance your knowledge about the agar gel electrophoresis and polyacrylamide gel electrophoresis
	SO4.2 Explain key factors affecting mobility	LI 4.2: PAGE for the separation of protein	CI 4.2: Factors affecting electrophoretic mobility	4.2: Understand the basis of separation of protein in PAGE
	SO4.3 Study in detail about free electrophoresis		CI 4.3: Free electrophoresis,	
	SO4.4Study about moving boundary electrophoresis		CI 4.4: moving boundary electrophoresis,	
	SO4.5 explain in detail about zone electrophoresis	LI 4.2: perform zone electrophoresis	CI 4.5: zone electrophoresis,	
	SO4.6Study in detail about paper electrophoresis		CI 4.6: paper electrophoresis,	
	SO4.7Study In detail about capillary electrophoresis		CI 4.7:, capillary electrophoresis,	
	SO4.8describe about gel electrophoresis		CI 4.8: gel electrophoresis	
	SO4.8describe about immunoelectrophoresis		CI 4.9: immuno-electrophoresis,	
	SO4.8describe about isoelectric focusing		CI 4.10: isoelectric-focusing	
	SO4.8describe about PAGE		CI 4.11: PAGE	
	SO4.8describe application of electrophoresis		CI 4.12: Applications of electrophoresis	

Suggested Sessional	Assignments:	Working principle of Gel electrophoresis
Work (SW): anyone	Mini Project:	Application of DNA-Protein Interaction analysis
	Other Activities (Specify):	Find out the videos discussing about the various types of electrophoresis techniques.

Course-Curriculum:	Approximate Hours					
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx. Hrs	12	06	01	02	21
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-01BT301.5: Learn the essential ideas behind Isolation of DNA and RNA	SO5.1: Explain the Isolation of DNA	LI 5.1:Nucleic Acid isolation	CI 5.1 DNA isolation – Principle and Protocol	SL5.1: Understand the southern blotting, northern blotting and western blotting
	SO5.2: Explain Isolation of DNA		CI 5.2DNA isolation from Different sources	
	SO5.3Explain RNA isolation		CI 5.3 RNA isolation	
	SO5.4 Understand genomic DNA isolation	LI 5.2: Genomic DNA isolation	CI5.4 Genomic DNA isolation	
	SO5.5Understand Plasmid DNA isolation	LI 5.3: Plasmid DNA isolation	CI 5.5 Plasmid DNA isolation	
	SO5.6Understand blotting and their applications		CI 5.6 Blotting Techniques	SL5.2: Understand blotting and their applications
	SO5.7 study southern blotting		CI 5.7 Southern Blotting	
	SO5.8 study northern blotting		CI 5.8 Northern Blotting	
	SO5.9 study western blotting		CI5.9 Western Blotting	
	SO5.10 study about Biosensor		CI5.10 Introduction to Biosensor	
	SO5.11 study Application of Biosensor		CI5.11 Application of Biosensor	
	SO5.12 study Nanotechnology and its application		CI5.12 Nanotechnology and its application	

Suggested Sessional Work (SW): Anyone	Assignments: Mini Project:	Working principle of Centrifugation Image development and application of x-rays
	Other Activities (Specify):	Ultracentrifugation: Application in isolation of different cell organelles

Course duration (in hours) to attain Course Outcomes									
(Course title: Bioanalytical Tools and Techniques)	(Course title: Bioanalytical Tools and Techniques)								
Course Outcomes(COs)	Class	LaboratoryInstruction	Self-Learning	Sessional work	Total Hours				
	lecture(CI)	(LI)	(SL)	(SW)	(Li+CI+SL+SW)				
CO1-01BT301.1: Recognize the finer points of	12	6	2	1	21				
microscopy.									
CO2-01BT301.2: Recognize the differences between	12	6	2	1	21				
colorimetry, fluorescence, UV visible spectroscopy,									
and centrifugation.									
CO3-01BT301.3: Calculate the Rf value from a	12	6	2	1	21				
chromatogram to study paper, ion exchange, and									
affinity chromatography apart.									
CO4-01BT301.4: Understand the working principle	12	6	2	1	21				
and application of electrophoresis									
CO5-01BT301.5: Learn the essential ideas behind	12	6	2	1	21				
the isolation of DNA and nanotechnology.									
Total Hours	60	30	10	05	95				

Suggested learning Resources:

S. no.	Title
1	Principles and Techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walker, Cambridge University Press, 3 & 2018
2	Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall, Pearson Prentice Hall, 2 & 2005
3	Principles and Practice of Bioanalysis, Richard F. Venn, CRC Press Inc, 2 & 2008

Suggested instructions/Implementation strategies: 1. Improved lecture

- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Cement Plant
- 7. Demonstration
- 8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
- 9. Brainstorming

End-semester Assessment Scheme for setting up question papers and assessments to evaluate the Course Outcome: (Course title: Bioanalytical Tools and Techniques)							
Course Outcomes		Marks Distribution					
	Α	An	E	С	Marks		
CO1-01BT301.1: Recognize the finer points of microscopy.	2	1	1	1	5		
CO2-01BT301.2: Recognize the differences between colorimetry, fluorescence, UV visible spectroscopy, and centrifugation.	2	4	2	2	10		
CO3-01BT301.3: Calculate the Rf value from a chromatogram to study paper, ion exchange, and affinity chromatography apart.	3	5	5	2	15		
CO4-01BT301.4: Understand the working principle and application of electrophoresis	2	3	3	2	10		
CO5-01BT301.5: Learn the essential ideas behind the isolation of DNA and nanotechnology.	5	4	1	0	10		
Total Marks	14	17	12	07	50		
Legend: A-Apply, A- Analyze, E- Evaluate, C- Create							

CO, PO and PSO Mapping

Program Title: B. Sc. Biotechnology, 3rd Sem Course Code: 01BT301 Course Title: Bioanalytical Tools and Techniques

				CO/PO) Mappiı	ng									
Course Outcome					Pro	gram Ou	itcomes (POs)					Program Specific Outcomes (PSOs)		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-01BT301.1: Recognize the finer points of microscopy.	-	-	-	1	2	2	2	-	1	2	2	3	3	2	1
CO2-01BT301.2: Recognize the differences between colorimetry, fluorescence, UV visible spectroscopy, and centrifugation.	-	-	-	-	-	-	3	-	2	2	3	3	2	1	2
CO3-01BT301.3: Calculate the Rf value from a chromatogram to study paper, ion exchange, and affinity chromatography apart.	-	1	1	1	-	-	2	-	3	1	1	2	1	2	1
CO4-01BT301.4: Understand the working principle and application of electrophoresis	-	1	1	-	2	2	2	3	-	1	-	-	2	2	3
CO5-01BT301.5: Learn the essential ideas behind the isolation of DNA and nanotechnology.	1	1	1	-	-	2	3	3	1	2	2	2	2	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs	COs	SOs No.	Laboratory Instruction	Classroom Instruction (CI)	Self-
110.					(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-01BT301.1: Recognize the finer points of microscopy.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI1, LI2 LI3,	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8,1.9, 1.10,1.11, 1.12	1SL-1,2,
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO2-01BT301.2: Recognize the differences between colorimetry, fluorescence, UV visible spectroscopy, and centrifugation.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI1, LI2 LI3,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9, 2.10, 2.11, 2.12	2SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO3-01BT301.3: Calculate the Rf value from a chromatogram to study paper, ion exchange, and affinity chromatography apart.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI1, LI2 LI3,	3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	3SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO4-01BT301.4: Understand the working principle and application of electrophoresis	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI1, LI2 LI3,	4.1,4.2,4.3,4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10,4.11,4.12	4SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO5-01BT301.5: Learn the essential ideas behind the isolation of DNA and nanotechnology.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI1, LI2, LI3,	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,5.10,5.11 5.12	5SL-1,2

Program Name	Bachelor of Science (Hons.) Biotechnology	Bachelor of Science (Hons.) Biotechnology					
Semester	Ш						
CourseCode:	02BC301						
Coursetitle:	Clinical Biochemistry	linical Biochemistry Curriculum Developer: Mrs. Pratima Mishra, Guest Faculty					
Pre-requisite:	Students should have basic knowledge of Biomolecules, Biochemistry, Clinical Biochemistry						
Rationale:	The Clinical Biochemistry course in a B.Sc. Hons Biotechnology program is essential for understanding biochemical mechanisms underlying human health and disease. It covers principles of biomolecules, enzymology, metabolism, and molecular diagnostics relevant to clinical settings. This knowledge is crucial for developing and interpreting diagnostic tests, monitoring treatment responses, and understanding biochemical basis of diseases. It prepares students for roles in clinical laboratories, pharmaceutical industries, and healthcare sectors, where they contribute to disease diagnosis, treatment development, and personalized medicine. The course integrates theoretical knowledge with practical skills in biochemical analysis, fostering analytical thinking and preparing graduates for careers in biomedical research, healthcare delivery, and biotechnological innovation						
Course Outcomes (COs):	CO1-02BC301.1: Proficiency in assessing fluid and elect CO2-02BC301.2: Learning in-depth information regard CO3-02BC301.3: Recognize various concepts of diseas CO4- 02BC301.4: Gain comprehensive assess of drug a CO5-02BC301.5: Achieve proficiency in managing diso	ctrolyte balance disorders in disease states, conducting function tests with clinical relevance. ling the components of metabolic, endocrine, and nutritional disorders and their clinical implications e diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS. action mechanisms, apoptosis in cancer, and medical applications of radioisotopes. rders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.					

Scheme of Studies:

Board of Study	Course Code	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)	
MINOR	02BT301	Clinical Biochemistry	4	4	1	5	14	4+2=6	

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MINOR	02BT301	Clinical Biochemistry	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MINOR	02BT301-L	Clinical Biochemistry	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and	ApproximateHours						
session levels, which students are anticipated to accomplish through various modes of			-				
instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional		Item	Cl	LI	SW	SL	Total
Work (SW), and Self Learning (SL). As the course progresses, students should showcase		Approx.Hrs	12	06	01	05	24
their mastery of Session Outcomes (SOs), culminating in the overall achievement of							
Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-02BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	SO1.1 Define and Describe concept of Fluid & electrolyte balance	LI1.1 Perform SGPT	Unit 1 CI1.1 Fluid & electrolyte balance and imbalance in various diseases.	SL1.1 Search various reference books and study material to start the learning
	SO1.2 Describe function tests of pancreases,	Perform SGOT	CI1.2 Function tests of pancreases,	SL1.2 Check clinical significance of function test
	SO1.3 Explain function tests of gastric	LI1.2 Perform Kidney function test	CI1.3 Function tests of gastric,	SL1.3 Learn about various categories of body function test
	SO1.4 Describe function tests of Thyroid,		CI1.4 Function tests of Thyroid,	SL1.4 Case study related to mall function of body fluid
	SO1.5 Describe function tests of Kidney		CI1.5 Function tests of Kidney	
	SO1.6 Describe function tests of Liver		CI1.6 Function tests of Liver	
	SO1.7 Describe direct wander wall's test		CI1.7 Direct wander wall's test	
	SO1.8 Assess indirect wander wall's test		CI1.8 Indirect wander wall's test	SL1.5 case study related to mall function of body components.
	SO1.9 Describe clinical significance of wander wall's test		CI1.9 clinical significance wander wall's test	
	SO1.10 Assess clinical significance of SGPT		CI1.10 Clinical significance of SGPT	
	SO1.11 Assess Clinical Significance of SGOT		CI1.11 Clinical Significance of SGOT	
	so1.12 Discuss Clinical role of diagnostics		CI1.12 Clinical role of diagnostics	

Suggested Sessional Work	SW1.1 Assignments	Describe in detail on different body function test
(SW):anyone	SW1.2Mini Project	Prepare a chart on body function test.
	SW1.3 Other Activities (Specify)	Collect the data about biological role of body functional components

			I	ltem		Cl	LI	SW	SL	Total
			A	Approx.I	Hrs	12	06	01	05	24
Course	Session Outcomes	Laboratory Instruction	Classroom Instruction	2	Self I	Learni	ng (S	L)		
	(SUS)	(LI)			T A 1	D .1	-1	(1	1:6	
depth information regarding the components of metabolic,	Fatty liver and Jaundice	Cratinine	CI2.1 Fatty liver, Jauno	dice c	scompo	onents	st of blo	od te	st	lerent
endocrine, and nutritional disorders and their clinical implications										
	SO2.2 Explain about the role of Blood sugars	LI2.2 Blood Examination	CI2.2 Blood sugars		SL2. fat in	2 Asso body	ess b	iologi	cal ro	ole of
	SO2.3 Explain about the role of Ketone bodies	LI2.3 Urea Examination	CI2.3 Ketone bodies		SL2. lipop	3 Lean roteins	rn a S	about	role	e of
	SO2.4 Explain about Diabetes mellitus		CI2.4 Diabetes mellitus	s	SL2. and c	4 Lear liabete	rn s s.	ugar	imba	alance
	SO2.5 Describe the role of Arthritis		CI2.5 Arthritis		SL2. imba	5 Le lance a	arn and as	abou sociat	t Th ed iss	nyroid ues.
	SO2.6 Describe role of Fats in diseases		CI2.6 Fats in diseases							
	SO2.7 Describe role of Lipoprotein disorders		CI2.7 Lipoproteins disorders							
	SO2.8 Assess the role of Nutrition and Chronic disease		CI2.8 Nutrition and Chudisease	ronic						
	SO2.9 Discuss about disorder of Thyroid		CI2.9 Disorders of Thy Hyperthyroidism,	yroid:						
	SO2.10 Discuss about disorder of Hypothyroidism		CI2.10 Hypothyroidism							
	SO2.11 Explore the role of Thyroid function test		CI2.11 Thyroid fun Tests: T3, T4	nction						
	SO2.12Explore the roleof Thyroid function test		CI2.12 Thyroid fun Tests: TSH, TRH	nction						

Suggested Sessional	SW2.1 Assignments	Describe in detail Diabetes mellitus its symptom, diagnosis and treatment
Work (SW) :anyone	SW2.2 Mini Project	Explain the role of Thyroid and problems occurred due to its imbalance.
	SW2.3 Other Activities (Specify)	Write an article on clinical role of blood sugar and fat.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	05	24

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-02BC301 3. Recognize various	SO3.1 Explain the concept of	SI.3.1 Perform	IInit-III	SL31 Read about various Enzymes
concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.	enzymes in different diagnosis of diseases	ELISA	CI3.1 Enzymes in different diagnosis of diseases	used in different diagnosis
	SO3.2 Explain clinical significance of enzymes	SL3.2 Perform WIDAL	CI3.2 their clinical significance	SL3.2 Collect the information about Biochemistry of detoxification
	SO3.3 Assessing Cerebrospinal fluid (CSF) chemistry	SL3.3 Perform RIA	CI3.3 Cerebrospinal fluid (CSF) chemistry	Collect the information about Xenobiotic metabolism
	SO3.4 Assessing clinical significance of Cerebrospinal fluid		CI3.4 clinical significance	
	SO3.5 Assessing the Biochemistry of detoxification		CI3.5 Biochemistry of detoxification	
	SO3.6 Assessing mechanism of Xenobiotic metabolism		CI3.6 Xenobiotic metabolism	SL3.3 Collect information about inborn impact of chelation therapy
	SO3.7 Describe about mechanism of Metal ion toxicity		CI3.7 Metal ion toxicity	SL3.4 Study about impact of antioxidant therapy
	SO3.8 Assessing the role of chelation therapy		CI3.8 Chelation therapy	
	SO3.9 Describe about role of antioxidant therapy		CI3.9 antioxidant therapy	
	SO3.10 Assessing mechanism of Ageing		CI3.10 Biochemistry of Ageing	
	SO3.11 Assessing mechanism and impact of Cancer		CI3.11 Cancer	
	SO3.12 Assessing mechanism and impact of AIDS		CI3.12 AIDS	

Suggested Sessional	SW3.1 Assignments	Describe in detail about Biochemistry of detoxification
Work (SW): anyone	SW3.2 Mini Project	Describe the cause symptoms and treatment of Cancer.
	SW3.3 Other Activities (Specify)	Prepare a model for explaining Life cycle of Ageing / HIV virus

			Item	Cl LI SW SL Total
			Approx.Hrs	12 06 01 05 24
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Classroom Instruction(CI)	Self-Learning(SL)
		Instruction(LI)		
CO4- 02BC301.4: Gain	SO4.1 Exploring mechanism of	LI4.1 Demonstration of	Unit-IV	SL4.1 Read about various drug
comprehensive assess of drug	drug action- Penicillin	apoptosis	CI4.1 Mechanism of drug	action mechanism
action mechanisms, apoptosis			action- Penicillin	
in cancer, and medical				
applications of radioisotopes.				
	SO4.2 Assessing mechanism of	LI4.2 Demonstration of	CI4.2 Mechanism of drug	SL4.2 Collect the information
	drug action- Tetracycline	chemotherapy	action-Tetracycline	about causes of cancer
	SO4.3 Explaining mechanism	LI4.3 Demonstration of	CI4.3 Mechanism of drug	
	of drug action- Streptomycin	mechanism of drug action	action- Streptomycin	
	SO4.4 Explaining mechanism		CI4.4 Mechanism of drug	
	of drug action- Chloramphenicol		action- Chloramphenicol	
	SO4.5 Evaluate mechanism of		CI4.5 Mechanism of drug	
	drug action- Sulphonamides.		action- Sulphonamides.	
	SO4.6 Evaluate clinical		CI4.6 Clinical significance of	SL4.3 Collect information about side effect of drugs
	significance of drugs		drugs	side effect of drugs
	SO4.7 Describe the impact of		CI4.7 Apoptosis:	SL4.4 Collect information about
	apoptosis			side effect of chemotherapy
	SO4.8 Describe carcinogens		CI4.8 Carcinogens	SL4.5 Collect information about
				side effect of radiation therapy
	SO4.9 Describe cancerous		CI4.9 Cancerous growth	
	growth			
	SO4.10 Describe the impact of		CI4.10 Chemotherapy	
	chemotherapy			
	SO4.11 Describe the impact of		CI4.11 radioactivity	
	radioactivity			
	SO4.12 Elaborate the concept of		CI4.12 radioisotopes in	
	radioisotopes		medicine	

Suggested Sessional	SW4.1 Assignments	Describe in detail about mechanism of drug action
Work (SW): anyone	SW4.2 Mini Project	Describe the impact of environmental consequences in cancer
	SW4.3 Other Activities (Specify)	Prepare a model for explaining mechanism and treatment of cancer.

 Item
 C1
 LI
 SW
 SL
 Total

 Approx.Hrs
 10
 06
 01
 05
 24

Course Outcome	SessionOutcomes(SOs	LaboratorvInstr	Classroom Instruction(CI)	Self-
(CO))	uction(LI)		Learning(SL)
CO5-02BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	SO5.1 Explore about disorders of mineral metabolism and trace element	LI5.1 Detection of anaemia	Unit-V CI5.1 Disorders of mineral metabolism and trace elements	SL4.1 Read about various disorders of mineral metabolism
	SO5.2 Able to execute role of hypocalcemia	LI5.2 Perform Immunodiagnostic test	CI5.2 Hypocalcemia	SL4.2 Collect the information about different disorders
	SO5.3 Apply the role of Hypo Hypercalcemia	LI5.3 Perform WIDAL	CI5.3 Hypercalcemia	SL4.3 Case studies about disorders
	SO5.4 Apply the role of Hypophosphatemia		CI5.4 Hypophosphatemia	
	SO5.5 Apply the role of Hyperphosphatemia		CI5.5 Hyperphosphatemia	SL4.4 Case studies related to anemia's
	SO5.6 Evaluate the disorders of amino acid		CI5.6 Disorders of amino acids	SL4.5 Case studies thalassemias.
	SO5.7 Assess the disorders of steroids		CI5.7 Disorders of steroids	
	SO5.8 Assess the disorders of vitamins		CI5.8 Disorders of vitamins	
	SO5.9 Explore about disorders of erythrocyte metabolism		CI5.9 Disorders of erythrocyte metabolism	
	SO5.10 Explore about hemoglobinopathis		CI5.10 hemoglobinopathis	
	SO5.11 Explore about thalassemias		CI5.11 thalassemias	
	SO5.12 explore about anemia's		CI5.12 anemia's	

Suggested Sessional	SW5.1 Assignments	Explain general mechanism of disorders occurred in body.
Work (SW): anyone	SW5.2 Mini Project	Describe the various symptoms and treatments of vitamin disorders.
	SW5.3 Other Activities (Specify)	Prepare one model for showing mechanism of disorders.

Course duration (in hours) to attain Course Outcomes:

Course Title: Clinical Bioc		Course Code:02BC301			
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-02BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	12	6	5	1	24
CO2-02BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and nutritional disorders and their clinical implications	12	6	5	1	24
CO3-02BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.	12	6	5	1	24
CO4- 02BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes.	12	6	5	1	24
CO5-02BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	12	6	5	1	24
Total Hours	60	30	25	05	120

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Clinical Biochemistry

Course Code:02BC301

Course Outcomes		Marks Distribution			
	Α	An	Ε	С	Total Marks
CO1-02BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	2	1	1	1	5
CO2-02BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and nutritional disorders and their clinical implications	2	4	2	2	10
CO3-02BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.	3	5	5	2	15
CO4- 02BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes.	2	3	3	2	10
CO5-02BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	5	4	1	0	10
Total Marks	14	17	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Biochemistry by G. Zubey.
2	Biochemistry, D. Freifilder, W.H. Freeman & Company.
3	Harper's Biochemistry, Murray et al., Mc Graw Hill.
4	Principles of Biochemistry, Lehininger, Nelson and Cox.
5	Clinical Biochemistry by MN Chaterji and Rana Shinde

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) Biotechnology **Semester:** III Semester

Course Title: Clinical Biochemistry

Course Code: 02BC301

Course Outcome (Cos)		Program Outcomes (POs)								Program Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	1	2	2	2	3	3	2	3	3	1	2	3	2	2	3
CO2-02BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and nutritional disorders and their clinical implications	1	2	1	1	2	2	2	2	2	2	2	2	2	3	2
CO3-02BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.	1	2	2	2	1	2	1	1	2	1	2	2	1	2	2
CO4- 02BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes.	1	1	2	1	2	3	2	2	3	2	1	3	1	2	3
CO5-02BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	1	2	2	1	1	3	1	1	3	2	2	3	1	2	3

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs &	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning
PSOs No.			Instruction		(SL)
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO1-02BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	IL 1 IL 2 IL 3	1.1,1.2,1.3,1.4,1.5,1.6.1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO2-02BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and nutritional disorders and their clinical implications	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5,2.6,2.7,2.8,2.9,2.10, 2.11,2.12	IL 1 IL 2 IL 3	2.1, 2.2, 2.3, 2.4,2.5,2.6,2.7,2.8,2.9,2.10, 2.11,2.12	2SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO3-02BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6, .7,3.8,3.9,3.10,.311,3.12	IL 1 IL 2 IL 3	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9, 3.10,3.11,3.12	3SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO4- 02BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes.	SO4.1 SO4.2 SO4.3 SO4.4,SO 4.5,SO4.6, SO4.7, SO4.8, SO 4.9, SO4.10 SO4.11 SO4.12	IL 1 IL 2 IL 3	4.1,4.2,4.3,4.4,4.5,4.6, 4.7, 4.8 ,4.9, 4.10,4.11, 4.12	4SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO5-02BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	SO5.1 SO5.2 SO5.3 SO5.4,SO5.5, SO5.6, SO5.7, SO5.8, SO5.9, SO5.10, SO5.11, SO5.12	IL 1 IL 2 IL 3	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12	5SL-1,2,3,4,5

Program Name	Bachelor of Science (B.Sc.)- Biotechnology						
Semester	III						
Course Code:	02MB301						
Course title:	Fermentation Technology	Curriculum Developer: Er. Arpit Srivastava, Assistant Professor					
Pre-requisite:	Students should have basic knowledge of microbiology						
Rationale:	Industrial microbiology and fermentation study and solve problems related to industrial production processes. They may examine microbial growth found in the pipes of a chemical factory, monitor the impact industrial waste has on the local ecosystem, or oversee the microbial activities used in cheese production to ensure quality.Fermentation is frequently used for the cultivation of biomass and in the production of enzymes, pharmaceuticals, energy, food and feedstock, bioactive compounds, biopolymers, etc., in which different microorganisms, and including filamentous fungi, are involved						
CourseOutcomes (COs):	CO1-02MB301.1. Define various modes and techniques of fermentation CO2-02MB301.2. Differentiate and predict the suitability of the fermentation methods and vessels CO3-02MB301.3. Identify and develop the microbial inoculum for industrial processing CO4-02MB301.4. Interpretate the mechanism of fermentation process in industry CO5-02MB301.5. Examine the mechanism of biological product development using microbes						

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)
MINOR	02MB301	Fermentation Technology	4	4	1	4	13	4+2=6

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Progressive A	ssessment (PRA)			
Board of Study	Couse Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02MB301	Fermentation Technology	15	20	5	5	5	50	100

Scheme of Assessment: Practical

					S	cheme of Assess	nent (Marks)		
					Progressive A	ssessment (PRA)		_	
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	02MB301-L	Fermentation Technology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course	Approximate Hours						
and session levels, which students are anticipated to accomplish through various modes							
of instruction including Classroom Instruction (CI). Laboratory Instruction (LI).		Item	Cl	LI	SW	SL	Total
Sessional Work (SW), and Self Learning (SL). As the course progresses, students should		Approx. Hrs	12	06	01	03	22
showcase their mastery of Session Outcomes (SOs), culminating in the overall							
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-02MB301.1.	SO1.1 Define and Describe	LI1.1 Perform	Unit 1	SL1.1
Define various modes and techniques of fermentation	concept of fermentation	Sterilization	CI1.1 Introduction to fermentation	Search various reference books and study material to start the learning
	SO1.2 Describe history of fermentation		CI1.2 History of fermentation	SL1.2 List out major contributors of fermentation
	SO1.3 Explain principle of fermentation	LI1.2 Media sterilization	CI1.3 Principle of fermentation	SL1.3 Learn about various categories of fermentation
	SO1.4 Describe fermentation	LI1.3 Isolation of	CI1.4 Development of Fermentation	
	industry	microbes	Industry	
	SO1.5 Describe requirement of fermentation		CI1.5 General Requirement for fermentation Process	
	SO1.6 Describe factors affecting fermentation		CI1.6 Factors affecting fermentation	
	SO1.7 Describe isolation of microbes		CI1.7 Isolation of industrially important microbes	
	SO1.8 Assess protocol for media preparation		CI1.8 Media preparation	
	SO1.9 Describe process of strilization		CI1.9 Sterilization	
	SO1.10 Assess concept of strain improvement		CI1.10 Strain improvement	
	so1.11 Assess role of condition optimization		CI1.11 Condition optimization	
	so1.12 Discuss about microbial growth		CI1.12 Growth and incubation	

Suggested Sessional	SW1.1 Assignments	Describe in detail "Applications of Microorganisms in various Sectors"
Work (SW):anyone	SW1.2Mini Project	Make a project on "Historical Process of Fermentation and Products produced in India"
	SW1.3 Other Activities (Specify)	List down the tables of different domains of microorganisms which are industrially important

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Appro	ximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom	_						
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	12	06	01	05	24
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
		Instruction (L1)		
CO1-02MB301.2. Differentiate and predict the suitability of the fermentation methods and vessels	SO2.1 Define and Describe concept of inoculate	LI2.1 To Demonstrate the working of Equipment's used in Sterilization	Unit 1 CI2.1 Development of inoculate for industrial fermentation	SL2.1 Search various reference books and study material to start the learning
	SO2.2 Describe kinetics of microbial growth	LI2.2 To perform the primary and secondary of microorganisms from different kinds of samples	CI2.2 Kinetics of microbial growth	SL2.2 List out major instruments used for sterilization
	SO2.3 Explain principle of sterilization	L12.3 To prepare the different kinds of nutrient media for microbial culture	CI2.3 Sterilization	SL2.3 Learn about various categories of fermentation
	SO2.4 Describe types of sterilization		CI2.4 Types of sterilization	
	SO2.5 Describe physical method		CI2.5 Physical method	
	SO2.6 Describe chemical method		CI2.6 Chemical method	
	SO2.7 Describe radiation sterilization		CI2.7 Radiation sterilization	
	SO2.8 Assess protocol for media preparation		CI2.8 Media preparation	
	SO2.9 Describe process of media sterilization		CI2.9 Media sterilization process	
	SO2.10 Assess concept of fermentation		CI2.10 Mode of fermentation	
	so2.11 Assess role of condition optimization		CI2.11 Condition optimization	
	so2.12 Discuss about microbial growth		CI2.12 Operations performed	

Suggested Sessional	SW1.1 Assignments	Write down any 5 kinds of Unit Operations used in Sterilization
Work (SW):anyone	SW1.2Mini Project	Make a project on showing how microbial colonies grow on different kinds of Culture Media
	SW1.3 Other Activities (Specify)	Derive equations and Numerical problems based on "Modes of Fermentation"

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate Hours					
levels, which students are anticipated to accomplish through various modes of instruction including						
Classroom Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL)	Item	Cl	LI	SW	SL	Total
As the course progresses, students should showcase their mastery of Session Outcomes (SOs).	Approx. Hrs	12	06	01	05	24
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-02MB301.3. Identify and develop the microbial inoculum for industrial processing	SO3.1 Define and Describe concept of fermentor	LI3.1 To Demonstrate the working of a pH electrode	Unit 1 CI3.1 Fermentor	SL3.1 Search various reference books and study material to define various kinds of reactors used in industries
	SO3.2 Describe basic design of fernmentor	LI3.2 To perform the primary and secondary of microorganisms from different kinds of samples	CI3.2 Basic design	SL3.2 Find out the literature showing production of acids and solvents in industries
	SO3.3 Explain construction of fermentor	LI3.3 To prepare the different kinds of nutrient media for microbial culture	CI3.3 Construction of fermentor	SL3.3 Find out how Biogas can be produced
	SO3.4 Describe about ancillaries		CI3.4 ancillaries	SL3.4 Write about different bioproducts manufacture in laboratory
	SO3.5 Describe different types of fermentation		CI3.5 Different types of fermentations	SL3.5 Find out the applications of Solid-substrate fermentation in industries
	SO3.6 Describe about aerobic fermentation		CI3.6 Over view of aerobic fermentation	
	SO3.7 Describe about anaerobic fermentation		CI3.7 Over view of anaerobic fermentation	
	SO3.8 Access protocol for fermentation process		CI3.8 Fermentation process	
	SO3.9 Describe application of fermentation p0rocess		CI3.9 Their application in biotechnology industry	
	SO3.10 Assess concept of solid state fermentation		CI3.10 Solid state fermentation	
	so3.11 Assess principle and working of SSF		CI3.11 Principle and working	
	SO3.12 DiscussaboutApplications of SSF		CI3.12 Its Applications	

Suggested Sessional	SW3.1 Assignments	Describe in detail cultivation of microorganisms
Work (SW):anyone	SW3.2Mini Project	Prepare a flowchart showing industrial production of biological products using fermentation
-	SW3.3 Other Activities (Specify)	Make a Power Point Presentation on "Different Types of Microbial Culture Media"

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Appro	ximate Hours	
which students are anticipated to accomplish through various modes of instruction including Classroom	1		-
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the	ł	Item	C
course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the	l	Approx. Hrs	1
overall achievement of Course Outcomes (COs) upon the course's conclusion.			

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	04	23

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-02MB301.4. Interpretate the mechanism of fermentation process in industry	SO4.1 Define and Describe concept of submerged fermentor	LI4.1 To perform the Wine production using fruit waste and yeast	Unit 1 CI4.1 Submerged Fermentor	SL4.1 Find out more on Solvents and their production process
	SO4.2 Describe concept of product development	LI4.2 To prepare the different kinds of Submerged Substrates for microbial culture	CI4.2 Product development in fermentation	SL4.2 List out the difference between Solid and Submerged State Fermentation
	SO4.3 Explain acetone	LI4.3 To determine the distribution of nutrients through Mass Transfer in reactor	CI4.3 Acetone	SL4.3 Explore the role of Diffusion, distribution and Dispersion in Mass transfer
	SO4.4 Describe about butanol		CI4.4 butanol	SL4.4 Draw a well labelled diagram of different kinds of bioreactors and its parts
	SO4.5 Describe about ethanol		CI4.5 ethanol	
	SO4.6 Describe about role of biomass		CI4.6 Role of biomass in fermentation	
	SO4.7 Describe about fundamental numerical		CI4.7 Fundamental numerical	
	SO4.8 Access about deviation on mass transfer		CI4.8 Deviation on mass transfer	
	SO4.9 Describe designing of reactor		CI4.9 Designing of typical reactor	
	SO4.10 Assess concept of reactor		CI4.10 principle	
	so4.11 Assess principle and working of reactor		CI4.11 working	
	SO4.12 DiscussaboutApplications of reactor		CI4.12 Its Applications	

Suggested Sessional	SW4.1 Assignments	Explain the role of Solid and Submerged State Fermentation
Work (SW): anyone	SW4.2 Mini Project	Describe how therapeutics being produced in biotech-based industries
	SW4.3 Other Activities (Specify)	Make a list of different kinds of microorganisms which can produce fermented products

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	se and session levels, Approximate Hours						
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	12	06	01	04	23
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-02MB301.5 Examine the mechanism of biological product development using microbes	SO5.1 Define and Describe concept of downstream processing	LI5.1 To perform the downstream processing using various unit operations like (filtration)	Unit 1 CI5.1 Basics of downstream processing	SL5.1 Explore the various kinds of downstream processing
	SO5.2Describeconceptofdownstreamprocessinginfermentation technologySO5.3Explain unit operation	LI5.1 To perform the downstream processing using various unit operations like (centrifugation) LI5.3 To prepare the different kinds of Solid Substrates for microbial	CI5.2 Role of Downstream processing in fermentation technology CI5.3 Various types of unit operations	SL5.2ReadresearchonadvancementinfermentrationtechnologySL5.3Explorevariousforthemicrobialproductionof
	SO5.4 Describe about production of citric acid		CI5.4 Production of citric Acids	other vitaminsSL5.4Explore the variousprotocols of the microbialproduction of other amino acids
	SO5.5 Describe about citric acids		CI5.5 Fermentation conditions of citric Acids	
	SO5.6 Describe about acetic acids fermentation		CI5.6 Production of acetic acids	
	SO5.7 Describe about acetic acid production process		CI5.7 Fermentation conditions of acetic Acids	
	SO5.8 Access about vitamin B12 fermentation		CI5.8 Production of Vitamin B12	
	SO5.9 Describe about vitamin B12 fermentation		CI5.9 Fermentation conditions of Vitamin B12	
	SO5.10 Assess concept of antibiotic production process		CI5.10 Production of Antibiotics	
	so5.11 Assess fermentation conditions of antibiotics		CI5.11 Fermentation conditions of Antibiotics	
	so5.12 Discuss about production process of amino acids		CI5.12 Production of Amino acids	

Suggested Sessional	SW5.1 Assignments	Explain general characteristics of Downstream processing and its significance
Work (SW): anyone	SW5.2 Mini Project	Describe the production process of acids and other biomolecules through fermentation
	SW5.3 Other Activities (Specify)	Make a power point presentation on "Downstream Processing and Unit Operations associated with it"

Course duration (in hours) to attain Course Outcomes:

Course Title: Fermentation technologies	ogy	gy			B301
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-02MB301.1: Define various modes and techniques of	12	6	3	1	22
fermentation					
CO2-02MB301.2:Differentiate and predict the suitability	12	6	5	1	24
of the fermentation methods and vessels					
CO3-02MB301.3:Identify and develop the microbial	12	6	5	1	24
inoculums for industrial processing					
CO4-02MB301.4: Interpretate the mechanism of	12	6	4	1	23
fermentation process in industry					
CO5-02MB301.5:Examine the mechanism of biological	12	6	4	1	23
product development using microbes					
Total Hours	60	30	21	05	116

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End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Fermentation Technology

Course Code: 02MB301

Course Outcomes		Marks Distribution				
	Α	An	E	C	I otal Marks	
CO1-02MB301.1: Define various modes and techniques of fermentation	2	1	1	0	5	
CO2-02MB301.2: Differentiate and predict the suitability of the fermentation methods and vessels	2	4	3	0	10	
CO3-02MB301.3: Identify and develop the microbial inoculum for industrial processing	3	5	4	1	15	
CO4-02MB301.4: Interpretate the mechanism of fermentation process in industry	2	3	2	1	10	
CO5-02MB301.5:Examine the mechanism of biological product development using microbes	5	4	2	2	10	
Total Marks	14	17	12	04	50	

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Textbook of Microbiology by Ananthnarayanan and Paniker's, eighth edition, Universities Press
2	Microbiology; Lansing M Prescott, John P. Harley, Donald A Klein, Sixth edition, Mc Graw Hill Higher education.
3	J.E. Bailey and D.F. Ollis, Biochemical Engineer-ing Fundamentals, McGraw-Hill, New York
4	Industrial Microbiology and Biotechnology, Pradeep Verma, Springer, 2022
5	An Introduction to Industrial Microbiology, Sivakumar, K. Sukesh and Joe, S. Chand Publications, 2010
6	Principle of Fermentation Technology-P.F. Stanbury, A. Whitakerand S.J.Hall –Butterworth, New Delhi

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Industrial plant of fermentation industries
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biotechnology Semester: III Semester Course Title: Fermentation Technology Course Code: 02MB301

CO/PO Mapping															
Course Outcome		Program Outcomes (POs)								Program	Program Specific Outcomes (PSOs)				
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02MB301.1: Define various modes and techniques of fermentation	-	1	-	1	2	2	1	-	3	1	3	1	1	2	1
CO2-02MB301.2: Differentiate and predict the suitability of the fermentation methods and vessels	-	1	-	-	-	-	3	-	3	2	3	3	3	-	2
CO3-02MB301.3: Identify and develop the microbial inoculums for industrial processing	-	2	1	1	-	-	3	-	3	1	3	3	1	1	1
CO4-02MB301.4: Interpretate the mechanism of fermentation process in industry	1	-	1	-	2	2	2	3	-	1	3	3	2	2	3
CO5-02MB301.5: Examine the mechanism of biological product development using microbes	1	-	2	-	-	2	3	3	-	2	3	3	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning
			Instruction (LI)		(SL)
PO 1,2,3,4,5, 6, 7,	CO1-02MB301.1:	SO1.1 SO1.2 SO1.3	LI1, LI2 LI3,	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8,1.9, 1.10,1.11,	1SL-1,2,3,
8, 9 10, 11, 12	Define various modes	SO1.4 SO1.5 SO1.6		1.12	
	and techniques of	SO1.7 SO1.8 SO1.9			
PSO 1,2,3	fermentation	SO1.10 SO1.11 SO1.12			
PO 1,2,3,4,5, 6, 7,	CO2-02MB301.2:	SO2.1 SO2.2 SO2.3	LI1, LI2, LI3,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10,	2SL-1,2,3,4,5
8, 9 10, 11, 12	Differentiate and predict	SO2.4 SO2.5 SO2.6		2.11, 2.12	
	the suitability of the	SO2.7 SO2.8 SO2.9			
PSO 1,2,3	fermentation methods	SO2.10 SO2.11 SO2.12			
	and vessels				
PO 1,2,3,4,5, 6, 7,	CO3-02MB301.3:	SO3.1 SO3.2 SO3.3	LI1, LI2 LI3,	3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11,	3SL-1,2,3,4,5
8, 9 10, 11, 12	Identify and develop the	SO3.4 SO3.5 SO3.6		3.12	
	microbial inoculum for	SO3.7SO3.8 SO3.9			
PSO 1,2,3	industrial processing	SO3.10 SO3.11 SO3.12			
PO 1,2,3,4,5, 6, 7,	CO4-02MB301.4:	SO4.1 SO4.2 SO4.3	LI1, LI2, LI3,	4.1,4.2,4.3,4.4, 4.5, 4.6, 4.7, 4.8, 4.9,	4SL-1,2,3,4
8, 9 10, 11, 12	Interpretate the	SO4.4 SO4.5 SO4.6		4.10,4.11,4.12	
	mechanism of	SO4.7 SO4.8 SO4.9			
PSO 1,2,3	fermentation process in	SO4.10 SO4.11 SO4.12			
	industry				
PO 1,2,3,4,5, 6, 7,	CO502MB301.5:	SO5.1 SO5.2 SO5.3	LI1, LI2, LI3,	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,5.10,5.11	5SL-1,2,3,4
8, 9 10, 11, 12	Examine the mechanism	SO5.4 SO5.5 SO5.6		5.12	
	of biological product	SO5.7 SO5.8 SO5.9			
PSO 1,2,3	development using	SO5.10 SO5.11 SO5.12			
	microbes				

Program Name	Bachelor of Science (Hons.) Biotechnology										
Semester	III	an a									
CourseCode:	03BC301										
Coursetitle:	Clinical Biochemistry	Curriculum Developer: Mrs. Pratima Mishra, Guest Faculty									
Pre-requisite:	Students should have basic knowledge of Biomolecules, Biochemistry, Clinical Biochemistry										
Rationale:	The Clinical Biochemistry course in a B.Sc. He human health and disease. It covers principle settings. This knowledge is crucial for devel biochemical basis of diseases. It prepares stude they contribute to disease diagnosis, treatment practical skills in biochemical analysis, fosteri delivery, and biotechnological innovation.	The Clinical Biochemistry course in a B.Sc. Hons Biotechnology program is essential for understanding biochemical mechanisms underlying numan health and disease. It covers principles of biomolecules, enzymology, metabolism, and molecular diagnostics relevant to clinical ettings. This knowledge is crucial for developing and interpreting diagnostic tests, monitoring treatment responses, and understanding biochemical basis of diseases. It prepares students for roles in clinical laboratories, pharmaceutical industries, and healthcare sectors, where hey contribute to disease diagnosis, treatment development, and personalized medicine. The course integrates theoretical knowledge with practical skills in biochemical analysis, fostering analytical thinking and preparing graduates for careers in biomedical research, healthcare lelivery, and biotechnological innovation.									
Course Outcomes (COs):	 CO1-03BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance. CO2-03BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and nutritional disorders and their clinical implications CO3-03BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS. CO4- 03BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes. CO5-03BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism. 										

Scheme of Studies:

Board of Study	Course Code	CourseTitle	Cl	LI	SW	SW SL Total Study Hours(CI+LI+SW+S		Total Credits(C) (L:T:P=3:0:1)	
Generic Elective	03BT301	Clinical Biochemistry	3	2	1	5	11	3+1=4	

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03BT301	Clinical Biochemistry	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03BT301-L	Clinical Biochemistry	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and	ApproximateHours						
session levels, which students are anticipated to accomplish through various modes of							
instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional		Item	Cl	LI	SW	SL	Total
Work (SW), and Self Learning (SL). As the course progresses, students should showcase		Approx.Hrs	09	04	01	05	19
their mastery of Session Outcomes (SOs), culminating in the overall achievement of							
Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)			
CO1-03BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	SO1.1 Define and Describe concept of Fluid & electrolyte balance	LI1.1 Perform SGPT AND SGOT	Unit 1 CI1.1 Fluid & electrolyte balance and imbalance in various diseases.	SL1.1 Search various reference books and study material to start the learning			
	SO1.2 Describe function tests of pancreases,		CI1.2 Function tests of pancreases,	SL1.2 Check clinical significance of function test			
	SO1.3 Explain function tests of gastric	LI1.2 Perform Kidney function test	CI1.3 Function tests of gastric,	SL1.3 Learn about various categories of body function test			
	SO1.4 Describe function tests of Thyroid,		CI1.4 Function tests of Thyroid,	SL1.4 Case study related to mall function of body fluid			
	SO1.5 Describe function tests of Kidney		CI1.5 Function tests of Kidney				
	SO1.6 Describe function tests of Liver		CI1.6 Function tests of Liver				
	SO1.7 Describe direct wander wall's test		CI1.7 Direct wander wall's test				
	SO1.8 Assess indirect wander wall's test		CI1.8 Indirect wander wall's test	SL1.5 case study related to mall function of body components.			
	SO1.9 Describe clinical significance of wander wall's test		CI1.9 clinical significance wander wall's test				

Suggested Sessional Work	SW1.1 Assignments	Describe in detail on different body function test				
(SW):anyone	SW1.2Mini Project	Prepare a chart on body function test.				
	SW1.3 Other Activities (Specify)	Collect the data about biological role of body functional components				

				Item		Cl	LI	SW	SL	Total
		1		Approx.	.Hrs	09	04	01	05	19
Course	Session Outcomes	Laboratory Instruction	Classroom Instruction	1	Self L	earni/	ng (S	L)		
Outcome (CO)	(SOs)	(LI)	(CI)							
CO2-03BC301.2: Learning in-	SO2.1 Assess the concept of		Unit-II		SL2.1	Enli	st	the	dif	ferent
depth information regarding the	Fatty liver and Jaundice		CI2.1 Fatty liver, Jau	indice	compo	nents	of blo	ood te	st	
components of metabolic,										
endocrine, and nutritional										
disorders and their clinical										
implications										
	SO2.2 Explain about the role	LI2.1 Blood Examination	CI2.2 Blood sugars		SL2.2	2 Asse	ess b	iologi	cal ro	ole of
	of Blood sugars				fat in	body				
	SO2.3 Explain about the role	LI2.2 Urea Examination	CI2.3 Ketone bodies		SL2.3 Learn about			role	e of	
	of Ketone bodies				lipopr	oteins				
	SO2.4 Explain about Diabetes		CI2.4 Diabetes mellit	us	SL2.4		n s	ugar	1mba	alance
	mellitus				and di	labete	s.			
					CT A			1		
	SO2.5 Describe the role of		CI2.5 Arthritis		SL2.5) Le	arn	abou	t Th	nyroid
	Arthritis				imbal	ance a	ind as	social	ted iss	ues.
	SO2.6 Describe role of Fats in		CI2.6 Fats in diseases	5						
	diseases									
	SO2.7 Discuss about disorder		CI2.7 Disorders of T	hyroid:						
	of Thyroid		Hyperthyroidism,							
	SO2.8 Discuss about disorder		CI2.8 Hypothyroidisr	n						
	of Hypothyroidism									
	SO2.9 Explore the role of		CI2.9 Thyroid fu	unction						
	Thyroid function test		Tests: T3, T4, TSH, TR	RH						
Suggested Sessional	W2 1 Assignments	Describe in detail Diabetes	mellitus its symptom di	agnosis a	nd tree	tment				
Work (SW) · anyona	W2 2 Mini Project	Explain the role of Thuroid	and problems occurred	due to ite	imbala	nce				
	W2.3 Other Activities (Specify)	Write an article on clinical	role of blood sugar and f	fat	moaia	nee.				

Item	Cl	LI	SW	SL	Total	
Approx.Hrs	09	04	01	05	19	

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-03BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS,	SO3.1 Explain the concept of enzymes in different diagnosis of diseases & their clinical significance	SL3.1 Perform ELISA	Unit-III CI3.1 Enzymes in different diagnosis of diseases & their clinical significance	SL3.1 Read about various Enzymes used in different diagnosis
	SO3.2 Assessing Cerebrospinal fluid (CSF) chemistry and its clinical significance	SL3.2 Perform RIA	CI3.2 Cerebrospinal fluid (CSF) chemistry and clinical significance	SL3.2 Collect the information about Biochemistry of detoxification
	SO3.3 Assessing the Biochemistry of detoxification		CI3.3 Biochemistry of detoxification	Collect the information about Xenobiotic metabolism
	SO3.4 Assessing mechanism of Xenobiotic metabolism		CI3.4 Xenobiotic metabolism	
	SO3.5 Describe about mechanism of Metal ion toxicity		CI3.5 Metal ion toxicity	
	SO3.6 Assessing the role of chelation therapy		CI3.6 Chelation therapy	SL3.3 Collect information about inborn impact of chelation therapy
	SO3.7 Describe about role of antioxidant therapy		CI3.7 antioxidant therapy	SL3.4 Study about impact of antioxidant therapy
	SO3.8 Assessing mechanism of Ageing		CI3.8 Biochemistry of Ageing	
	SO3.9 Assessing mechanism and impact of Cancer		CI3.9 Cancer, AIDS	

Suggested Sessional	SW3.1 Assignments	Describe in detail about Biochemistry of detoxification
Work (SW): anyone	SW3.2 Mini Project	Describe the cause symptoms and treatment of Cancer.
	SW3.3 Other Activities (Specify)	Prepare a model for explaining Life cycle of Ageing / HIV virus

				Item	Cl	LI	SW	SL	Total
				Approx.Hrs	09	01	01	05	19
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruct	tion(CI)	Self-Le	earnii	ng(SL))	
CO4- 03BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes.	SO4.1 Exploring mechanism of drug action- Penicillin	LI4.1 Demonstration of apoptosis	Unit-IV CI4.1 Mechanism action- Penicillin	of drug	SL4.1 F action n	Read an	about nism	variou	s drug
	SO4.2 Assessing mechanism of drug action- Tetracycline		CI4.2 Mechanism action- Tetracycline	of drug	SL4.2 C about ca	Collect auses o	the of cance	infor er	mation
	SO4.3 Explaining mechanism of drug action- Streptomycin		CI4.3 Mechanism action- Streptomycin	of drug n					
	SO4.4 Explaining mechanism of drug action- Chloramphenicol		CI4.4 Mechanism action- Chlorampher	of drug nicol					
	SO4.5 Evaluate mechanism of drug action- Sulphonamides.		CI4.5 Mechanism action- Sulphonamic	of drug les.					
	SO4.6 Describe the impact of apoptosis		CI4.6 Apoptosis: 0	Carcinogens	SL4.3 (side effe	Collect ect of o	inforı drugs	nation	about
	SO4.7 Describe the impact of chemotherapy		CI4.7 Cancerous Chemotherapy	growth &	SL4.4 C side effe	Collect ect of (infor: chemot	nation herapy	about
	SO4.8 Describe the impact of radioactivity		CI4.8 radioactivity	/	SL4.5 C side effe	Collect ect of 1	infori radiatic	nation	about apy
	SO4.9 Elaborate the concept of radioisotopes		CI4.9 radioisotope medicine	es in					

Suggested Sessional	SW4.1 Assignments	Describe in detail about mechanism of drug action
Work (SW): anyone	SW4.2 Mini Project	Describe the impact of environmental consequences in cancer
	SW4.3 Other Activities (Specify)	Prepare a model for explaining mechanism and treatment of cancer.

			[]	Item	Cl	LI	SW	SL	Total
			1	Approx.Hrs	09	02	01	05	19
Course Outcome	SessionOutcomes(SOs	LaboratoryInstr	Classroom Instruc	tion(CI)		Self	[-		
(CO))	uction(LI)			Lea	arnin	g(SL))	
CO5-03BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	SO5.1 Explore about disorders of mineral metabolism and trace element		Unit-V CI5.1 Disorders metabolism and trace	of mineral e elements	SL4. variot miner	1 Rea us ral me	ad disorc etabolis	abo lers sm	out of
	SO5.2 Able to execute role of hypo-hypercalcemia	LI5.1 Perform Immunodiagnostic test	СІ5.2 Нуро-Нуре	rcalcemia	SL4 infor diffe	.2 Col rmatic erent c	llect on lisorde	th abou ers	e it
	SO5.3 Apply the role of Hypo Hyperphosphatemia		СІ5.3 Нуро Нурег	rphosphatemia	SL4 abou	.3 Cas it disc	se orders	studie	2S
	SO5.4 Evaluate the disorders of amino acid		CI5.4 Disorders of	f amino acids					
	SO5.5 Assess the disorders of steroids		CI5.5 Disorders of	f steroids	SL4 relat	.4 Cas ted to	se anemi	studie a's	2S
	SO5.6 Assess the disorders of vitamins		CI5.6 Disorders of	f vitamins	SL4 thala	.5 Cas assem	se ias.	studie	s
	SO5.7 Explore about disorders of erythrocyte metabolism		CI5.7 Disorders of metabolism	of erythrocyte					
	SO5.8 Explore about hemoglobinopathis		CI5.8 hemoglobin	opathis					
	SO5.9 Explore about thalassemias		CI5.9 Thalassemia	as, anemia's					

Suggested Sessional	SW5.1 Assignments	Explain general mechanism of disorders occurred in body.
Work (SW): anyone	SW5.2 Mini Project	Describe the various symptoms and treatments of vitamin disorders.
	SW5.3 Other Activities (Specify)	Prepare one model for showing mechanism of disorders.
Course duration (in hours) to attain Course Outcomes:

Course Title: Clinical Bioc	hemistry	Course Code:03BC301					
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)		
CO1-03BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	9	4	5	1	19		
CO2-03BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and nutritional disorders and their clinical implications	9	4	5	1	19		
CO3-03BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.	9	4	5	1	19		
CO4- 03BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes.	9	1	5	1	19		
CO5-03BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	9	2	5	1	19		
Total Hours	45	15	25	05	95		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Clinical Biochemistry

Course Code:03BC301

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-03BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states,	2	1	1	1	5
conducting function tests with clinical relevance.					
CO2-03BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and	2	4	2	2	10
nutritional disorders and their clinical implications					
CO3-03BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification,	3	5	5	2	15
xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.					
CO4- 03BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and	2	3	3	2	10
medical applications of radioisotopes.					
CO5-03BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements,	5	4	1	0	10
amino acids, steroids, vitamins, erythrocyte metabolism.					
Total Marks	14	17	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Biochemistry by G. Zubey.
2	Biochemistry, D. Freifilder, W.H. Freeman & Company.
3	Harper's Biochemistry, Murray et al., Mc Graw Hill.
4	Principles of Biochemistry, Lehininger, Nelson and Cox.
5	Clinical Biochemistry by MN Chaterji and Rana Shinde

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) Biotechnology **Semester:** III Semester

Course Title: Clinical Biochemistry

Course Code: 03BC301

Course Outcome (Cos)					Prog	gram ()	utcom	es (POs	s)				Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-03BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	1	2	2	2	3	3	2	3	3	1	2	3	2	2	3
CO2-03BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and nutritional disorders and their clinical implications	1	2	1	1	2	2	2	2	2	2	2	2	2	3	2
CO3-03BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.	1	2	2	2	1	2	1	1	2	1	2	2	1	2	2
CO4- 03BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes.	1	1	2	1	2	3	2	2	3	2	1	3	1	2	3
CO5-03BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	1	2	2	1	1	3	1	1	3	2	2	3	1	2	3

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO1-03BC301.1: Proficiency in assessing fluid and electrolyte balance disorders in disease states, conducting function tests with clinical relevance.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	1.1,1.2,	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8, 1.9,	1SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO2-03BC301.2: Learning in-depth information regarding the components of metabolic, endocrine, and nutritional disorders and their clinical implications	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	2.1, 2.2,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, ,	2SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO3-03BC301.3: Recognize various concepts of disease diagnosis, CSF chemistry, detoxification, xenobiotic metabolism, metal toxicity, ageing, cancer, AIDS.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	3.1,3.2	3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8, 3.9,	3SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO4- 03BC301.4: Gain comprehensive assess of drug action mechanisms, apoptosis in cancer, and medical applications of radioisotopes.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	4.1,	4.1,4.2,4.3,4.4, 4.5, 4.6,4.7, 4.8, 4.9,	4SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO5-03BC301.5: Achieve proficiency in managing disorders of mineral metabolism, trace elements, amino acids, steroids, vitamins, erythrocyte metabolism.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 S05.8 SO5.9	5.1,	5.1,5.2,5.3,5.4,5.5, 5.6, 5.7, 5.8, 5.9,	5SL-1,2,3,4,5

Program Name	Bachelor of Science (B.Sc.)- Biotechnology						
Semester	III	III					
Course Code:	03MB301						
Course title:	Fermentation Technology	Curriculum Developer: Er. Arpit Srivastava, Assistant Professor					
Pre-requisite:	Students should have basic knowledge of microbiology						
Rationale:	Industrial microbiology and fermentation study and solve problems related to industrial production processes. They may examine microbial growth found in the pipes of a chemical factory, monitor the impact industrial waste has on the local ecosystem, or oversee the microbial activities used in cheese production to ensure quality.Fermentation is frequently used for the cultivation of biomass and in the production of enzymes, pharmaceuticals, energy, food and feedstock, bioactive compounds, biopolymers, etc., in which different microorganisms, and including filamentous fungi, are involved.						
Course Outcomes (COs):	CO1-03MB301.1. Define various modes and techniques of fermentation CO2-03MB301.2. Differentiate and predict the suitability of the fermentation methods and vessels CO3-03MB301.3. Identify and develop the microbial inoculum for industrial processing CO4-03MB301.4. Interpretate the mechanism of fermentation process in industry CO5-03MB301.5. Examine the mechanism of biological product development using microbes						

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)	
MINOR	03MB301	Fermentation Technology	3	2	1	4	10	3+1=4	

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					S	cheme of Assessn	nent (Marks)		
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	03MB301	Fermentation Technology	15	20	5	5	5	50	100

Scheme of Assessment: Practical

					S	cheme of Assess	nent (Marks)		
					Progressive A	ssessment (PRA)		_	
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor	03MB301-L	Fermentation Technology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course	Approximate Hours						
and session levels, which students are anticipated to accomplish through various modes							
of instruction including Classroom Instruction (CI). Laboratory Instruction (LI).		Item	Cl	LI	SW	SL	Total
Sessional Work (SW), and Self Learning (SL). As the course progresses, students should		Approx. Hrs	09	04	01	03	17
showcase their mastery of Session Outcomes (SOs), culminating in the overall							
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-03MB301.1. Define various modes and techniques of fermentation	SO1.1 Define and Describe concept of fermentation	LI1.1 Media sterilization	Unit 1 CI1.1 Introduction to fermentation	SL1.1 Search various reference books and study material to start the learning
	SO1.2 Describe history of fermentation	LI1.2 Isolation of microbes	CI1.2 History of fermentation	SL1.2 List out major contributors of fermentation
	SO1.3 Explain principle of fermentation		CI1.3 Principle of fermentation	SL1.3 Learn about various categories of fermentation
	SO1.4 Describe fermentation industry		CI1.4 Development of Fermentation Industry	
	SO1.5 Describe requirement of fermentation		CI1.5 General Requirement for fermentation Process	
	SO1.6 Describe factors affecting fermentation		CI1.6 Factors affecting fermentation	
	SO1.7 Describe isolation of microbes		CI1.7 Isolation of industrially important microbes	
	SO1.8 Assess protocol for media preparation, strain improvement		CI1.8 Media preparation, Strain improvement	
	so1.9 Assess role of condition optimization, microbial growth		CI1.9 Condition optimization, Growth and incubation	

Suggested Sessional	SW1.1 Assignments	Describe in detail "Applications of Microorganisms in various Sectors"
Work (SW):anyone	SW1.2Mini Project	Make a project on "Historical Process of Fermentation and Products produced in India"
	SW1.3 Other Activities (Specify)	List down the tables of different domains of microorganisms which are industrially important

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	evels, Approximate Hours						
which students are anticipated to accomplish through various modes of instruction including Classroom	_						
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	09	03	01	03	17
achievement of Course Outcomes (COs) upon the course's conclusion.	-						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-03MB301.2. Differentiate and predict the suitability of the fermentation methods and vessels	SO2.1 Define and Describe concept of inoculate	LI2.1 To perform the primary and secondary of microorganisms from different kinds of samples	Unit 1 CI2.1 Development of inoculate for industrial fermentation	SL2.1 Search various reference books and study material to start the learning
	SO2.2 Describe kinetics of microbial growth	LI2.2 To prepare the different kinds of nutrient media for microbial culture	CI2.2 Kinetics of microbial growth	SL2.2 List out major instruments used for sterilization
	SO2.3 Explain principle of sterilization		CI2.3 Sterilization	SL2.3 Learn about various categories of fermentation
	SO2.4 Describe types of sterilization		CI2.4 Types of sterilization	
	SO2.5 Assess protocol for media preparation		CI2.5 Media preparation	
	SO2.6 Describe process of media sterilization		CI2.6 Media sterilization process	
	SO2.7 Assess concept of fermentation		CI2.7 Mode of fermentation	
	so2.8 Assess role of condition optimization		CI2.8 Condition optimization	
	so2.9 Discuss about microbial growth		CI2.9 Operations performed	

Suggested Sessional	SW1.1 Assignments	Write down any 5 kinds of Unit Operations used in Sterilization
Work (SW):anyone	SW1.2Mini Project	Make a project on showing how microbial colonies grow on different kinds of Culture Media
SW1.3 Other Activities (Specify) Derive equations and Numerical problems based on "Modes of Ferm		Derive equations and Numerical problems based on "Modes of Fermentation"

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate Hours					
levels, which students are anticipated to accomplish through various modes of instruction including						
Classroom Instruction (CI). Laboratory Instruction (LI). Sessional Work (SW), and Self Learning (SL).	Item	Cl	LI	SW	SL	Total
As the course progresses, students should showcase their mastery of Session Outcomes (SOs).	Approx. Hrs	09	04	01	05	19
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-03MB301.3. Identify and develop the microbial inoculum for industrial processing	SO3.1 Define and Describe concept of fermentor	LI3.1 To perform the primary and secondary of microorganisms from different kinds of samples	Unit 1 CI3.1 Fermentor	SL3.1 Search various reference books and study material to define various kinds of reactors used in industries
	SO3.2 Describe basic design of fernmentor	LI3.2 To prepare the different kinds of nutrient media for microbial culture	CI3.2 Basic design	SL3.2 Find out the literature showing production of acids and solvents in industries
	SO3.3 Explain construction of fermentor		CI3.3 Construction of fermentor ancillaries	SL3.3 Find out how Biogas can be produced
	SO3.4 Describe different types of fermentation		CI3.4 Different types of fermentations	SL3.4 Write about different bioproducts manufacture in laboratory
	SO3.5 Describe about aerobic fermentation		CI3.5 Over view of aerobic and anaerobic fermentation	SL3.5 Find out the applications of Solid-substrate fermentation in industries
	SO3.6 Access protocol for fermentation process		CI3.6 Fermentation process	
	SO3.7 Describe application of fermentation p0rocess		CI3.7 Their application in biotechnology industry	
	SO3.8 Assess concept of solid state fermentation		CI3.8 Solid state fermentation	
	SO3.9 Discuss about Applications of SSF		CI3.9 Its Applications	

Suggested Sessional	SW3.1 Assignments	Describe in detail cultivation of microorganisms			
Work (SW):anyone	SW3.2Mini Project	Prepare a flowchart showing industrial production of biological products using fermentation			
	SW3.3 Other Activities (Specify) Make a Power Point Presentation on "Different Types of Microbial Cul				

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Appro	ximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the		Item	Cl	LI	SW	SL	Total
course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the		Approx. Hrs	09	03	01	04	17
overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-03MB301.4. Interpretate the mechanism of fermentation process in industry	SO4.1 Define and Describe concept of submerged fermentor	LI4.1 To perform the Wine production using fruit waste and yeast	Unit 1 CI4.1 Submerged Fermentor	SL4.1 Find out more on Solvents and their production process
	SO4.2 Describe concept of product development	LI4.2 To prepare the different kinds of Submerged Substrates for microbial culture	CI4.2 Product development in fermentation	SL4.2 List out the difference between Solid and Submerged State Fermentation
	SO4.3 Explain acetone		CI4.3 Acetone	SL4.3 Explore the role of Diffusion, distribution and Dispersion in Mass transfer
	SO4.4 Describe about butanol		CI4.4 butanol	SL4.4 Draw a well labelled diagram of different kinds of bioreactors and its parts
	SO4.5 Describe about ethanol		CI4.5 ethanol	
	SO4.6 Describe about role of biomass		CI4.6 Role of biomass in fermentation	
	SO4.7 Access about deviation on mass transfer		CI4.7 Fundamental numerical Deviation on mass transfer	
	SO4.8 Describe designing of reactor		CI4.8 Designing of typical reactor	
	SO4.9 DiscussaboutApplications of reactor		CI4.9 Its Applications	

Suggested Sessional	ed Sessional SW4.1 Assignments Explain the role of Solid and Submerged State Fermentation					
Work (SW): anyone	SW4.2 Mini Project	Describe how therapeutics being produced in biotech-based industries				
	SW4.3 Other Activities (Specify)	Make a list of different kinds of microorganisms which can produce fermented products				

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Ар	proximate Hou	S				
which students are anticipated to accomplish through various modes of instruction including Classroom	room						
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	09	00	01	04	14
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-03MB301.5 Examine the mechanism of biological product development using microbes	SO5.1 Define and Describe concept of downstream processing		Unit 1 CI5.1 Basics of downstream processing	SL5.1 Explore the various kinds of downstream processing
	SO5.2 Describe concept of downstream processing in fermentation technology		CI5.2 Role of Downstream processing in fermentation technology	SL5.2 Read research on advancement in fermentration technology
	SO5.3 Explain unit operation		CI5.3 Various types of unit operations	SL5.3 Explore various protocols for the microbial production of other vitamins
	SO5.4 Describe about production of citric acid		CI5.4 Production of citric Acids	SL5.4 Explore the various protocols of the microbial production of other amino acids
	SO5.5 Describe about citric acids		CI5.5 Fermentation conditions of citric Acids	
	SO5.6 Describe about acetic acids fermentation		CI5.6 Production of acetic acids	
	SO5.7 Access about vitamin B12 fermentation		CI5.7 Production of Vitamin B12	
	SO5.8 Assess concept of antibiotic production process		CI5.8 Production of Antibiotics	
	so5.9 Discuss about production process of amino acids		CI5.9 Production of Amino acids	

Suggested Sessional	sted Sessional SW5.1 Assignments Explain general characteristics of Downstream processing and its significance							
Work (SW): anyone	SW5.2 Mini Project	Describe the production process of acids and other biomolecules through fermentation						
	Make a power point presentation on "Downstream Processing and Unit Operations associated with it"							

Course duration (in hours) to attain Course Outcomes:

Course Title: Fermentation technology		Course Code:03MB301				
Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours	
	(CI)	Instruction(L1)	(SL)	(5W)	(LI+CI+SL+SW)	
CO1-03MB301.1: Define various modes and techniques of	09	4	3	1	17	
fermentation						
CO2-03MB301.2:Differentiate and predict the suitability	09	4	3	1	17	
of the fermentation methods and vessels						
CO3-03MB301.3:Identify and develop the microbial	09	4	5	1	19	
inoculums for industrial processing						
CO4-03MB301.4: Interpretate the mechanism of	09	3	4	1	17	
fermentation process in industry						
CO5-03MB301.5:Examine the mechanism of biological	09	0	4	1	14	
product development using microbes						
Total Hours	45	15	19	05	84	

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End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Fermentation Technology

Course Code: 03MB301

Course Outcomes					
	Α	An	E	C	I otal Marks
CO1-03MB301.1: Define various modes and techniques of fermentation	2	1	1	0	5
CO2-03MB301.2: Differentiate and predict the suitability of the fermentation methods and vessels	2	4	3	0	10
CO3-03MB301.3:Identify and develop the microbial inoculum for industrial processing	3	5	4	1	15
CO4-03MB301.4: Interpretate the mechanism of fermentation process in industry	2	3	2	1	10
CO5-03MB301.5:Examine the mechanism of biological product development using microbes	5	4	2	2	10
Total Marks	14	17	12	04	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Textbook of Microbiology by Ananthnarayanan and Paniker's, eighth edition, Universities Press
2	Microbiology; Lansing M Prescott, John P. Harley, Donald A Klein, Sixth edition, Mc Graw Hill Higher education.
3	J.E. Bailey and D.F. Ollis, Biochemical Engineer-ing Fundamentals, McGraw-Hill, New York
4	Industrial Microbiology and Biotechnology, Pradeep Verma, Springer, 2022
5	An Introduction to Industrial Microbiology, Sivakumar, K. Sukesh and Joe, S. Chand Publications, 2010
6	Principle of Fermentation Technology-P.F. Stanbury, A. Whitakerand S.J.Hall –Butterworth, New Delhi

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Industrial plant of fermentation industries
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biotechnology Semester: III Semester Course Title: Fermentation Technology Course Code: 03MB301

			(CO/PO M	apping										
Course Outcome		Program Outcomes (POs)						Program	Program Specific Outcomes (PSOs)						
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-03MB301.1: Define various modes and techniques of fermentation	-	1	-	1	2	2	1	-	3	1	3	1	1	2	1
CO2-03MB301.2: Differentiate and predict the suitability of the fermentation methods and vessels	-	1	-	-	-	-	3	-	3	2	3	3	3	-	2
CO3-03MB301.3: Identify and develop the microbial inoculums for industrial processing	-	2	1	1	-	-	3	-	3	1	3	3	1	1	1
CO4-03MB301.4: Interpretate the mechanism of fermentation process in industry	1	-	1	-	2	2	2	3	-	1	3	3	2	2	3
CO5-03MB301.5: Examine the mechanism of biological product development using microbes	1	-	2	-	-	2	3	3	-	2	3	3	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning
			Instruction		(SL)
			(LI)		
PO 1,2,3,4,5, 6, 7,	CO1-03MB301.1:	SO1.1 SO1.2 SO1.3	LI1, LI2,	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9,	1SL-1,2,3,
8, 9 10, 11, 12	Define various modes	SO1.4 SO1.5 SO1.6			
	and techniques of	SO1.7 SO1.8 SO1.9			
PSO 1,2,3	fermentation				
PO 1,2,3,4,5, 6, 7,	CO2-03MB301.2:	SO2.1 SO2.2 SO2.3	LI1, LI2,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9,	2SL-1,2,3,
8, 9 10, 11, 12	Differentiate and predict	SO2.4 SO2.5 SO2.6			
	the suitability of the	SO2.7 SO2.8 SO2.9			
PSO 1,2,3	fermentation methods				
	and vessels				
PO 1,2,3,4,5, 6, 7,	CO3-03MB301.3:	SO3.1 SO3.2 SO3.3	LI1, LI2	3.1,3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9,	3SL-1,2,3,4,5
8, 9 10, 11, 12	Identify and develop the	SO3.4 SO3.5 SO3.6			
	microbial inoculum for	SO3.7SO3.8 SO3.9			
PSO 1,2,3	industrial processing				
PO 1,2,3,4,5, 6, 7,	CO4-03MB301.4:	SO4.1 SO4.2 SO4.3	LI1, LI2,	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9,	4SL-1,2,3,4
8, 9 10, 11, 12	Interpretate the	SO4.4 SO4.5 SO4.6			
	mechanism of	SO4.7 SO4.8 SO4.9			
PSO 1,2,3	fermentation process in				
	industry				
PO 1,2,3,4,5, 6, 7,	CO503MB301.5:	SO5.1 SO5.2 SO5.3	,	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	5SL-1,2,3,4
8, 9 10, 11, 12	Examine the mechanism	SO5.4 SO5.5 SO5.6			
	of biological product	SO5.7 SO5.8 SO5.9			
PSO 1,2,3	development using				
	microbes				

Program Name	Bachelor of Science (Hons.) Biotechnology	Bachelor of Science (Hons.) Biotechnology					
Semester	III						
CourseCode:	04BT301	04BT301					
Coursetitle:	Plant Tissue Culture Technology Curriculum Developer: Dr. Deepak Mishra, Professor						
Pre-requisite:	Students should have basic knowledge of Botany, Biotechnology and Biochemistry						
Rationale:	The Plant Tissue Culture Technology course is integral to the B.Sc. (Hons.) Biotechnology program as it imparts essential skills in manipulating plant cells and tissues. Students learn sterile techniques, media formulation, culture methods for genetic engineering and crop improvement. This course fosters practical expertise in tissue culture methodologies, preparing students for careers in agricultural biotechnology, plant biotechnology, and biotech industries. Understanding plant tissue culture enhances students' ability to innovate in sustainable agriculture, bioprospecting, and conservation biology. It equips them with foundational knowledge to contribute to advancements in biotechnological research, addressing global challenges in food security and environmental sustainability.						
Course Outcomes (COs):	CO1-04BT301.1: Proficiency in assessing principles of CO2-04BT301.2: Learning in-depth information regard CO3-04BT301.3: Explore protoplast isolation, culture, CO4- 04BT301.4: Gain comprehensive assesses of hap CO5-04BT301.5: Achieve proficiency in virus-free plan	plant tissue culture, lab organization, media preparation, sterilization techniques, culture initiation. ding plant tissue culture methods including callus culture, organogenesis, and embryo culture techniques. somatic hybridization, selection of hybrids, cybrids, somaclonal variation, mechanisms, and applications. loid plant production methods, including anther culture, microspore culture, androgenesis, and gynogenesis. t production, germplasm conservation, artificial seed preparation, PGPR and acclimatization,					

Scheme of Studies:

Board of Study	Course Code	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)	
SEC	04BT301	Plant Tissue Culture Technology	3	2	1	5	11	3+1=4	

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Scł	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
				Class Test				End	Total Marks
Board of	Course Code	Course Title	Class/Home	2	Seminar one	Class Attendance	Total Marks	Semester	
Study	Couse Coue	Course Thie	Assignment	(2 best out				Assessment	
			5 number	of 3)	(SA)	(AT)	(CA+CT+SA+AT)	(ESA)	(PRA+ ESA)
			3 marks each	10 marks		(/11)			
			(CA)	each (CT)					
		Plant Tissue							
SEC	04BT301	Culture	15	20	10	5	50	50	100
		Technology							

Scheme of Assessment: Practical

					S	cheme of Assessn	nent (Marks)		
					Progressive As	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
SEC	04BT301-L	Plant Tissue Culture Technology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Approximat	teHours					
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx.Hrs	09	04	01	05	19
achievement of Course Outcomes (COs) upon the course's conclusion.	-						

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-04BT301.1: Proficiency in assessing principles of plant tissue culture, lab organization, media preparation, sterilization techniques, culture initiation.	SO1.1 Define and Describe concept of plant tissue culture	LI1.1 Study organization and instrumentation in PTC	Unit 1 CI1.1 Introduction to Plant Tissue Culture	SL1.1 Search various reference books and study material to start the learning
	SO1.2 Describe historical prospective of PTC,		CI1.2 Historical Prospective	SL1.2 Collect information about organization of PTC Lab
	SO1.3 Explain about PTC Lab organization	LI1.2 Media preparation and sterilization	CI1.3 general organization of PTC Lab	SL1.3 Learn about various categories of PTC
	SO1.4 Describe about PTC Media,		CI1.4 Plant tissue Culture Media	SL1.4 standardize the protocol for explants sterilization .
	SO1.5 Describe about stock solution		CI1.5 Stock Solution Preparation	
	SO1.6 Describe about sterilization techniques		CI1.6 Sterilization techniques	
	SO1.7 Describe about culture initiation		CI1.7 Culture Initiation	
	SO1.8 Assess about totipotency		CI1.8 Totipotency	SL1.5 standardize the protocol for culture intiation
	SO1.9 Describe Cryo and organogenic differentiation		CI1.9 Cryo and organogenic differentiation	

Suggested Sessional Work	SW1.1 Assignments	Describe in detail on plant tissue culture lab and PTC methods
(SW):anyone	SW1.2Mini Project	Prepare a chart on totipotency
	SW1.3 Other Activities (Specify)	Collect the data about biological role of plant tissue culture techniques.

				Item		Cl	LI	SW	SL	Total
				Approx	.Hrs	10	06	01	05	22
Course	Session Outcomes	Laboratory Instruction	Classroom Instruction	l	Self 1	Learn	ing (S	SL)		
Outcome (CO)	(SOs)	(LI)	(CI)							
CO2-04BT301.2: Learning in-	SO2.1 Assess the concept of	LI2.1 Perform shoot tip	Unit-II		SL2.1	Enli	ist	the	dif	ferent
depth information regarding	different Methods of Plant	culture	CI2.1 Different Metho	ods of	metho	ods of	plant	tissue	cultur	e
plant tissue culture methods	Tissue Culture		Plant Tissue Culture							
including callus culture,										
organogenesis, and embryo										
culture techniques.										
	SO2.2 Explain about the role		CI2.2 Callus Culture		SL2.	2 Ass	ess b	iologi	cal ro	ole of
	of Callus Culture				plant	tissue	cultu	re		
	SO2.3 Explain about the role	LI2.2 Perform callus	CI2.3 Cell Susp	ension	SL2.	3 Star	ıdardi	ze th	e pro	otocol
	of Cell Suspension Culture	culture	Culture		for ca	allus c	ulture	;	- F-	
	SO2.4 Explain about Single	LI2.3 Perform root culture	CI2.4 Single Cell Cult	ture	SL2.	4 Star	ndardi	ze th	e pro	otocol
	Cell Culture				for co	ell sus	pensio	on cult	ure	
	SO2.5 Describe the role of		CI2.5 Organ Culture		SL2.	5 Sta	andar	dize tl	ne pro	otocol
	Organ Culture				for S	ingle o	cell cu	lture		
	SO2.6 Describe role of Shoot		CI2.6 Shoot Me	eristem						
	Meristem Culture		Culture							
	CI2.7 Describe		CI2.8 Organogenesis							
	Organogenesis									
	SO2.7 Assess the role of		CI2.9 Somatic							
	Somatic Embryogenesis		Embryogenesis							
	SO2.8 Discuss about Embryo		CI2.10 Embryo Cultur	re and						
	Culture and Embryo rescue		Embryo rescue							
Suggested Sessional S	W2.1 Assignments	Describe in detail callus cul	lture and characterization	of callu	s					
Work (SW) :anyone	W2.2 Mini Project	Explain the role of hormon	es in organogenesis.							
S	W2.3 Other Activities (Specify)	Make a chart on plant tissue	e culture methods.							

Item	Cl	LI	SW	SL	Total
	 10	0.4	0.1	05	00

			Appro	X.HIS 10 04 01 03 20
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning (SL)
		Instruction(LI)	(CI)	
CO3-04BT301.3: Explore protoplast	SO3.1 Explain the concept of	SL3.1 Perform	Unit-III	SL3.1 Read about various components
isolation, culture, somatic	Protoplast Isolation and fusion	organogenesis	CI3.1 Protoplast Isolation	used in protoplast isolation and
hybridization, selection of hybrids,			and fusion	protoplast fusion
cybrids, somaclonal variation,				
mechanisms, and applications.				
	SO3.2 Assessing Methods of		CI3.2 Methods of	SL3.2 Standardize protocol for protoplast
	protoplast isolation		protoplast isolation	isolation and protoplast culture
	SO3.3 Assessing the Protoplast	SL3.2 Perform	CI3.3 Protoplast culture	
	culture	protoplast fusion	L.	
	SO3.4 Assessing mechanism of		CI3.4 Somatic	SL3.3 Standardize protocol for
	Somatic hybridization		hybridization	protoplast fusion
	SO3.5 Describe about		CI3.5 identification and	SL3.4 Collect information about impact of
	identification and selection of		selection of hybrid cells	protoplast fusion on hybrid production
	hybrid cells			
	SO3.6 Assessing the role of		CI3.6 Cybrids	SL3.5 Collect information about impact
	Cybrids			of somaclonal variation
	SO3.7 Describe about role of		CI3.7 Potential of somatic	
	somatic hybridization		hybridization its limitations	
	SO3.8 Assessing mechanism of		CI3.8 Somaclonal	
	somaclonal variation		variation-Mechanism	
	SO3.9 Assessing methods of		CI3.9 Somaclonal variation	
	somaclonal variation		- Methods	
	SO3.10 Assessing application of		CI3.10 Somaclonal variation	
	somaclonal variation		- Applications	

Suggested Sessional	SW3.1 Assignments	Describe in detail about mechanism of protoplast fusion
Work (SW): anyone	SW3.2 Mini Project	Describe the criteria used for identification of somaclones.
	SW3.3 Other Activities (Specify)	Prepare a model for representing process of protoplast isolation, culture and fusion.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	10	00	01	05	16

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
CO4- 04BT301.4: Gain comprehensive assesses of haploid plant production methods, including anther culture, microspore culture, androgenesis, and gynogenesis.	SO4.1 Exploring mechanism of In vitro haploid production		Unit-IV CI4.1 In vitro haploid production	SL4.1 Read about various methods used for haploid plant production
	SO4.2 Assessing role of Anther culture		CI4.2 Anther culture	SL4.2 Standardize the protocol for anther culture
	SO4.3 Explaining the role of Androgenic methods		CI4.3 Androgenic methods	
	SO4.4 Explaining the role of Microspore culture		CI4.4 Microspore culture	SL4.3 Standardize the protocol for Microspore culture
	SO4.5 Evaluate the role of androgenesis		CI4.5 Androgenesis Significance and use of haploids	
	SO4.6 Describe the Ploidy level and chromosome doubling		CI4.6 Ploidy level and chromosome doubling	
	SO4.7 Describe the impact of diplodization		CI4.7 diplodization	SL4.4 Collect information about impact of androgenesis
	SO4.8 Describe the impact of Gynogenic haploids		CI4.8 Gynogenic haploids	SL4.5 Collect information about impact of gynogenesis
	SO4.9 Elaborate the concept of Factors affecting gynogenesis		CI4.9 Factors affecting gynogenesis	
	SO4.10 Elaborate Chromosome elimination techniques		CI4.10 Chromosome elimination techniques for production of haploids in cereals.	

Suggested Sessional	SW4.1 Assignments	Describe in detail about mechanism of haploid plant production
Work (SW): anyone	SW4.2 Mini Project	Describe the impact of chromosome elimination on haploid production.
	SW4.3 Other Activities (Specify)	Prepare a model for explaining process of haploid plant production

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	02	01	05	14

Course Outcome (CO)	SessionOutcomes(SOs	LaboratoryInstr uction(LI)	Classroom Instruction(CI)	Self- Learning(SL)
CO5-04BT301.5: Achieve proficiency in virus-free plant production, germplasm conservation, artificial seed preparation, PGPR and acclimatization,	SO5.1 Explore about production of virus free plants		Unit-V CI5.1 Production of Virus Free Plants	SL4.1 Read about various methods used for production of virus free plants.
	SO5.2 Able to execute role of germplasm conservation		CI5.2 Germplasm Conservation	SL4.2 Study impact of germplasm conservation
	SO5.3 Apply the role of artificial seed preparation	LI5.1 Production of artificial seeds	CI5.3 Artificial Seed Preparation	SL4.3 Study impact of artificial seeds
	SO5.4 Evaluate the role of PGPR		CI5.4 Plant Growth Promoting Bacteria	SL4.4 Study impact of PGPR.
	SO5.5 Assess the role of acclimatization		CI5.5 Concept and Methods of Acclimatization	SL4.5 Standardize protocol for hardening
	SO5.6 Assess the application of plant tissue culture		CI5.6 Application of Plant Tissue Culture	

Suggested Sessional	SW5.1 Assignments	Explain general mechanism of germplasm conservation.
Work (SW): anyone	SW5.2 Mini Project	Describe the various techniques of virus free plant production.
	SW5.3 Other Activities (Specify)	Prepare one model for showing process of acclimatization.

Course duration (in hours) to attain Course Outcomes:

Course Title: Plant Tissue Cult		Course Code:04BT301			
Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-04BT301.1: Proficiency in assessing principles of plant	09	4	5	1	19
tissue culture, lab organization, media preparation,					
sterilization techniques, culture initiation.					
CO2-04BT301.2: Learning in-depth information regarding plant	10	6	5	1	22
tissue culture methods including callus culture, organogenesis,					
and embryo culture techniques.					
CO3-04BT301.3: Explore protoplast isolation, culture, somatic	10	4	5	1	20
hybridization, selection of hybrids, cybrids, somaclonal					
variation, mechanisms, and applications.					
CO4- 04BT301.4: Gain comprehensive assesses of haploid	10	0	5	1	16
plant production methods, including anther culture,					
microspore culture, androgenesis, and gynogenesis.					
CO5-04BT301.5: Achieve proficiency in virus-free plant	06	2	5	1	14
production, germplasm conservation, artificial seed					
preparation, PGPR and acclimatization,					
Total Hours	45	16	25	05	91

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Plant Tissue Culture Technology

Course Code: 04BT301

Course Outcomes		Marks Distribution			
	Α	An	Ε	С	Total Marks
CO1-04BT301.1: Proficiency in assessing principles of plant tissue culture, lab organization, media preparation, sterilization techniques, culture initiation.	2	1	1	1	5
CO2-04BT301.2: Learning in-depth information regarding plant tissue culture methods including callus culture, organogenesis, and embryo culture techniques.	2	4	2	2	10
CO3-04BT301.3: Explore protoplast isolation, culture, somatic hybridization, selection of hybrids, cybrids, somaclonal variation, mechanisms, and applications.	3	5	5	2	15
CO4- 04BT301.4: Gain comprehensive assesses of haploid plant production methods, including anther culture, microspore culture, androgenesis, and gynogenesis.	2	3	3	2	10
CO5-04BT301.5: Achieve proficiency in virus-free plant production, germplasm conservation, artificial seed preparation, PGPR and acclimatization,	5	4	1	0	10
Total Marks	14	17	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Bhojwani, S.S. and Razdan 2504 Plant Tissue Culture and Practice.
2	Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3	Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2508 8th edition Principles of Genetics. Wiley India.
4	Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2505 Biology. Tata MC Graw Hill.
5	Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6	Russell, P.J. 2509 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7	Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8	Slater, A., Scott, N.W. & Fowler, M.R. 2508 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) Biotechnology

Semester: III Semester

Course Title: Plant Tissue Culture Technology

Course Code: 04BT301

Course Outcome (Cos)	Program Outcomes (POs) P C				Prog Outo	Program Specific Outcomes (PSOs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-04BT301.1: Proficiency in assessing principles of plant tissue culture, lab organization, media preparation, sterilization techniques, culture initiation.	1	2	2	2	1	2	2	3	3	1	2	3	2	2	3
CO2-04BT301.2: Learning in-depth information regarding plant tissue culture methods including callus culture, organogenesis, and embryo culture techniques.	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2
CO3-04BT301.3: Explore protoplast isolation, culture, somatic hybridization, selection of hybrids, cybrids, somaclonal variation, mechanisms, and applications.	1	1	2	2	1	2	1	1	2	1	2	2	1	1	2
CO4- 04BT301.4: Gain comprehensive assesses of haploid plant production methods, including anther culture, microspore culture, androgenesis, and gynogenesis.	2	2	2	1	2	1	2	2	3	2	1	3	1	2	3
CO5-04BT301.5: Achieve proficiency in virus- free plant production, germplasm conservation, artificial seed preparation, PGPR and acclimatization,	2	1	2	1	2	2	1	1	3	2	2	3	1	1	3

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
PO 1,2,3,4,5, 6,	CO1-04BT301.1: Proficiency in assessing	SO1.1 SO1.2 SO1.3	1.1,1.2,	1.1, 1.2, 1.3, 1.4,	1SL-1,2,3,4,5
7,8,9,10,11, 12	principles of plant tissue culture, lab	SO1.4 SO1.5 SO1.6		1.5, 1.6, 1.7, 1.8,	
	organization, media preparation, sterilization	SO1.7 SO1.8 SO1.9		1.9,	
PSO 1,2,3	techniques, culture initiation.				
PO 1,2,3,4,5, 6,	CO2-04BT301.2: Learning in-depth information	SO2.1 SO2.2 SO2.3	2.1, 2.2, 2.3	2.1, 2.2, 2.3, 2.4,	2SL-1,2,3,4,5
7,8,9,10,11, 12	regarding plant tissue culture methods including	SO2.4 SO2.5 SO2.6		2.5, 2.6, 2.7, 2.8,	
	callus culture, organogenesis, and embryo	SO2.7 SO2.8 SO2.9		2.9, 2.10,	
PSO 1,2,3	culture techniques.	SO2.10			
PO 1,2,3,4,5, 6,	CO3-04BT301.3: Explore protoplast isolation,	SO3.1 SO3.2 SO3.3	3.1,3.2,	3.1, 3.2, 3.3, 3.4,	3SL-1,2,3,4,5
7,8,9,10,11, 12	culture, somatic hybridization, selection of	SO3.4 SO3.5 SO3.6		3.5, 3.6, 3.7, 3.8,	
	hybrids, cybrids, somaclonal variation,	SO3.7 SO3.8 SO3.9		3.9, 3.10,	
PSO 1,2,3	mechanisms, and applications.	SO3.10			
PO 1,2,3,4,5, 6,	CO4- 04BT301.4: Gain comprehensive assesses	SO4.1 SO4.2 SO4.3		4.1, 4.2, 4.3, 4.4,	4SL-1,2,3,4,5
7,8,9,10,11, 12	of haploid plant production methods, including	SO4.4 SO4.5 SO4.6		4.5, 4.6, 4.7, 4.8,	
	anther culture, microspore culture,	SO4.7 SO4.8 SO4.9		4.9, 4.10	
PSO 1,2,3	androgenesis, and gynogenesis.	SO4.10			
PO 1,2,3,4,5, 6,	CO5-04BT301.5: Achieve proficiency in virus-	SO5.1 SO5.2 SO5.3	5.1,	5.1, 5.2, 5.3, 5.4,	5SL-1,2,3,4,5
7,8,9,10,11, 12	free plant production, germplasm conservation,	SO5.4 SO5.5 SO5.6		5.5, 5.6,	
	artificial seed preparation, PGPR and				
PSO 1,2,3	acclimatization,				

Program name	Bachelor of Science (B.Sc.)- Biotechnology
Semester	IV
CourseCode:	01BT401
Coursetitle:	Genetics Developer: Dr. Kamlesh Kumar Soni, Assistant Professor
Pre-requisite:	Student should have basic knowledge biology
Rationale:	The study of genetics students is essential for understanding the fundamental principles of inheritance, variation, and evolution. It equips students with knowledge crucial for medical advancements, biotechnology, and research in biological sciences. Genetics also has significant applications in fields such as forensic science, agriculture, and environmental management. It prepares students to address ethical, legal, and social issues related to genetic technologies. Overall, genetics provides a strong foundation for diverse career opportunities in science and technology.
CourseOutcomes (COs)	 DIBT401CO1Students will comprehend the introduction to the Genetics and essentiality of cell cycles and heredity 01BT401CO2Students will understand non-allelic genetic interactions and the organization of the eukaryotic nuclear genomeand the functions of centromeres and telomeres. 01BT401CO3Students will understand the genetic organization of prokaryotic and viral genomes, the structure and characteristics of bacterial and eukaryotic chromosomes, and the concepts of euchromatin, heterochromatin, gene structure, and genetic coding. 01BT401CO4The outcome of this syllabus is a comprehensive understanding of genetic mutations, chromosomal structure variations, sex determination mechanisms, and their implications in inheritance and genetic disorders 01BT401CO5A deep understanding of genetic linkage, crossing over, chromosome mapping, extra chromosomal inheritance mechanisms, and evolutionary principles in population genetics

Scheme of Studies:

			Scheme o	fstudies (Ho	urs/Week)			
Board ofStudy	CourseCode	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)
MAJOR	01BT401	Genetics	4	4	1	3	12	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial(T) and others);

LI: Laboratory Instruction(Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

				Scheme of Assessment (Marks)							
					Progressive Asso	essment (PRA)					
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)		
MAJOR	01BT401	Genetics	15	20	10	5	50	50	100		

Scheme of Assessment: Practical

					S	cheme of Assessi	ment (Marks)		
					Progressive As	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MAJOR	01BT401-L	Genetics	35	5	5	5	50	50	100

Course-Curriculum:	ApproximateHou	rs				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	03	22
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01BT401CO 1:Students	SO 1.1: Will be understanding the	LI 1.1: Modern organics; display	CI 1.1:Introduction: Historical	SL 1.1: Study about the basic
will comprehend the	basic of genetics		developments in the field of	of gene
introduction to the			genetics; Organisms suitable for	
genetics and essentiality			geneticexperimentation and their	
of cell cycles and heredity			genetic significance	
	SO 1.2: know about the importance of	LI1.2: Preparation of slides to	CI1.2: Cell Cycle: Mitosis and	SL1.2: Learn about
	cell cycles	see the cell cycle phases	Meiosis:,	fundamental of cell cycles
	SO 1.3: understand the control points	LI1.3: Preparation of slides to	CI1.3: Control points in cell-cycle	SL1.3: Study the
	in cell cycle	see the Meiosis	progression in yeast. Role of	fundamentals of
			meiosis in life cycles of organisms.	chromosome pairing.
	SO 1.4: learn about concept of		CI1.4: Mendelian genetics:	
	medallion genetics		Mendel's experimental design,	
	SO 1.5: learn about different types of		CI1.5: monohybrid, di-hybrid and	
	crosses		tri hybrid crosses,	
	SO 1.6: learn how characters segregate		CI1.6: Law of segregation &	
	and assort		Principle of independent assortment	
	SO 1.7: How alleles intact to govern a		CI1.7: Verification of segregates by	
	phenotypes		test and back crosses,	
	SO 1.8 Explain about chromosomal		CI1.8: Chromosomal theory of	
	theory of inheritance		inheritance	
	SO 1.9: How alleles intact to govern a		CI1.9: Allelic interactions: Concept	
	phenotypes		of dominance, recessiveness,	
	SO 1.10: illustrate about different types		CI1.10: incomplete dominance, co-	
	of dominance		dominance, semi-dominance,	
	SO 1.11: Explain about pleiotropy,		CI1.11: pleiotropy, multiple alleles	
	multiple alleles			
	SO 1.12: know why some allele are		CI1.12:Pseudo-allele, essential and	
	important for survival		lethal genes	

Suggested Sessional Work	SW1.1 Assignments	Brief the cell cycle
(SW): anyone	SW1.2 Mini Project	Explain different laws of mendal's
	SW1.3 Other Activities (Specify)	Watch animation on alleles and their function

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ItemClLISWSLTotalApprox.Hrs1206010221

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01BT401CO2Students will	SO2.1: know the basics of non-allelic	LI2.1: Photograph of	CI2.1:Non allelic interactions:	SL2.1: Study about the
understand non-allelic genetic	interaction	chromosome organization	Interaction producing new	alleles and allelomorph
interactions and the organization of			phenotype	
the eukaryotic nuclear genomeand	SO2.2: Assess about Complementary	LI2.2: Preparation of slides	CI2.2: Complementary genes,	SL2.2: Gain basic
the functions of centromeres and	genes, epistasis (dominant & recessive),	to see the Mitosis I	epistasis (dominant & recessive),	information chromosome
telomeres				and importance of their various location
	SO2.3 Assess about duplicate genes and	LI2.3: Preparation of slides	CI2.3: duplicate genes and	
	inhibitory genes	to see the Mitosis II	inhibitory genes.	
	SO2.4: explain about chromosomal		CI2.4: Chromosome and genomic	
	organization		organization	
	SO2.5: how eukaryotic chromosomes		CI2.5: Eukaryotic nuclear genome	
	are arranged in a cell		nucleotide sequence composition	
	SO2.6: learn why repetitive DNA is		CI2.6: Unique & repetitive DNA,	
	important			
	SO2.7: learn why satellite DNA is		CI2.7: satellite DNA	
	important			
	SO2.7: learn why centromere and		CI2.8: Centromere and telomere	
	telomere are important		DNA sequences	
	SO2.9: know about multiple repetitive		CI2.9: Middle repetitive sequences-	
	sequences			
	SO2.10: know the essentiality of		CI2.10: VNTRs & dinucleotide	
	VNTRs		repeats	
	SO2.11: know the essentiality of LINES		CI2.11: Repetitive transposed	
	and SINEs		sequences- SINEs & LINEs,	
	SO2.12: know the essentiality of		CI2.12: middle repetitive multiple	
	repetitive DNA		copy genes	

Suggested Sessional Work	SW1.1 Assignments	Explain the intron and exon
(SW): anyone	SW1.2 Mini Project	Prepare the poster explaining Genetic interaction with example of complementary gene
	SW1.3 Other Activities (Specify)	Explain how centromere and telomeres are important

Course-Curriculum:	ApproximateHou	rs				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	05	24
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01BT401CO3 Students will understand the genetic organization of prokaryotic and	SO3.1: Discuss about hoe viral ang bacterial genome are organised	LI3.1: Karyotyping	CI3.1: Genetic organization of prokaryotic and viral genome	SL3.1: Build-up the concept on the genome and gene
viral genomes, the structure and characteristics of bacterial and eukaryotic chromosomes, and the concepts of euchromatin,	SO3.2: will understand the packaging of chromosome	LI3.2: DNA isolation	CI3.2: Structure and characteristics of bacterial chromosome	SL3.2: Advance the knowledgeabout chromosome organization
and genetic coding	SO3.3: Will understand the chromosome structure		CI3.3: Structure and characteristics of eukaryotic chromosome	
	SO3.4: will understand about chromosomal morphology	LI3.3: PCR	CI3.4:. Chromosome morphology	SL3.3: Clear the basic concept of the transactional regulation at chromosome level
	SO3.5: Arrangement of Chromosomes and expression of genes present on them		CI3.5: Concept of euchromatin and heterochromatin	SL3.4: Boost your knowledge onhistone and non-histone protein , DNA-protein interaction
	SO3.6: Learn how such long DNA is packaged in small cell		CI3.6: Packaging of DNA molecule into chromosomes	SL3.5 Know about the arrangement of the chromosome based on their size
	SO3.7: Gain knowledge about chromosome morphology		CI3.7: Chromosome banding pattern,	
	SO3.8: know more about karyotype		CI3.8: karyotype,	
	SO3.9: Know more of giant chromosome		CI3.9: Giant chromosomes	
	SO3.10: how one gene produce one polypeptide and protein		CI3.10: One gene one polypeptide hypothesis	
	SO3.11: Know more of various components of gene		CI3.11: Concept of cistron, exons, introns,	
	SO3.12: Know more of genetic code		CI3.12: Concept of genetic code	

Suggested Sessional Work	Assignments:	Describe the Giant chromosome
(SW): anyone	Mini Project:	Draw chromosomes packaging in a poster
	Other Activities (Specify):	Prepare the Giant chromosome in a poster

Course-Curriculum:	ApproximateHou	rs				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	04	23
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01BT401CO4 The outcome of this syllabus is a comprehensive understanding of genetic mutations, chromosomal structure variations,	SO4.1: learning why mutation is important	LI4.1:Demonstration of - Barr Body -Rhoeo translocation	CI4.1: Chromosome and gene mutations: Definition and types of mutations, causes of mutations	SL4.1: learn how mutation is created
sex determination mechanisms, and their implications in inheritance and genetic disorders	SO4.2: Know the biology mutant microorganism	LI4.1:Demonstration of – Ame's Test	CI4.2: Ame's test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants,	SL4.2: Read how mutants are screened
	SO4.3: How variation in whole chromosomes occurs	LI4.1:Demonstration of – Chromosome structure	CI4.3: Variations in chromosomes structure- deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations	SL4.3: Detailing on the chromosome structural variations
	SO4.4: Lean how variation occur in single chromosome		CI4.4:Chromosomal abnormalities– Aneuploidy and Euploidy	SL4.4: Learn the effect of chromosome abnormalities
	SO4.5: Will be able to understand the sex determination in organisms		CI4.5: Sex determination	
	SO4.6: Discuss sex linkage		CI4.5: sex linkage	
	SO4.7: Will be able to understand the sex determination in organisms		CI4.7: Mechanisms of sex determination	
	SO4.8: Know how various external factor affect the sex determination		CI4.8: Environmental factors and sex determination,	
	SO4.9: Will be able to understand the sex differentiation		CI4.9: sex differentiation	
	SO4.10: Discuss mechanism of Barr bodies		CI4.10: Barr bodies, dosage compensation,	
	SO4.11: Know about genetic balance theory		CI4.11: genetic balance theory,	
	SO4.12: understand about chromosome		CI4.12: Fragile-X-syndrome and chromosome	

Suggested Sessional Work	Assignments:	Explain the mutation and their types
(SW): anyone	Mini Project:	Explain in detail about chromosome aberrations
	Other Activities (Specify):	Prepare a poster explaining the sex determination

Course-Curriculum:	ApproximateHour	'S				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	05	24
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01BT401CO5A deep understanding of genetic	SO5.1: Know linkage affect the phenotype.	LI 5.1: Demonstration of linkage	CI5.1: Genetic linkage, crossing over	SL5.1: Principle of linkage
linkage, crossing over, chromosome mapping, extra chromosomal inheritance mechanisms, and	SO5.2: how tightly genes are linked	O5.2: how tightly genes are linked LI5.2: Study of polyploidy in onion root tip by colchicine CI5.2: Chromosome mapping		SL5.2: Study fundamental of recombination
evolutionary principles in population genetics	SO5.2: Learn how recombination produces new phenotype	LI5.3: Pedigree charts of some common characters like blood group, color blindness and PTC tasting	CI5.3: Linkage and Recombination of genes in a chromosome crossing over,	SL5.3: Study molecular mechanism of regulation
	SO5.3: Understand the cytological changes occur during the crossing over		CI5.4:Cytological basis of crossing over, Molecular mechanism of crossing over	SL5.4: read in details about the extra chromosomal factor that affect the phonotype
	SO5.4: Know the importance of multiple crossing over		CI5.5: Crossing over at four strand stage, Multiple crossing overs Genetic mapping	
	SO5.5: Learn about extra chromosomal inheritance		CI5.6: Extra chromosomal inheritance:	
	SO5.6: How maternal material affect the phenotypes		CI5.7: Rules of extra nuclear inheritance	
	SO5.8: discuss about maternal inheritance		CI5.8: Maternal effects, maternal inheritance,	SL5.5: Learn the population genetics
	SO5.8: explain about cytoplasmic inheritance		CI5.9: cytoplasmic inheritance, organelle heredity,	
	SO5.8: Explain genomic impriniting		CI5.10: genomic imprinting	
	SO5.8: discuss about population genetics		CI5.11: Evolution and population genetics: In breeding and out breeding	
	SO5.8: discuss about Hary Weinberg Law		CI5.12: Hardy Weinberg law (prediction, derivation).	

Suggested Sessional	Assignments:	In details explain the maternal effect		
Work (SW): Anyone	Mini Project:	Explain the crossing over		
	Other Activities (Specify):	Explain the linkage and recombination		
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Course duration (in hours) to attain Course Outcomes							
(Course title: Genetics (Course code:)							
Course Outcomes(COs)	Class lecture(CI)	LaboratoryInstruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)		
01BT401CO 1Students will comprehend the introduction to the	12	6	3	1	22		
genetics and essentiality of cell cycles and heredity							
01BT401CO2Students will understand non-allelic genetic	12	6	2	1	21		
interactions and the organization of the eukaryotic nuclear							
genomeand the functions of centromeres and telomeres							
01BT401CO3Students will understand the genetic organization of	12	6	5	1	24		
prokaryotic and viral genomes, the structure and characteristics of							
bacterial and eukaryotic chromosomes, and the concepts of							
euchromatin, heterochromatin, gene structure, and genetic coding							
01BT401CO4The outcome of this syllabus is a comprehensive	12	6	4	1	23		
understanding of genetic mutations, chromosomal structure							
variations, sex determination mechanisms, and their implications							
in inheritance and genetic disorders							
01BT401CO5:A deep understanding of genetic linkage, crossing	12	6	5	1	24		
over, chromosome mapping, extra chromosomal inheritance							
mechanisms, and evolutionary principles in population genetics							
Total Hours	60	30	19	05	114		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:												
Course title: Genetic Engineering & Technology) (Course code:)												
Course Outcomes		Total										
	Α	An	Ε	С	Marks							
01BT401CO1 Students will comprehend the introduction to the genetics and essentiality of cell cycles and heredity	2	1	1	1	5							
01BT401CO2 Students will understand non-allelic genetic interactions and the organization of the eukaryotic nuclear genomeand the functions of centromeres and telomeres	2	4	2	2	10							
01BT401CO3S tudents will understand the genetic organization of prokaryotic and viral genomes, the structure and characteristics of bacterial and eukaryotic chromosomes, and the concepts of euchromatin, heterochromatin, gene structure, and genetic coding	3	5	5	2	15							
01BT401CO4 The outcome of this syllabus is a comprehensive understanding of genetic mutations, chromosomal structure variations, sex determination mechanisms, and their implications in inheritance and genetic disorders	2	3	3	2	10							
01BT401CO5 A deep understanding of genetic linkage, crossing over, chromosome mapping, extra chromosomal inheritance mechanisms, and evolutionary principles in population genetics	5	4	1	0	10							
Total Marks	14	17	12	07	50							
Legend: A-Apply, A- Analyze, E- Evaluate, C- Create												

Suggested learning Resources:

S.no.	Title	Author	Publisher	Edition & Year
1	Principles of Genetics	Gardner, E.J., Simmons, M.J., Snustad, D.P.	John Wiley & Sons	8& 2006
2	Principles of Genetics	Michael J. Simmons, D. Peter Snustad	Wiley	7& 2015
3	iGenetics- A Molecular Approach	Peter J. Russell	Benjamin Cummings, San Francisco	3& 2010

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Cement Plant
- 7. Demonstration
- 8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
- 9. Brainstorming

CO, PO and PSO Mapping

Program Title: B. Sc. Biotechnology, 4thSem Course Code: 01BT401 Course Title: Genetics

CO/PO Mapping															
Course Outcome	Program Outcomes (POs)										Program Specific Outcomes (PSOs)				
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
01BT401CO1 Students will comprehend the introduction to the genetics and essentiality of cell cycles and heredity	3	3	1	1	-	-	2	1	1	3	3	2	2	2	2
01BT401CO2 Students will understand non-allelic genetic interactions and the organization of the eukaryotic nuclear genomeand the functions of centromeres and telomeres	1	1	2	2	2	-	1	1	-	2	3	2	2	2	1
01BT401CO3S tudents will understand the genetic organization of prokaryotic and viral genomes, the structure and characteristics of bacterial and eukaryotic chromosomes, and the concepts of euchromatin, heterochromatin, gene structure, and genetic coding	1	3	2	3	2	-	-	2	3	1	1	2	3	3	1
01BT401CO4 The outcome of this syllabus is a comprehensive understanding of genetic mutations, chromosomal structure variations, sex determination mechanisms, and their implications in inheritance and genetic disorders	2	3	3	2	2	2	-	1	1	2	1	-	1	1	3
01BT401CO5 A deep understanding of genetic linkage, crossing over, chromosome mapping, extra chromosomal inheritance mechanisms, and evolutionary principles in population genetics	2	-	2	-	1	3	2	2	1	3	2	2	3	2	3
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															
Program Title: B. Sc. Biotechnology, 4th Sem Course Code:01BT401 Course Title: Genetics

Course Curriculum Map:					
POs & PSOs No.	COs No	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	01BT401CO1 Students will comprehend the introduction to the genetics and essentiality of cell cycles and heredity	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	1 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	01BT401CO2 Students will understand non-allelic genetic interactions and the organization of the eukaryotic nuclear genomeand the functions of centromeres and telomeres	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	2.1, 2.2, 2.3,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	2 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	01BT401CO3S tudents will understand the genetic organization of prokaryotic and viral genomes, the structure and characteristics of bacterial and eukaryotic chromosomes, and the concepts of euchromatin, heterochromatin, gene structure, and genetic coding	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	3 SL-1,2,3,4,5
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	01BT401CO4 The outcome of this syllabus is a comprehensive understanding of genetic mutations, chromosomal structure variations, sex determination mechanisms, and their implications in inheritance and genetic disorders	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	4 SL-1,2,3,4
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	01BT401CO5 A deep understanding of genetic linkage, crossing over, chromosome mapping, extra chromosomal inheritance mechanisms, and evolutionary principles in population genetics	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 S05.9 SO5.10 SO5.11 SO5.12	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	5 SL-1,2,3,4,5

Program Name	Bachelor of Science (Hons.) in Biotechnolog	y .
Semester	IV	
Course Code:	02BC401	
Course title:	Enzymology	Curriculum Developer: Dr. Deepak Mishra, Professor
Pre-requisite:	Student should have basic knowledge of B	iotechnology, Biochemistry and Molecular Biology.
Rationale:	The Enzymology course in a B.Sc. Ho comprehensive knowledge and practical s processes at the molecular level, pivot environmental science. This course equip kinetics, essential for designing and opt applications in biotechnology, students de them for careers in research, development	ns. Biotechnology program serves a crucial role by providing students with kills in the study of enzymes. Enzymes are fundamental to understanding biological cal in fields ranging from healthcare and pharmaceuticals to agriculture and is students with an understanding of enzyme structure, function, regulation, and imizing biotechnological processes. By exploring enzyme mechanisms and their velop the proficiency to innovate and solve complex biological problems, preparing t, and industrial applications within the biotechnology sector.
Course Outcomes (COs):	CO1-02BC401.1: Familiarization with the base CO2-02BC401.2: Acquired Skills to analyze a CO3-02BC401.3: Equipped to comprehend the CO4-02BC401.4: Recognize various methods	sic concepts, key principles and mechanism of actions of enzymes. mechanism of single substrate enzyme catalyzed reaction and enzyme inhibition kinetics refundamentals of bi and multi substrate kinetics and enzyme catalysis related to Protein Ligand binding enzyme immobilization and Protein engineering
	CO5-02BC401.5: Explore role of enzyme ext	raction and purification and diverse applications of enzymes in various fields.

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)
MINOR	02BC401	Enzymology	4	4	1	5	13	4+2=6

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MINOR	02BC401	Enzymology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)					
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MINOR	02BC401-L	Enzymology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are	Approximate Hours					
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction						
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Item	Cl	LI	SW	SL	Total
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-02BC401.1: Familiarization with the basic concepts, key principles and	O1-02BC401.1: SO1.1 Define and Describe L11.1 Determination of enzyme Unit-1 activity C1.1 Enzymes		Unit-1 Cl1.1 Enzymes: Introduction	SL1.1 Search various reference books and study material to start the learning of enzymes
mechanism of actions of enzymes.	SO1.2 Explain nomenclature of enzyme	LI1.2 study the effect of pH on enzyme activity	Cl1.2 Nomenclature of Enzyme	SL1.2 Examine role of enzymes in biological system
	SO1.3 Explain IUB Nomenclature System		CI1.3 IUB Nomenclature System	SL1.3 Examine the effect of different factors on enzyme
	SO1.4 Explain classification of enzyme	LI1.3 study the effect of Temperature on enzyme activity	Cl1.4 Classification	SL1.4 Enlist the enzymes.
	SO1.5 Explore Characteristics of enzyme		CI1.5 characteristics of enzyme	SL1.5 Examine the presence in enzyme in biological systems
	SO1.6 Study the factor affecting enzyme activity		Cl1.6 Factors affecting enzyme activity	
	SO1.7 Study about pH sensitivity		CI1.7 pH Sentivity	
	SO1.8 Study about thermolability		Cl1.8 Thermolability	
	SO1.9 Study the enzyme specificity		CI1.9 Enzyme Specificity	
	SO1.10 Study the theories of ES Complex formation		Cl1.10 Theories of enzyme substrate complex formation	
	SO1.11 Study the Lock and Key Model		Cl1.11 Lock and Key Model	
	SO1.12 Study the Induced Fit Hypothesis		Cl1.12 Induced Fit Hypothesis	

Suggested Sessional	SW1.1 Assignments	Describe in detail biological significance of enzymes
Work (SW):anyone	SW1.2Mini Project	Prepare a list of enzymes used in biological reaction and biological systems
	SW1.3 Other Activities (Specify)	Preparation of laboratory manual for studying enzymes.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-02BC401.2: Acquired Skills to analyze mechanism of single	SO2.1 Explore the concept Kinetics of single substrate reaction	LI2.1 study the effect of Km	Unit-II CI2.1 Enzyme Kinetics: Kinetics of single substrate reaction,	SL2.1 Search various books and resources for study the enzyme kinetics
substrate enzyme catalyzed reaction and enzyme inhibition kinetics	SO2.2 Describe the Michaelis Menton equation	LI2.2 study the effect of Vmax	CI2.2 Michaelis Menton equation	SL2.2 study about different kintic parameters
	SO2.3 Reflecting Briggs- Haldane modification	LI2.3 study the effect of Substrate Concentration	CI2.3 Briggs-Haldane modification	
	SO2.4 Explain Line Weaver Burk Plot		CI2.4 Line Weaver Burk Plot	SL2.3 to learn about plots of enzyme activity
	SO2.5 Assessing Eadie-Hofstee and hanes plot		CI2.5 Eadie-Hofstee and hanes plot	SL2.4 standardize the protocol for enzyme activity
	SO2.6 Explaining the concept of enzyme inhibition		CI2.6 Enzyme Inhibition: Concept	SL2.5 to learn models of enzyme kinetics
	SO2.7 Explaining the types of inhibition		CI2.7 types of inhibition	
	SO2.8 Explaining the kinetics of inhibition		CI2.8 Kinetics of Enzyme Inhibition	
	SO2.9 Explaining the kinetics of Competitive inhibition		CI2.9 Kinetics of Competitive Inhibition	
	SO2.10 Explaining kinetics of Uncompetitive inhibition		CI2.10 Kinetics of Un Competitive Inhibition	
	SO2.11 Explaining kinetics of Non Competitive inhibition		CI2.11 Kinetics of Non Competitive Inhibition	
	SO2.12 Explaining the kinetics of Mixed inhibition		CI2.12 Kinetics of Mixed Inhibition	

Suggested Sessional Work	SW2.1 Assignments	Assess the impact on enzyme kinetics in biological system
(SW):anyone	SW2.2Mini Project	Designing of poster for showing plots of enzyme kinetics
-	SW2.3 Other Activities (Specify)	To analysed the impact of enzyme kinetics in living organisms

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning(SL)
		Instruction(LI)	(CI)	
CO3-02BC401.3: Equipped to	SO3.1 Explain the concept Bi	LI3.1 study the effect of	Unit-III	SL3.1 Study about example of bi
comprehend the fundamentals of	Bi reaction	enzyme inhibition	CI3.1 Classification of	bi reaction
bi and multi substrate kinetics			BiBi reaction	
and enzyme catalysis.				
	SO3.2 Assessing the concept		CI3.2 Ping pong BiBi	SL3.2 Study different types of
	of Ping pong bibi mechanism		mechanism	mechanisms of bibi reaction
	SO3.3Explaining Kinetics of	LI3.2 study the effect of	CI3.3 Alberty Equation	SL3.3 categorization of different
	Alberty equation	kinetic parameters		kinetic parameters
	SO3.4 Assessing Kinetics of	LI3.2 study the effect of	CI3.4 Dalziel Equation	
	Dalziel Equation	Enzyme Concentration		
	SO3.5 Describe Mechanism of		CI3.5 Multisubstrate	SL3.4 Study of role of multi
	multi-substrate kinetics		Kinetics	substrate reaction
	SO3.6 Assessing the concept		CI3.6 Allosteric Enzyme	SL3.5 Assess models for studying
	of Allosteric enzyme			allosteric enzymes
	SO3.7 Describe about MWC		CI3.7 MWC model.	
	model			
	SO3.8 Describe about KNF		CI3.8 KNF model.	
	Model			
	SO3.9 Describe concwept of		CI3.9 Enzyme catalysis	
	enzyme catalysis			
	O3.10 Describe mechanism of		CI3.10 Mechanism of	
	enzyme catalysis		enzyme catalysis	
	SO3.11 Assessing the concept		CI3.11 Chymotripsin	
	of Chymotripsin			
	SO3.12 Describe about		CI3.12 Ribonuclease	
	Ribonuclease			

Suggested Sessional	SW3.1 Assignments	Describe in detail about kinetics of enzyme inhibition
Work (SW): anyone	SW3.2 Mini Project	Describe the role of factors on enzyme catalysis.
	SW3.3 Other Activities (Specify)	Prepare a an article on protein ligand binding and its impact.

				Cl	LI	SW	SL	Total	
				Approx. Hrs	12	06	01	05	24
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Classroom Instru	ction (CI)	Self-Learning (SL)				
		Instruction(LI)							
CO4-02BC401.4: Recognize	SO4.1	LI4.1 to perform enzyme	Unit-IV		SL4.1				
various methods related to	Exploring the concept of Protein	immobilization by gel	CI4.1 Protein Lig	and Binding	Learn about different categories				
Protein Ligand binding enzyme	Ligand Binding	entrapment methods			of Prot	ein lig	gand bi	nding	
immobilization and Protein									
engineering.									
	SO4.2 Assessing role of	LI4.2 To perform enzyme	CI4.2 Cooperativ	ity					
	cooperativity	immobilization by covalent							
	CO42 Franking the bill speed on	binding			CT 4 3	C			
	SO4.3 Explaining the nill equation	L14.3 To perform enzyme	CI4.5 Hill Equati	on	SL4.2 Compare application of				
		mmoomzation							
	SO4.4 Explaining the adhair		CI4.4 Adhair Equ	ation	SL4.3 Learn about various				
	equation.				protein	ligan	d com	plex	
	SO4.5 Evaluate impact of		CI4.5 Enzyme Im	mobilization:	SL4.4	optin	nizatio	n of pr	otocol
	immobilization		Basic concept		for enz	ymes	immol	bilizati	on
	SO4.6 evaluate the methods of		CI4.6 Methods	of	SL4.5	optim	ization	of pro	otocol
	immobilization		1mmobilization	nd Limitations	for enz	yme e	extracti	lon	
	SO4. 7 Discuss Benefits and Limitations of immobilization		of immobilization	nd Lininations					
	SO4.8 Describe the application of		CI48 Application	n of					
	enzyme immobilization		immobilized enzym	e					
	SO4.9 Basic Concept of Protein		CI4.9 Basic conc	cept of Protein					
	Engineering		Engineering						
	SO4.10 Basic mechanism of Protein		CI4.10 Basic m	echanism of					
	Engineering		Protein Engineering	5					
	SO4.11 Describe site directed		CI4.11 Site	Directed					
	mutagenesis		Mutagenesis						
	SO4.12 Discuss its mechanism		CI4.12 Mechanism	n of Site					
			directed mutagensis	5					

Suggested Sessional	SW4.1 Assignments	Explain about different types of enzyme immobilization techniques and its impact.
Work (SW): anyone	SW4.2 Mini Project	Standardize the protocol for enzyme immobilization.
	SW4.3 Other Activities (Specify)	Prepare one article on protein engineering

SW SL Total Item Cl LI 06 01 05 Approx.Hrs 12 24 **Course Outcome** Laboratory Classroom Self-Session Outcomes(SOs) Instruction(LI) Learning(SL) (CO)**Instruction**(CI) CO5-02BC401.5: Explore role SO5.1 Elaborate the concept of LI5.1 To perform Unit-V **SL5.1** Learn about basic Enzyme extraction of enzyme extraction and enzyme purification **CI5.1** Extraction of enzyme concept of enzyme purification diverse and engineering applications of enzymes in various fields. SO5.2 Elaborate the concept of LI5.2 To perform **CI5.2** Purification of Enzymes SL5.2 Learn about role Enzyme purification enzyme Extraction purification of enzyme SO5.3 Elaborate the application of LI5.3 To perform CI5.3 Application of SL5.3 Learn about enzyme engineering chromatography for enzyme engineering biological function of enzyme enzyme **SL5.4 SO5.4** Elaborate the role of enzyme Learn about CI5.4 enzyme engineering in in molecular biology applications of enzyme in molecular biology nutrition SL5.5 Learn about role & CI5.5 Application of enzyme **SO5.5** Elaborate the role of enzyme engineering engineering in animal nutrition biosensors **SO5.6** Elaborate concept of enzyme CI5.6 enzyme electrodeselectrode Concept **SO5.7** Explain types of enzyme CI5.7 types of enzyme electrode electrodes application application CI5.8 their SO5.8 Assess of as biosensors in industry biosensor in industries **SO5.9** Explain concept of biosensor CI5.9 Concept of biosensors **SO5.10** Elaborate types of CI5.10 types of biosensor biosensor CI5.11 biosensors in health care Elaborate application **SO5.11** of biosensor in Health care

Suggested Sessional	SW5.1 Assignments	Explain general application of enzyme in industries and different areas
Work (SW): anyone	SW5.2 Mini Project	Describe the role of enzyme engineering and site directed mutagenesis
	SW5.3 Other Activities (Specify)	Prepare a detail document on enzyme electrode and biosensors

CI5.12

environment.

biosensors

in

Elaborate application

SO5.12

of biosensor in environment

Course duration (in hours) to attain Course Outcomes:

Course Title: Enzymology Course Code:02BC401 **Course Outcomes(COs)** Self-Learning Sessional work **Total Hours Class lecture** Laboratory Instruction(LI) (SL) (Li+CI+SL+SW) (**CI**) **(SW) CO1-02BC401.1:** Familiarization with the basic concepts, 12 5 1 24 6 key principles and mechanism of actions of enzymes. CO2-02BC401.2: Acquired Skills to analyze mechanism 12 24 6 5 1 of single substrate enzyme catalyzed reaction and enzyme inhibition kinetics CO3-02BC401.3: Equipped to comprehend the 12 6 5 24 1 fundamentals of bi and multi substrate kinetics and enzyme catalysis CO4-02BC401.4: Recognize various methods related to 12 5 6 1 24 Protein Ligand binding enzyme immobilization and Protein engineering. **CO5-02BC401.5:** Explore role of enzyme extraction and 12 5 6 1 24 purification and diverse applications of enzymes in various fields. 30 25 **Total Hours** 60 05 120

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Enzymology

Course Code: 02BC401

Course Outcomes		Marks I	Distributio	n	
	Α	An	E	С	Total Marks
CO1-02BC401.1: Familiarization with the basic concepts, key principles and mechanism of	2	1	1	1	5
actions of enzymes.					
CO2-02BC401.2: Acquired Skills to analyze mechanism of single substrate enzyme catalyzed	2	4	2	2	10
reaction and enzyme inhibition kinetics					
CO3-02BC401.3: Equipped to comprehend the fundamentals of bi and multi substrate kinetics	2	3	3	2	10
and enzyme catalysis					
CO4-02BC401.4: Recognize various methods related to Protein Ligand binding enzyme	3	5	5	2	15
immobilization and Protein engineering.					
CO5-02BC401.5: Explore role of enzyme extraction and purification and diverse applications of	5	4	1	0	10
enzymes in various fields.					
Total Marks	14	17	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Enzymes by Palmer (2001): Horwood Publishing Series.
2	Fundamentals of Enzymology by Price and Stevens (2002): Oxford University Press.
3	Enzyme Technology by Helmut uhling (1998): John Wiley
4	Introduction to Proteins Structure by Branden and Tooze (1998): Garland Publishing Group.
5	Lehninger's Principles of Biochemistry: Nelson & Cox

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B Sc. (Hons.) Biotechnology Semester: IV Semester Course Title: Enzymology Course Code: 02BC401

Course Outcome (Cos)		Program Outcomes (POs)								Program Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02BC401.1: Familiarization with the basic concepts, key principles and mechanism of actions of enzymes.	2	2	3	2	3	3	2	2	2	1	3	2	3	2	3
CO2-02BC401.2: Acquired Skills to analyze mechanism of single substrate enzyme catalyzed reaction and enzyme inhibition kinetics	2	1	2	1	2	2	2	1	1	2	2	1	2	3	3
CO3-02BC401.3: Equipped to comprehend the fundamentals of bi and multi substrate kinetics and enzyme catalysis	2	2	2	2	2	2	3	2	2	1	2	2	1	1	3
CO4-02BC401.4: Recognize various methods related to Protein Ligand binding enzyme immobilization and Protein engineering.	1	1	3	1	3	3	3	1	2	2	3	1	2	2	3
CO5-02BC401.5: Explore role of enzyme extraction and purification and diverse applications of enzymes in various fields.	2	1	3	1	3	3	3	1	1	2	3	1	2	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
PO 1,2,3,4,5, 6,	CO1-02BC401.1: Familiarization with the	SO1.1 SO1.2	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4,	1SL-1,2,3,4,5
7,8,9,10,11, 12	basic concepts, key principles and mechanism	SO1.3 SO1.4		1.5, 1.6, 1.7, 1.8,	
	of actions of enzymes.	SO1.5 SO1.6		1.9, 1.10, 1.11,	
PSO 1,2,3		SO1.7 SO1.8		1.12	
		SO1.9 SO1.10			
		SO1.11 SO1.12			
PO 1,2,3,4,5, 6,	CO2-02BC401.2: Acquired Skills to analyze	SO2.1 SO2.2	2.1, 2.2, 2.3,	2.1, 2.2, 2.3, 2.4,	2SL-1,2,3,4,5
7,8,9,10,11, 12	mechanism of single substrate enzyme	SO2.3 SO2.4		2.5, 2.6, 2.7, 2.8,	
	catalyzed reaction and enzyme inhibition	SO2.5 SO2.6		2.9, 2.10, 2.11,	
PSO 1,2,3	kinetics	SO2.7 SO2.8		2.12	
		SO2.9 SO2.10			
		SO2.11 SO2.12			
PO 1,2,3,4,5, 6,	CO3-02BC401.3: Equipped to comprehend	SO3.1 SO3.2	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4,	3SL-1,2,3,4,5
7,8,9,10,11, 12	the fundamentals of bi and multi substrate	SO3.3 SO3.4		3.5, 3.6, 3.7, 3.8,	
	kinetics and enzyme catalysis	SO3.5 SO3.6		3.9, 3.10, 3.11,	
PSO 1,2,3		SO3.7 SO3.8		3.12	
		SO3.9 SO3.10			
		SO3.11 SO3.12			
PO 1,2,3,4,5, 6,	CO4-02BC401.4: Recognize various	SO4.1 SO4.2	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4,	4SL-1,2,3,4,5
7,8,9,10,11, 12	methods related to Protein Ligand binding	SO4.3 SO4.4		4.5, 4.6, 4.7, 4.8,	
	enzyme immobilization and Protein	SO4.5 SO4.6		4.9, 4.10, 4.11,	
PSO 1,2,3	engineering.	SO4.7 SO4.8		4.12	
		SO4.9 SO4.10			
		SO4.11 SO4.12			
PO 1,2,3,4,5, 6,	CO5-02BC401.5: Explore role of enzyme	SO5.1 SO5.2	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4,	5SL-1,2,3,4,5
7,8,9,10,11, 12	extraction and purification and diverse	SO5.3 SO5.4		5.5, 5.6, 5.7, 5.8,	
	applications of enzymes in various fields.	SO5.5 SO5.6		5.9, 5.10, 5.11,	
PSO 1,2,3		SO5.7 SO5.8		5.12	
		S05.9 SO5.10			
		SO5.11 SO5.12			

Program Name	B.Sc. (Hons.) Biotechnology							
Semester	IV							
CourseCode:	02MB401							
Coursetitle:	Medical Microbiology Curriculum Developer: Mrs. Maahi Choure, Guest Faculty							
Pre-requisite:	Understanding fundamental concepts in biolog	Understanding fundamental concepts in biology, including cell biology, genetics, and basic microbiology.						
Rationale:	Medical microbiology is essential for understa insights into how pathogens cause disease, how Knowledge gained from medical microbiolog significant challenge in global health.	anding the role of microorganisms in human health and disease. This field provides critical w the immune system responds, and the mechanisms of action for antibiotics and vaccines. y is crucial for diagnosing, treating, and preventing infectious diseases, which remains a						
CourseOutcomes (COs):	CO1-02MB401.1: Understand the fundamenta CO2-02MB401.2: Analyze the morphology, pa CO3-02MB401.3: Examine the characteristics CO4-02MB401.4: Analyze the etiology and ch CO5-02MB401.5: Evaluate the clinical feature	Is of microbial ecology and human microbiota athogenesis, and laboratory diagnosis of gram-positive bacterial infections and management of gram-negative bacterial infections aracteristics of viral infections as and treatment of fungal and protozoan infections						

Scheme of Studies:

	CourseCode	de CourseTitle						
Board ofStudy			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)
MINOR	02MB401	Medical Microbiology	4	4	1	2	11	4+2=6

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits. Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MINOR	02MB401	Medical Microbiology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)						
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MINOR	02MB401-L	Medical Microbiology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session	ApproximateHours					
levels, which students are anticipated to accomplish through various modes of instruction including			1			
Classroom Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning	Item	Cl	LI	SW	SL	Total
(SL) As the course progresses students should showcase their mastery of Session Outcomes (SOs)	Approx.Hrs	12	06	01	02	21
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.		•				

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-02MB401.1: : Understand the fundamentals of microbial	SO1.1 Introduction to Normal Microflora	LI1.1 Learn how to handle pathogens	CI1.1 Introduction to Normal Microflora	SL1.1 Remember Carriers in Disease Transmission
ecology and human microbiota	SO1.2 Role and Importance of Normal Microflora	LI1.1 Perform sterilization	CI1.2 Role and Importance of Normal Microflora	SL1.2 Explore microflora of university
	SO1.3 Introduction to Nosocomial Infections	LI1.1 identification of toxins	CI1.3 Introduction to Nosocomial Infections	
	SO1.4 Carriers in Disease Transmission		CI1.4 Carriers in Disease Transmission	
	SO1.5 Septic Shock and Septicemia		CI1.5 Septic Shock and Septicemia	
	SO1.6 Concept of Pathogenicity		CI1.6 Concept of Pathogenicity	
	SO1.7 Virulence Factors		CI1.7 Virulence Factors	
	SO1.8 Types and Mechanisms of Toxins		CI1.8 Types and Mechanisms of Toxins	
	SO1.9 Biosafety Levels		CI1.9 Biosafety Levels	
	SO1.10 Normal Microflora		CI1.10 Normal Microflora	
	SO1.11 Nosocomial Infections		CI1.11 Nosocomial Infections	
	SO1.12 Analysis on Septic Shock		CI1.12 Analysis on Septic Shock	

Suggested Sessional	SW1.1 Assignments	Summarizes the Analysis on Septic Shock.
Work (SW):anyone	SW1.2Mini Project	DemonstrateTypes and Mechanisms of Toxins.
	SW1.3 Other Activities (Specify)	

Item	Cl	LI	SW	SL	Total
Approx.Hi	s 12	6	1	2	21

Course Outcome	SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction (CI)	Self Learning (SL)
CO2-02MB401.2: Analyze the morphology.	SO2.1 Introduction to Gram-Positive Bacteria	LI2.1 Prepare morphology and Pathogenesis of <i>S.</i> <i>aureus</i> wet lab	CI2.1 Introduction to Gram- Positive Bacteria	SL2.1 Research on M. tuberculosis
pathogenesis, and laboratory diagnosis of gram-positive	SO2.2 Morphology and Pathogenesis of <i>S. aureus</i>	LI2.2 Perform diagnosis of S. pyogenes	CI2.2 Morphology and Pathogenesis of <i>S. aureus</i>	SL2.2 Case Study on C. diphtheriae
bacterial infections	SO2.3 Symptoms and Laboratory Diagnosis of <i>S. aureus</i>	LI2.3 Perform diagnosis of B. anthracis	CI2.3 Symptoms and Laboratory Diagnosis of <i>S.</i> <i>aureus</i>	
	SO2.4 Preventive Measures and Chemotherapy for <i>S. aureus</i>		CI2.4 Preventive Measures and Chemotherapy for <i>S. aureus</i>	
	SO2.5 Morphology, Pathogenesis, and Symptoms of <i>S. pyogenes</i>		CI2.5 Morphology, Pathogenesis, and Symptoms of <i>S. pyogenes</i>	
	SO2.6 Laboratory Diagnosis and Chemotherapy for <i>S. pyogenes</i>		CI2.6 Laboratory Diagnosis and Chemotherapy for S. pyogenes	
	SO2.7 Pathogenesis and Symptoms of <i>B. anthracis</i>		CI2.7 Pathogenesis and Symptoms of <i>B. anthracis</i>	
	SO2.8 Preventive Measures and Chemotherapy for <i>B. anthracis</i>		CI2.8 Preventive Measures and Chemotherapy for <i>B.</i> <i>anthracis</i>	
	SO2.9 Clostridium Species (<i>C. perfringens, C. tetani, C. botulinum</i>)		CI2.9 Clostridium Species (<i>C. perfringens, C. tetani, C. botulinum</i>)	
	SO2.10 Pathogenesis and Symptoms of <i>M.tuberculosis</i>		CI2.10 Pathogenesis and Symptoms of <i>M.</i> <i>tuberculosis</i>	
	SO2.11 Pathogenesis and Symptoms of <i>M. leprae</i>		CI2.11 Pathogenesis and Symptoms of <i>M. leprae</i>	
	SO2.12 Laboratory Diagnosis and Chemotherapy for <i>M. leprae</i>		CI2.12 Laboratory Diagnosis and Chemotherapy for <i>M. leprae</i>	

Suggested Sessional	SW2.1 Assignments	Justify the role of Preventive Measures and Chemotherapy.		
Work (SW):anyone	SW2.2Mini Project	Understand the pathogenesis of M. leprae.		
	SW2.3 Other Activities (Specify)	Remember laboratory diagnosis technique.		

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	6	1	2	21

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning(SL)
		Instruction(LI)	(CI)	
CO3-02MB401.3: Examine the	SO3.1 Introduction to Gram-	LI3.1 Identification of	CI3.1 Introduction to Gram-	SL3.1Practice local
characteristics and management	Negative Bacteria	gram negative bacteria	Negative Bacteria	alignment
of gram-negative bacterial	SO3.2 Morphology and	LI3.2 Identification	CI3.2 Morphology and	SL3.2Practice global
infections	Pathogenesis of E. coli	of gram positive	Pathogenesis of E. coli	alignment
		bacteria		
	SO3.3 Symptoms and	LI3.3 Identification	CI3.3 Symptoms and	
	Laboratory Diagnosis of N.	of pathogens	Laboratory Diagnosis of N.	
	gonorrhoeae		gonorrhoeae	
	SO3.4 Preventive Measures and		CI3.4 Preventive Measures	
	Chemotherapy for N.		and Chemotherapy for N.	
	meningitidis		meningitidis	
	SO3.5 Pathogenesis and		CI3.5 Pathogenesis and	
	Symptoms of P. aeruginosa		Symptoms of P. aeruginosa	
	SO3.6 Laboratory Diagnosis and		CI3.6 Laboratory Diagnosis	
	Chemotherapy for S. typhi		and Chemotherapy for S. typhi	
	SO3.7 Morphology and		CI3.7 Morphology and	
	Pathogenesis of S. dysenteriae		Pathogenesis of S. dysenteriae	
	SO3.8 Preventive Measures and		CI3.8 Preventive Measures	
	Chemotherapy for Y. pestis		and Chemotherapy for Y. pestis	
	SO3.9 Overview of <i>H</i> .		CI3.9 Overview of <i>H</i> .	
	influenzae		influenzae,	
	SO3.10 Overview of <i>V. cholerae</i>		CI3.10 Overview of <i>M</i> .	
			pneumoniae	
	SO3.11 Overview of M .		CI3.11 Overview of M .	
	pneumoniae		pneumoniae	
	SO3.12 Overview of <i>T. pallidum</i>		CI3.12 Overview of T .	
	M. pneumoniae,		pallidum M. pneumoniae,	
	Rickettsiaceae, Chlamydiae.		Rickettsiaceae, Chlamydiae.	

Suggested Sessional	SW3.1 Assignments	Write about Local and global alignment.
Work (SW): anyone	SW3.2 Mini Project	
	SW3.3 Other Activities (Specify)	Search and find the amrita lab and there find alignment methods.

					Item	Cl	LI	SW S	L Total
					Approx.Hrs	12	6	1 2	21
Course Outcome (CO)	Session Outcomes(S	Os)	Laboratory Instruction(LI)	Classroom Inst	ruction(CI)	S	elf-Le	arning(S	L)
CO4-02MB401.4: Analyze the etiology and characteristics of viral infections	SO4.1 Introduction Diseases	to Viral	LI4.1 Compare and contrast the pathogenesis, symptoms, and treatment of different viral families	CI4.1 Introduc Diseases	ction to V	iral S	L4.1 of mea	Learn te pi sures	chniques reventive
	SO4.2 Morphology Pathogenesis of Pico	and ornaviruses	LI4.2 How to identify the HIV/AIDS	CI4.2 Morpho Pathogenesis Picornavirus	logy a s ses	and S of	L4.2 sym dise	Understa ptoms o: eases	nd f various
	SO4.3 Symptoms a Diagnosis of Orthon	and Laboratory 1yxoviruses	LI4.3 Diagnosis of viral infections	CI4.3 Sympton Laboratory Orthomyxov	ms a Diagnosis viruses	and of			
	SO4.4 Preventive Chemotherapy for P	Measures and aramyxoviruses		CI4.4 Preventive Chemotherapy for	ve Measures Paramyxovirus	and es			
	SO4.5 Pathogenesis of Rhabdoviruses	and Symptoms		CI4.5 Pathoge Symptoms of	nesis of Rhabdovirus	and es			
	SO4.6 Laboratory Chemotherapy for R	Diagnosis and eoviruses		CI4.6 Laborate Chemothera	ory Diagnosis a py for Reoviru	and ses			
	SO4.7 Morphology Pathogenesis of F Herpes Virus	and ox Virus and		CI4.7 Morpho Pathogenesis and Herpes	logy : s of Pox Vi Virus	and rus			
	SO4.8 Preventive Chemotherapy for P	Measures and apova Virus		CI4.8 Preventi Chemothera Virus	ve Measures a py for Pape	and ova			
	SO4.9 Overview of (including HIV) Hepatitis Viruses	of Retroviruses (AIDS) and		CI4.9 Overvie (including Hepatitis Vi	w of Retroviru HIV/AIDS) a ruses	ses and			
	SO4.10 Typ Retroviruses (includ and Hepatitis Viruse	es of ing HIV/AIDS) es		CI4.10 Types (including HIV/A Viruses	of Retrovir AIDS) and Hepa	uses titis			
	SO4.11 Mor Pathogenesis ofHerr	phology and bes Virus		CI4.11 Morpho Pathogenesis	logy s of Herpes Vir	and rus			
Suggested Coston-1 6	1304.12 Uver	view of Unit IV		of Langes Vince	w of unit I v]
Work (SW) anyong	SW4.1 Assignments	write aboutivio	orphology and Pathogenesis	ornerpes virus.					
Stork (Sty): anyone	SW4.3 Other	Search and lear	rn via YouTube how to take	Preventive Measu	ures and Chem	othera	apy for	the Papc	va
I	Activities (Specify)	Virus.							

			Item Cl Approx.Hrs 12	LI SW SL Total
Course Outcome	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-
CO5-02MB401.5: Evaluate the clinical features and treatment	SO5.1 Introduction to Fungal Infections	LI5.1 Antibiotic sentivity test	CI5.1 Fungal Infection	SL5.1Learn how Chemotherapy for Sustamia Infections
infections	SO5.2InfroductiontoProtozoanInfectionsSO5.3MorphologyandPathogenesis of Dermatorphytoses	LIS.2 How to perform pathogenesis test for fungus LIS.3 Prepare suitable media	CI5.2 Protozoan infection CI5.3 Morphology and Pathogenesis of Dermatorbytoses	SUS.2 Classify all Fungal
	SO5.4 Symptoms and Laboratory		CI5.4 Symptoms and	
	Diagnosis of Subcutaneous Infection		Laboratory Diagnosis of Suboratory Infection	
	SO5.5 Preventive Measures and Chemotherapy for Systemic Infections		CI5.5 Preventive Measures and Chemotherapy for Systemic Infections	
	SO5.6 Pathogenesis and Symptoms of Opportunistic Fungal Infections		CI5.6 Pathogenesis and Symptoms of Opportunistic Fungal Infections	
	SO5.7 Laboratory Diagnosis and Chemotherapy for Gastrointestinal Infections		CI5.7 Laboratory Diagnosis and Chemotherapy for Gastrointestinal Infections	
	SO5.8 Morphology and Pathogenesis of Blood-borne Infections		CI5.8 Morphology and Pathogenesis of Blood-borne Infections	
	SO5.9 Preventive Measures and Chemotherapy for Malaria		CI5.9 Preventive Measures and Chemotherapy for Malaria	
	SO5.10 Overview of Treatment Strategies for Fungal and Protozoan Infections 1		C15.10 Overview of Treatment Strategies for Fungal and Protozoan Infections 1	
	SO5.11 Overview of Treatment Strategies for Fungal and Protozoan Infections 2		CI5.11 Overview of Treatment Strategies for Fungal and Protozoan Infections 2	
	SO5.12 Overview of Treatment Strategies for Fungal and Protozoan Infections 3		CI5.12 Overview of Treatment Strategies for Fungal and Protozoan Infections 3	

Suggested Sessional	SW5.1 Assignments	Write aboutTreatment Strategies for Fungal and Protozoan Infections.
Work (SW): anyone	SW5.2 Mini Project	
	SW5.3 Other Activities (Specify)	Try to learn and apply preventive Measures and Chemotherapy for Malaria.

Course duration (in hours) to attain Course Outcomes:

Course Title: Medical Microbiology

Course Code:02MB401

Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-02MB401.1: : Understand the fundamentals of	12	6	2	1	21
microbial ecology and human microbiota					
CO2-02MB401.2: Analyze the morphology, pathogenesis,	12	6	2	1	21
and laboratory diagnosis of gram-positive bacterial					
infections					
CO3-02MB401.3: Examine the characteristics and	12	6	2	1	21
management of gram-negative bacterial infections					
CO4-02MB401.4: Analyze the etiology and characteristics	12	6	2	1	21
of viral infections					
CO5-02MB401.5: Evaluate the clinical features and	12	6	2	1	21
treatment of fungal and protozoan infections					
Total Hours	60	30	10	05	105

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Medical Microbiology

Course Code:02MB401

Course Outcomes		n			
	Α	An	Ε	С	Total Marks
CO1-02MB401.1: : Understand the fundamentals of microbial ecology and human microbiota	02	03	04	1	10
CO2-02MB401.2: Analyze the morphology, pathogenesis, and laboratory diagnosis of gram- positive bacterial infections	03	04	02	1	10
CO3-02MB401.3: Examine the characteristics and management of gram-negative bacterial infections	02	05	02	1	10
CO4-02MB401.4: Analyze the etiology and characteristics of viral infections	02	05	02	1	10
CO5-02MB401.5 : Evaluate the clinical features and treatment of fungal and protozoan infections	03	04	03	1	11
Total Marks	12	21	13	05	51

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details	
1	Essentials of Medical Microbiology Sastry Apurba S, Bhat SandhyaJaypee Brothers Medical Publishers	2020
2	Medical Microbiology RajanMJP Publishers 2021	

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Research lab (BSL-1)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Biotechnology Semester: IV Course Title: Medical Microbiology Course Code: 02MB401

	CO/PO/PSO Mapping														
Course Outcome (Cos)		Program Outcomes (POs)									Program Specific				
									Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02MB401.1: : Understand the															
fundamentals of microbial ecology and	-	-	-	1	2	2	1	-	1	2	2	3	3	3	1
human microbiota															
CO2-02MB401.2: Analyze the															
morphology, pathogenesis, and laboratory							2		2	2	2	2	1	1	2
diagnosis of gram-positive bacterial	-	-	-	-	-	-	3	-	4	4	5	5	1	1	2
infections															
CO3-02MB401.3: Examine the															
characteristics and management of gram-	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
negative bacterial infections															
CO4-02MB401.4: Analyze the etiology	_	1	1	_	2	2	2	3	_	1	_	_	1	2	3
and characteristics of viral infections	ons		1	-	2	4	2	3	-	1	-	-	1	2	3
CO5-02MB401.5: Evaluate the clinical															
features and treatment of fungal and		1	1	-	-	2	3	3	1	2	2	2	1	-	2
protozoan infections															

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
	CO1-02MB401.1: : Understand the	SO1.1 SO1.2	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4, 1.5,	
PO 1,2,3,4,5,6	fundamentals of microbial ecology and	SO1.3 SO1.4		1.6, 1.7, 1.8, 1.9,	
7,8,9,10,11,12	human microbiota	SO1.5 SO1.6		1.10, 1.11, 1.12	161 1 2
		SO1.7 SO1.8			13L-1,2
PSO 1,2, 3		SO1.9 SO1.10			
		SO1.11 SO1.12			
	CO2-02MB401.2: Analyze the	SO2.1 SO2.2	2.1, 2.2, 2.3,	2.1, 2.2, 2.3, 2.4, 2.5,	
PO 1,2,3,4,5,6	morphology, pathogenesis, and laboratory	SO2.3 SO2.4		2.6, 2.7, 2.8, 2.9,	
7,8,9,10,11,12	diagnosis of gram-positive bacterial	SO2.5 SO2.6		2.10, 2.11, 2.12	261 1 2
	infections	SO2.7 SO2.8			23L-1,2
PSO 1,2, 3		SO2.9 SO2.10			
		SO2.11 SO2.12			
	CO3-02MB401.3: Examine the	SO3.1 SO3.2	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4, 3.5,	
PO 1,2,3,4,5,6	characteristics and management of gram-	SO3.3 SO3.4		3.6, 3.7, 3.8, 3.9,	
7,8,9,10,11,12	negative bacterial infections	SO3.5 SO3.6		3.10, 3.11, 3.12	261 1 2
		SO3.7 SO3.8			53L-1,2
PSO 1,2, 3		SO3.9 SO3.10			
		SO3.11 SO3.12			
	CO4-02MB401.4: Analyze the etiology and	SO4.1 SO4.2	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4, 4.5,	
PO 1,2,3,4,5,6	characteristics of viral infections	SO4.3 SO4.4		4.6, 4.7, 4.8, 4.9,	
7,8,9,10,11,12		SO4.5 SO4.6		4.10, 4.11, 4.12	451 1 2
		SO4.7 SO4.8			43L-1,2
PSO 1,2, 3		SO4.9 SO4.10			
		SO4.11 SO4.12			
	CO5-02MB401.5: Evaluate the clinical	SO5.1 SO5.2	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5,	
PO 1,2,3,4,5,6	features and treatment of fungal and	SO5.3 SO5.4		5.6, 5.7, 5.8, 5.9,	
7,8,9,10,11,12	protozoan infections	SO5.5 SO5.6		5.10, 5.11, 5.12	551-1.2
		SO5.7 SO5.8			JJL-1,2
PSO 1,2, 3		S05.9 SO5.10			
		SO5.11 SO5.12			

Program Name	Bachelor of Science (Hons.) in Biotechnology						
Semester	IV						
Course Code:	03BC401						
Course title:	Enzymology Curriculum Developer: Dr. Deepak Mishra, Professor						
Pre-requisite:	Student should have basic knowledge of Biotechnology, Biochemistry and Molecular Biology.						
Rationale:	The Enzymology course in a B.Sc. Hor comprehensive knowledge and practical sk processes at the molecular level, pivot environmental science. This course equip kinetics, essential for designing and opti applications in biotechnology, students dev them for careers in research, development	ns. Biotechnology program serves a crucial role by providing students with kills in the study of enzymes. Enzymes are fundamental to understanding biological al in fields ranging from healthcare and pharmaceuticals to agriculture and s students with an understanding of enzyme structure, function, regulation, and mizing biotechnological processes. By exploring enzyme mechanisms and their velop the proficiency to innovate and solve complex biological problems, preparing , and industrial applications within the biotechnology sector.					
Course Outcomes CO1-03BC401.1: Familiarization with the basic concepts, key principles and mechanism of actions of enzymes. (COs): CO2-03BC401.2: Acquired Skills to analyze mechanism of single substrate enzyme catalyzed reaction and enzyme inhibition							
	CO3-03BC401.3: Equipped to comprehend th	e fundamentals of bi and multi substrate kinetics and enzyme catalysis					
	CO4-03BC401.4: Recognize various methods	related to Protein Ligand binding enzyme immobilization and Protein engineering.					
	CO5-03BC401.5: Explore role of enzyme extr	action and purification and diverse applications of enzymes in various fields.					

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW SL Total Study Hours(CI+LI+SW+SL)		Total Credits(C) (L:T:P=3:0:1)	
Generic Elective	03BC401	Enzymology	3	2	1	5	11	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

				Progressive Assessment (PRA)						
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
Generic Elective	03BC401	Enzymology	15	20	10	5	50	50	100	

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)					
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03BC401-L	Enzymology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Арр	proximate Hou	S				
which students are anticipated to accomplish through various modes of instruction including Classroom						·	
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	08	06	01	05	20
achievement of Course Outcomes (COs) upon the course's conclusion							

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-03BC401.1: Familiarization with the basic concepts, key principles and mechanism of actions of enzymes.	1.1: SO1.1 Define and LI1.1 D enzyme enzyme		Unit-1 Cl1.1 Enzymes: Introduction	SL1.1 Search various reference books and study material to start the learning of enzymes
	SO1.2 Explain nomenclature of enzyme	LI1.2 study the effect of pH on enzyme activity	CI1.2 Nomenclature of Enzyme	
	SO1.3 Explain IUE Nomenclature System		CI1.3 IUB Nomenclature System	
	SO1.4 Explain classification of enzyme	LI1.3 study the effect of Temperature on enzyme activity	Cl1.4 Classification	SL1.2 Examine role of enzymes in biological system
	SO1.5 Explore Characteristics of enzyme		CI1.5 characteristics of enzyme	SL1.3 Examine the effect of different factors on enzyme
	SO1.6 Study the factor affecting enzyme activity		Cl1.6 Factors affecting enzyme activity	
	SO1.7 Study the enzyme specificity		CI1.7 Enzyme Specificity	SL1.4 Enlist the enzymes.
	SO1.8 Study the theories of ES Complex formation		CI1.8 Theories of enzyme substrate complex formation	SL1.5 Examine the presence in enzyme in biological systems

Suggested Sessional	SW1.1 Assignments	Describe in detail biological significance of enzymes
Work (SW):anyone	SW1.2Mini Project	Prepare a list of enzymes used in biological reaction and biological systems
	SW1.3 Other Activities (Specify)	Preparation of laboratory manual for studying enzymes.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	08	01	01	05	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-03BC401.2: Acquired Skills to analyze mechanism of single substrate enzyme catalyzed reaction and enzyme inhibition kinetics	SO2.1 Explore the concept Kinetics of single substrate reaction	LI2.1 study the effect of Km	Unit-II CI2.1 Enzyme Kinetics: Kinetics of single substrate reaction,	SL2.1 Search various books and resources for study the enzyme kinetics
	SO2.2 Describe the Michaelis Menton equation		CI2.2 Michaelis Menton equation	SL2.2 study about different kintic parameters
	SO2.3 Reflecting Briggs- Haldane modification		CI2.3 Briggs-Haldane modification	
	SO2.4 Explain Line Weaver Burk Plot		CI2.4 Line Weaver Burk Plot	SL2.3 to learn about plots of enzyme activity
	SO2.5 Assessing Eadie-Hofstee and hanes plot		CI2.5 Eadie-Hofstee and hanes plot	SL2.4 standardize the protocol for enzyme activity
	SO2.6 Explaining the concept of enzyme inhibition		CI2.6 Enzyme Inhibition: Concept	SL2.5 to learn models of enzyme kinetics
	SO2.7 Explaining the types of inhibition		CI2.7 types of inhibition	
	SO2.8 Explaining the kinetics of inhibition		CI2.8 Kinetics of Enzyme Inhibition	

Suggested Sessional Work	SW2.1 Assignments	Assess the impact on enzyme kinetics in biological system
(SW):anyone	SW2.2Mini Project	Designing of poster for showing plots of enzyme kinetics
-	SW2.3 Other Activities (Specify)	To analysed the impact of enzyme kinetics in living organisms

				Item		Cl	LI	SW	SL	Total
				Appro	ox. Hrs	11	04	01	05	21
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instructi	on	Self-L	earnin	g(SL)		
		Instruction(LI)	(CI)							
CO3-03BC401.3: Equipped to	SO3.1 Explain the concept Bi	LI3.1 study the effect of	Unit-III		SL3.1	Study	y abo	ut exa	ample	of bi
comprehend the fundamentals	Bi reaction	enzyme inhibition	CI3.1 Classification	n of	bi reac	tion				
of bi and multi substrate			BiBi reaction							
kinetics and enzyme catalysis.										
	SO3.2 Assessing the concept of		CI3.2 Ping pong	BiBi	SL3.2	Study	y di	fferent	typ	es of
	Ping pong bibi mechanism		mechanism		mechai	nisms (of bib	i react	ion	
	SO3.3Explaining Kinetics of	LI3.2 study the effect of	CI3.3 Alberty Equat	ion	SL3.3	categ	oriza	tion of	of di	fferent
	Alberty equation	kinetic parameters	5 1		kinetic	paran	neters			
	SO3.4 Assessing Kinetics of	^	CI3.4 Dalziel Equat	ion		•				
	Dalziel Equation									
	SO3.5 Describe Mechanism of		CI3.5 Multisubstrate	e	SL3.4	Study	y of	role	of	multi
	multi-substrate kinetics		Kinetics		substra	te reac	tion			
	SO3.6 Assessing the concept		CI3.6 Allosteric Enz	zyme	SL3.5	Asse	ss mo	odels f	for stu	udying
	of Allosteric enzyme				alloster	ric enz	ymes			
	SO3.7 Describe about MWC		CI3.7 MWC and	KNF						
	and KNF model		model.							
	SO3.8 Describe about enzyme		CI3.8 Enzyme cata	lysis						
	catalysis									
	SO3.9 Describe mechanism of		CI3.9 Mechanism	of						
	enzyme catalysis		enzyme catalysis							
	SO3.10 Assessing the concept		CI3.10 Chymotripsi	n						
	of Chymotripsin									
	SO3.11 Describe about		CI3.11 Ribon	uclease						
	Ribonuclease									

Suggested Sessional	SW3.1 Assignments	Describe in detail about kinetics of enzyme inhibition
Work (SW): anyone	SW3.2 Mini Project	Describe the role of factors on enzyme catalysis.
	SW3.3 Other Activities (Specify)	Prepare a an article on protein ligand binding and its impact.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	04	01	05	22

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Classroom Instruction(CI)	Self-Learning(SL)
		Instruction(L1)		
CO4-03BC401.4:	SO4.1	LI4.1 to perform enzyme	Unit-IV	SL4.1
Recognize various methods	Exploring the concept of	immobilization by gel	CI4.1 Protein Ligand	Learn about different
related to Protein Ligand	Protein Ligand Binding	entrapment methods	Binding	categories of Protein ligand
binding enzyme		-		binding
immobilization and Protein				C
engineering.				
	SO4.2 Assessing role of	LI4.2 To perform enzyme	CI4.2 Cooperativity	
	cooperativity	immobilization by covalent	1 5	
		binding		
	SO4.3 Explaining the hill		CI4.3 Hill Equation	SL4.2 Compare application
	equation		1	of enzyme immobilization
	COAA E-sub-initial data that is			CIA2 Lagrange hand and sign
	SO4.4 Explaining the adhair		CI4.4 Adnair Equation	SL4.5 Learn about various
	equation.			protein ligand complex
	SO4.5 Evaluate impact of		CI4.5 Enzyme	SL4.4 optimization of protocol
	immobilization		Immobilization: Basic concept	for enzymes immobilization
	SO4.6 evaluate the methods of		CI4.6 Methods of	SL4.5 optimization of protocol
	immobilization		immobilization	for enzyme extraction
	SO4.7 Describe the application		CI4.7 Application of	
	of enzyme immobilization		immobilized enzyme	
	SO4.8 Describe the protein		CI4.8 Basic concept of	
	engineering		Protein Engineering	
	SO4.9 Describe site directed		CI4.9 Site Directed	
	mutagenesis		Mutagonagia	

Suggested Sessional	SW4.1 Assignments	Explain about different types of enzyme immobilization techniques and its impact.
Work (SW): anyone	SW4.2 Mini Project	Standardize the protocol for enzyme immobilization.
	SW4.3 Other Activities (Specify)	Prepare one article on protein engineering

It	em	Cl	LI	SW	SL	Total
A	pprox.Hrs	06	00	01	05	12

Session Outcomes(SOs)	Laboratory	Classroom	Self-
	Instruction(LI)	Instruction(CI)	Learning(SL)
SO5.1 Elaborate the concept of		Unit-V	SL5.1 Learn about basic
Enzyme extraction		CI5.1 Extraction of enzyme	concept of enzyme
			engineering
SO5.2 Elaborate the concept of		CI5.2 Purification of Enzymes	SL5.2 Learn about role
Enzyme purification			purification of enzyme
SO5.3 Elaborate the role of enzyme		CI5.3 Application of	SL5.3 Learn about
in molecular biology		enzyme engineering in	biological function of
		molecular biology	enzyme
SO5.4 Elaborate the role of enzyme		CI5.4 Application of enzyme	SL5.4 Learn about
in animal nutrition		engineering in animal nutrition	applications of enzyme in
			nutrition
SO5.5 Elaborate the role of enzyme		CI5.5 enzyme electrodes and	SL5.5 Learn about role &
electrodes as biosensor		their application as biosensors in	biosensors
		industry	
SO5.6 Elaborate the role of		CI5.6 biosensors in health care	
biosensors in health care		and environment.	
	Session Outcomes(SOs)SO5.1 Elaborate the concept of Enzyme extractionSO5.2 Elaborate the concept of Enzyme purificationSO5.3 Elaborate the role of enzyme in molecular biologySO5.4 Elaborate the role of enzyme in animal nutritionSO5.5 Elaborate the role of enzyme electrodes as biosensorSO5.6 Elaborate the role of biosensors in health care	Session Outcomes(SOs)Laboratory Instruction(LI)SO5.1 Elaborate the concept of Enzyme extractionInstruction(LI)SO5.2 Elaborate the concept of Enzyme purificationImage: Concept of Enzyme purificationSO5.3 Elaborate the role of enzyme in molecular biologyImage: Concept of Enzyme SOS.3 Elaborate the role of enzyme in animal nutritionSO5.5 Elaborate the role of enzyme electrodes as biosensorImage: Concept of Enzyme SOS.3 Elaborate the role of enzyme electrodes as biosensorSO5.6 Elaborate the role of enzyme electrodes as biosensorImage: Concept of Enzyme enzyme Enzyme Enzyme SOS.6 Elaborate the role of enzyme electrodes as biosensor	Session Outcomes(SOs)Laboratory Instruction(LI)Classroom Instruction(CI)SO5.1 Elaborate the concept of Enzyme extractionUnit-V CI5.1 Extraction of enzymeSO5.2 Elaborate the concept of Enzyme purificationCI5.2 Purification of EnzymesSO5.3 Elaborate the role of enzyme in molecular biologyCI5.3 Application of enzyme engineering in molecular biologySO5.4 Elaborate the role of enzyme in animal nutritionCI5.4 Application of enzyme engineering in animal nutritionSO5.5 Elaborate the role of enzyme in animal nutritionCI5.5 enzyme electrodes and their application as biosensors in industrySO5.6 Elaborate the role of biosensors in health careCI5.6 biosensors in health care

Suggested Sessional	SW5.1 Assignments	Explain general application of enzyme in industries and different areas
Work (SW): anyone	SW5.2 Mini Project	Describe the role of enzyme engineering and site directed mutagenesis
	SW5.3 Other Activities (Specify)	Prepare a detail document on enzyme electrode and biosensors

Course duration (in hours) to attain Course Outcomes:

Course Title: Enzymology **Course Code: 03BC401 Course Outcomes(COs)** Self-Learning Sessional work **Total Hours Class lecture** Laboratory Instruction(LI) (SL) (Li+CI+SL+SW) (**CI**) **(SW) CO1-03BC401.1:** Familiarization with the basic concepts, 8 5 1 20 6 key principles and mechanism of actions of enzymes. CO2-03BC401.2: Acquired Skills to analyze mechanism 8 1 5 1 15 of single substrate enzyme catalyzed reaction and enzyme inhibition kinetics CO3-03BC401.3: Equipped to comprehend the 11 4 5 21 1 fundamentals of bi and multi substrate kinetics and enzyme catalysis CO4-03BC401.4: Recognize various methods related to 12 5 4 1 22 Protein Ligand binding enzyme immobilization and Protein engineering. **CO5-03BC401.5:** Explore role of enzyme extraction and 5 12 6 0 1 purification and diverse applications of enzymes in various fields. 45 25 **Total Hours** 15 05 90

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Enzymology

Course Code: 03BC401

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-03BC401.1: Familiarization with the basic concepts, key principles and mechanism of	2	1	1	1	5
actions of enzymes.					
CO2-03BC401.2: Acquired Skills to analyze mechanism of single substrate enzyme catalyzed	2	4	2	2	10
reaction and enzyme inhibition kinetics					
CO3-03BC401.3: Equipped to comprehend the fundamentals of bi and multi substrate kinetics	2	3	3	2	10
and enzyme catalysis					
CO4-03BC401.4: Recognize various methods related to Protein Ligand binding enzyme	3	5	5	2	15
immobilization and Protein engineering.					
CO5-03BC401.5: Explore role of enzyme extraction and purification and diverse applications of	5	4	1	0	10
enzymes in various fields.					
Total Marks	14	17	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Enzymes by Palmer (2001): Horwood Publishing Series.
2	Fundamentals of Enzymology by Price and Stevens (2002): Oxford University Press.
3	Enzyme Technology by Helmut uhling (1998): John Wiley
4	Introduction to Proteins Structure by Branden and Tooze (1998): Garland Publishing Group.
5	Lehninger's Principles of Biochemistry: Nelson & Cox

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B Sc. (Hons.) Biotechnology Semester: IV Semester Course Title: Enzymology Course Code: 03BC401

Course Outcome (Cos)		Program Outcomes (POs)										Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-03BC401.1: Familiarization with the basic concepts, key principles and mechanism of actions of enzymes.	2	2	3	2	3	3	2	2	2	1	3	2	3	2	3
CO2-03BC401.2: Acquired Skills to analyze mechanism of single substrate enzyme catalyzed reaction and enzyme inhibition kinetics	2	1	2	1	2	2	2	1	1	2	2	1	2	3	3
CO3-03BC401.3: Equipped to comprehend the fundamentals of bi and multi substrate kinetics and enzyme catalysis	2	2	2	2	2	2	3	2	2	1	2	2	1	1	3
CO4-03BC401.4: Recognize various methods related to Protein Ligand binding enzyme immobilization and Protein engineering.	1	1	3	1	3	3	3	1	2	2	3	1	2	2	3
CO5-03BC401.5: Explore role of enzyme extraction and purification and diverse applications of enzymes in various fields.	2	1	3	1	3	3	3	1	1	2	3	1	2	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
PO 1,2,3,4,5, 6,	CO1-03BC401.1: Familiarization with the	SO1.1 SO1.2	1.1,1.2,1.3,1.4,1.5	1.1,1.2,1.3,1.4,1.5,	1SL-1,2,3,4,5
7,8,9,10,11, 12	basic concepts, key principles and mechanism	SO1.3 SO1.4		1.6, 1.7, 1.8,	
	of actions of enzymes.	SO1.5 SO1.6			
PSO 1,2,3		SO1.7 SO1.8			
PO 1,2,3,4,5, 6,	CO2-03BC401.2: Acquired Skills to analyze	SO2.1 SO2.2	2.1,	2.1, 2.2, 2.3, 2.4,	2SL-1,2,3,4,5
7,8,9,10,11, 12	mechanism of single substrate enzyme	SO2.3 SO2.4		2.5, 2.6, 2.7, 2.8,	
	catalyzed reaction and enzyme inhibition	SO2.5 SO2.6			
PSO 1,2,3	kinetics	SO2.7 SO2.8			
PO 1,2,3,4,5, 6,	CO3-03BC401.3: Equipped to comprehend	SO3.1 SO3.2	3.1,3.2,3.3	3.1,3.2,3.3,3.4,3.5,	3SL-1,2,3,4,5
7,8,9,10,11, 12	the fundamentals of bi and multi substrate	SO3.3 SO3.4		3.6, 3.7, 3.8, 3.9,	
	kinetics and enzyme catalysis	SO3.5 SO3.6		3.10 3.11	
PSO 1,2,3		SO3.7 SO3.8			
		SO3.9 SO2.10			
		SO3.11			
PO 1,2,3,4,5, 6,	CO4-03BC401.4: Recognize various	SO4.1 SO4.2	4.1,4.2,4.3	4.1,4.2,4.3,4.4,	4SL-1,2,3,4,5
7,8,9,10,11, 12	methods related to Protein Ligand binding	SO4.3 SO4.4		4.5, 4.6, 4.7, 4.8,	
	enzyme immobilization and Protein	SO4.5 SO4.6		4.9, 4.10, 4.11,	
PSO 1,2,3	engineering.	SO4.7 SO4.8		4.12	
		SO4.9 SO4.10			
		SO4.11 SO4.12			
PO 1,2,3,4,5, 6,	CO5-03BC401.5: Explore role of enzyme	SO5.1 SO5.2		5.1,5.2,5.3,5.4,5.5,	5SL-1,2,3,4,5
7,8,9,10,11, 12	extraction and purification and diverse	SO5.3 SO5.4		5.6,	
	applications of enzymes in various fields.	SO5.5 SO5.6			
PSO 1,2,3					

Program Name	B.Sc. (Hons.) Biotechnology							
Semester	IV th							
Course Code:	03MB401							
Course title:	Medical Microbiology Curriculum Developer: Mrs. Maahi Choure, Guest Faculty							
Pre-requisite:	Understanding fundamental concepts in biology, including cell biology, genetics, and basic microbiology.							
Rationale:	Medical microbiology is essential for understanding the role of microorganisms in human health and disease. This field provides critical insights into how pathogens cause disease, how the immune system responds, and the mechanisms of action for antibiotics and vaccines. Knowledge gained from medical microbiology is crucial for diagnosing, treating, and preventing infectious diseases, which remains a significant challenge in global health.							
Course Outcomes (COs):	CO1-03MB401.1: Understand the fundamentals of microbial ecology and human microbiota CO2-03MB401.2: Analyze the morphology, pathogenesis, and laboratory diagnosis of gram-positive bacterial infections CO3-03MB401.3: Examine the characteristics and management of gram-negative bacterial infections CO4-03MB401.4: Analyze the etiology and characteristics of viral infections CO5-03MB401.5: Evaluate the clinical features and treatment of fungal and protozoan infections							

Scheme of Studies:

Board of Study								
	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	Total Credits (C) (L:T:P=3:0:1)
Generic Elective	03MB401	Medical Microbiology	3	2	1	2	8	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03MB401	Medical Microbiology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

			Scheme of Assessment (Marks)								
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)		
Generic Elective	03MB401-L	Medical Microbiology	35	5	5	5	50	50	100		
Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session	ApproximateHours					
levels, which students are anticipated to accomplish through various modes of instruction including						
Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL).	Item	Cl	LI	SW	SL	Total
As the course progresses, students should showcase their mastery of Session Outcomes (SOs).	Approx.Hrs	09	02	01	02	14
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO) Session Outcomes(SOs)		Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-03MB401.1: : Understand the fundamentals of	SO1.1 Introduction to Normal Microflora	LI1.1 Learn how to handle pathogens	CI1.1 Introduction to Normal Microflora	SL1.1 Remember Carriers in Disease Transmission
human microbiota	SO1.2 Role and Importance of Normal Microflora		CI1.2 Role and Importance of Normal Microflora	SL1.2 Explore microflora of university
	SO1.3 Introduction to Nosocomial Infections		CI1.3 Introduction to Nosocomial Infections	
	SO1.4 Carriers in Disease Transmission		CI1.4 Carriers in Disease Transmission	
	SO1.5 Septic Shock and Septicemia		CI1.5 Septic Shock and Septicemia	
	SO1.6 Concept of Pathogenicity		CI1.6 Concept of Pathogenicity	
	SO1.7 Virulence Factors		CI1.7 Virulence Factors	
	SO1.8 Types and Mechanisms of Toxins		CI1.8 Types and Mechanisms of Toxins	
	SO1.9 Biosafety Levels		CI1.9 Biosafety Levels	

Suggested Sessional	SW1.1 Assignments	Summarizes the Analysis on Septic Shock.				
Work (SW):anyone	SW1.2Mini Project	DemonstrateTypes and Mechanisms of Toxins.				
	SW1.3 Other Activities (Specify)					

Item	Cl	LI	SV	N SL	Total
Approx.H	s 09	1	1	2	13

Course Outcome (CO)	SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction (CI)	Self Learning (SL)
CO2-03MB401.2: Analyze the morphology.	SO2.1 Introduction to Gram-Positive Bacteria	LI2.1 Prepare morphology and Pathogenesis of <i>S.</i> <i>aureus</i> wet lab	CI2.1 Introduction to Gram- Positive Bacteria	SL2.1 Research on M. tuberculosis
pathogenesis, and laboratory diagnosis of gram-positive	SO2.2 Morphology and Pathogenesis of <i>S. aureus</i>		CI2.2 Morphology and Pathogenesis of <i>S. aureus</i>	SL2.2 Case Study on C. diphtheriae
bacterial infections	SO2.3 Symptoms and Laboratory Diagnosis of <i>S. aureus</i>		CI2.3 Symptoms and Laboratory Diagnosis of <i>S.</i> <i>aureus</i>	
	SO2.4 Preventive Measures and Chemotherapy for <i>S. aureus</i>		CI2.4 Preventive Measures and Chemotherapy for <i>S. aureus</i>	
	SO2.5 Morphology, Pathogenesis, and Symptoms of <i>S. pyogenes</i>		CI2.5 Morphology, Pathogenesis, and Symptoms of <i>S. pyogenes</i>	
	SO2.6 Laboratory Diagnosis and Chemotherapy for <i>S. pyogenes</i>		CI2.6 Laboratory Diagnosis and Chemotherapy for <i>S.</i> <i>pyogenes</i>	
	SO2.7 Pathogenesis and Symptoms of <i>B. anthracis</i>		CI2.7 Pathogenesis and Symptoms of <i>B. anthracis</i>	
	SO2.8 Preventive Measures and Chemotherapy for <i>B. anthracis</i>		CI2.8 Preventive Measures and Chemotherapy for <i>B.</i> <i>anthracis</i>	
	SO2.9 Clostridium Species (C. perfringens, C. tetani, C. botulinum)		CI2.9 Clostridium Species (C. perfringens, C. tetani, C. botulinum)	

Suggested Sessional	SW2.1 Assignments	Justify the role of Preventive Measures and Chemotherapy.				
Work (SW):anyone	SW2.2Mini Project	Understand the pathogenesis of M. leprae.				
	SW2.3 Other Activities (Specify)	Remember laboratory diagnosis technique.				

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	4	1	2	16

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning(SL)
		Instruction(LI)	(CI)	_
CO3-03MB401.3: Examine the	SO3.1 Introduction to Gram-	LI3.1 Identification of	CI3.1 Introduction to Gram-	SL3.1Practice local
characteristics and management	Negative Bacteria	gram negative bacteria	Negative Bacteria	alignment
of gram-negative bacterial	SO3.2 Morphology and	LI3.2 Identification	CI3.2 Morphology and	SL3.2Practice global
infections	Pathogenesis of E. coli	of gram positive	Pathogenesis of E. coli	alignment
		bacteria		
	SO3.3 Symptoms and		CI3.3 Symptoms and	
	Laboratory Diagnosis of N.		Laboratory Diagnosis of N.	
	gonorrhoeae		gonorrhoeae	
	SO3.4 Preventive Measures and		CI3.4 Preventive Measures	
	Chemotherapy for N.		and Chemotherapy for N.	
	meningitidis		meningitidis	
	SO3.5 Pathogenesis and		CI3.5 Pathogenesis and	
	Symptoms of P. aeruginosa		Symptoms of <i>P. aeruginosa</i>	
	SO3.6 Laboratory Diagnosis and		CI3.6 Laboratory Diagnosis	
	Chemotherapy for S. typhi		and Chemotherapy for S. typhi	
	SO3.7 Morphology and		CI3.7 Morphology and	
	Pathogenesis of S. dysenteriae		Pathogenesis of S. dysenteriae	
	SO3.8 Preventive Measures and		CI3.8 Preventive Measures	
	Chemotherapy for Y. pestis		and Chemotherapy for Y. pestis	
	SO3.9 Overview of T. pallidum		CI3.9 Overview of T.	
	M. pneumoniae,		pallidum M. pneumoniae,	
	Rickettsiaceae, Chlamydiae.		Rickettsiaceae, Chlamydiae.	

Suggested Sessional	SW3.1 Assignments	Write about Local and global alignment.
Work (SW): anyone	SW3.2 Mini Project	
	SW3.3 Other Activities (Specify)	Search and find the amrita lab and there find alignment methods.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	4	1	2	16

Course Outcome (CO)	Session Outcomes(S	Os)	Laborator Instruction	Laboratory Instruction(LI)			Classroom Instruction(CI)			Self-Learning(SL)		
CO4-03MB401.4: Analyze the etiology and characteristics of viral infections	SO4.1 Introduction Diseases	to Viral	LI4.1 Co contrast th symptoms of differer	ompare he pathog s, and tre nt viral fa	and genesis, eatment milies	CI4.1 Di	Introductic seases	on to	Viral	SL4.1 of mea	Learn asures	techniques preventive
	SO4.2 Morphology Pathogenesis of Picc	and rnaviruses	LI4.2 Ho the HIV	ow to i V/AIDS	dentify	CI4.2 Pa Pic	Morpholog thogenesis cornaviruses	зу	and of	SL4.2 syn dise	Unders nptoms eases	stand of various
	SO4.3 Symptoms a Diagnosis of Orthon	nd Laboratory yxoviruses				CI4.3 La Or	Symptoms boratory thomyxoviru	Diagnosi 1ses	and is of			
	SO4.4 Preventive Chemotherapy for P	Measures and aramyxoviruses				CI4.4 Chemo	Preventive therapy for Pa	Measure aramyxov	es and iruses			
	SO4.5 Pathogenesis of Rhabdoviruses	and Symptoms				CI4.5 Sy	Pathogenes mptoms of I	sis Rhabdov	and iruses			
	SO4.6 Laboratory Chemotherapy for R	Diagnosis and eoviruses				CI4.6 Ch	Laboratory emotherapy	Diagno for Reov	sis and viruses			
	SO4.7 Morphology Pathogenesis of P Herpes Virus	and ox Virus and				CI4.7 Pa an	Morpholog thogenesis d Herpes Vir	gy of Pox rus	and Virus			
	SO4.8 Preventive Chemotherapy for P	Measures and apova Virus				CI4.8 Ch Vi	Preventive emotherapy rus	Measur for	es and Papova			
	SO4.9 Overview of (including HIV/ Hepatitis Viruses	f Retroviruses AIDS) and				CI4.9 (in He	Overview cluding HI patitis Virus	of Retro IV/AIDS ses	viruses) and			
5	SW4.1 Assignments	Write aboutMo	orphology ar	nd Pathog	genesis	ofHerpe	es Virus.					
Suggested Sessional Source (SW): anyone	W4.2 Mini Project	Search and lear	n via YouTu	ube how t	to take F	Prevent	ive Measure	s and Ch	emoth	erapy for	r the Pa	pova
	Activities (Specify)	Virus.				· cvent						2010

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	4	1	2	16

Course Outcome	SessionOutcomes(SOs)	LaboratoryInstruction(LI)	ClassroomInstruction(CI)	Self-
(CO)				Learning(SL)
CO5-03MB401.5: Evaluate	SO5.1 Introduction to Fungal and	LI5.1 How to perform	CI5.1 Introduction to Fungal	SL5.1Learn how
the clinical features and	Protozoan Infections	pathogenesis test for fungus	and Protozoan Infections	Chemotherapy for
treatment of fungal and				Systemic Infections
protozoan infections	SO5.2 Morphology and	LI5.2 Prepare suitable media	CI5.2 Morphology and	SL5.2 Classify all Fungal
	Pathogenesis of	for the protozoans	Pathogenesis of	and Protozoan
	Dermatophytoses		Dermatophytoses	Infections
	SO5.3 Symptoms and Laboratory		CI5.3 Symptoms and	
	Diagnosis of Subcutaneous		Laboratory Diagnosis of	
	Infection		Subcutaneous Infection	
	SO5.4 Preventive Measures and		CI5.4 Preventive Measures	
	Chemotherapy for Systemic		and Chemotherapy for Systemic	
	Infections		Infections	
	SO5.5 Pathogenesis and		CI5.5 Pathogenesis and	
	Symptoms of Opportunistic Fungal		Symptoms of Opportunistic	
	Infections		Fungal Infections	
	SO5.6 Laboratory Diagnosis and		CI5.6 Laboratory Diagnosis	
	Chemotherapy for Gastrointestinal		and Chemotherapy for	
	Infections		Gastrointestinal Infections	
	SO5.7 Morphology and		CI5.7 Morphology and	
	Pathogenesis of Blood-borne		Pathogenesis of Blood-borne	
	Infections		Infections	
	SO5.8 Preventive Measures for		CI5.8 Preventive Measures for	
	Malaria		Malaria	
	SO5.9 Chemotherapy for Malaria		CI5.9 Chemotherapy for Malaria	

Suggested Sessional	SW5.1 Assignments	Write aboutTreatment Strategies for Fungal and Protozoan Infections.
Work (SW): anyone	SW5.2 Mini Project	
	SW5.3 Other Activities (Specify)	Try to learn and apply preventive Measures and Chemotherapy for Malaria.

Course duration (in hours) to attain Course Outcomes:

Course Title: Medical Microbiology

Course Code:03MB401

Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-03MB401.1: : Understand the fundamentals of	9	2	2	1	14
microbial ecology and human microbiota					
CO2-03MB401.2: Analyze the morphology, pathogenesis,	9	1	2	1	13
and laboratory diagnosis of gram-positive bacterial					
infections					
CO3-03MB401.3: Examine the characteristics and	9	4	2	1	16
management of gram-negative bacterial infections					
CO4-03MB401.4: Analyze the etiology and characteristics	9	4	2	1	16
of viral infections					
CO5-03MB401.5: Evaluate the clinical features and	9	4	2	1	16
treatment of fungal and protozoan infections					
Total Hours	45	15	10	05	75

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Medical Microbiology

Course Code:03MB401

Course Outcomes					
	Α	An	Е	С	Total Marks
CO1-03MB401.1: : Understand the fundamentals of microbial ecology and human microbiota	02	03	04	1	10
CO2-03MB401.2: Analyze the morphology, pathogenesis, and laboratory diagnosis of grampositive bacterial infections	03	04	02	1	10
CO3-03MB401.3: Examine the characteristics and management of gram-negative bacterial infections	02	05	02	1	10
CO4-03MB401.4: Analyze the etiology and characteristics of viral infections	02	05	02	1	10
CO5-03MB401.5 : Evaluate the clinical features and treatment of fungal and protozoan infections	03	04	03	1	11
Total Marks	12	21	13	05	51

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details	
1	Essentials of Medical Microbiology Sastry Apurba S, Bhat SandhyaJaypee Brothers Medical Publishers 2020	
2	Medical Microbiology RajanMJP Publishers 2021	

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Research lab (BSL-1)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Biotechnology Semester: IV Course Title: Medical Microbiology Course Code: 03MB401

CO/PO/PSO Mapping															
Course Outcome (Cos)		Program Outcomes (POs)								Program Specific					
													Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-03MB401.1: : Understand the															
fundamentals of microbial ecology and	-	-	-	1	2	2	1	-	1	2	2	3	3	3	1
human microbiota															
CO2-03MB401.2: Analyze the															
morphology, pathogenesis, and laboratory							3		2	2	3	3	1	1	2
diagnosis of gram-positive bacterial	-	-	-	-	-	-	5	-	4	2	3	5	1	1	2
infections															
CO3-03MB401.3: Examine the															
characteristics and management of gram-	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
negative bacterial infections															
CO4-03MB401.4: Analyze the etiology	_	1	1	_	2	2	2	3	_	1	_	_	1	2	3
and characteristics of viral infections	-	-	1	-	2	4	2	5	-	1	-	-	1	2	5
CO5-03MB401.5: Evaluate the clinical															
features and treatment of fungal and	1	1	1	-	-	2	3	3	1	2	2	2	1	-	2
protozoan infections															

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-03MB401.1: : Understand the fundamentals of microbial ecology and human microbiota	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	1.1	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9,	1SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO2-03MB401.2: Analyze the morphology, pathogenesis, and laboratory diagnosis of gram-positive bacterial infections	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	2.1	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9,	2SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO3-03MB401.3: Examine the characteristics and management of gramnegative bacterial infections	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	3.1,3.2	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9,	3SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO4-03MB401.4: Analyze the etiology and characteristics of viral infections	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	4.1,4.2	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9,	4SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO5-03MB401.5 : Evaluate the clinical features and treatment of fungal and protozoan infections	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 S05.9	5.1,5.2	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	5SL-1

Program Name	Bachelor of Science B.Sc.(H)-Biotechnology							
Semester	IV							
Course Code:	04BT401							
Course title:	Entrepreneurship Development Curriculum Developer: Mr. Dhirendra Mishra, Teaching Associate							
Pre-requisite:	Students should have basic knowledge of Entrepreneurship Development							
Rationale:	Entrepreneurs perform a vital function in economic development. They have been referred to as the human agents needed "to mobilize capital, to exploit natural resources, to create markets and to carry on trade". It might well be said that the entrepreneurial input spells the difference between prosperity and poverty among nations.							
	Many economic theories emphasize the significant roles played by individual entrepreneurs as they combine talents, abilities, and drive to transform resources into profitable undertakings. Joseph Schumpeter, the first major writer to highlight the human agent in the process of economic development, believed that the economy was propelled by the activities of persons. Who wanted to promote new goods and new methods of production, or to exploit a new source of materials or new market not merely for profit but also to the purpose of creating.							
CourseOutcomes (COs):	CO1-04BT401.1: Basic aspects of establishing a business in a competitive environment CO2-04BT401.2: Apply the basic understanding to examine the existing business ventures CO3-04BT401.3: Examine various business considerations such as marketing, financial and teaming etc. CO4-04BT401.4: Assessing strategies for planning a business venture CO5-04BT401.5: Create business ideas that can drive the innovative society							

Scheme of Studies:

	Course Code	Course Title						
Board of Study			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	Total Credits(C) (L:T:P=2:0:0)
Skill Enhancement Course	04BT401	Entrepreneurship Development	2	0	1	3	7	2+0=2

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)			
				Progressive Assessment (PRA)						
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
Skill Enhanceme nt Course	04BT401	Entrepreneurship Development	15	20	10	5	50	50	100	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session	Approxi	mate Hours					
levels, which students are anticipated to accomplish through various modes of instruction including						·	
Classroom Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL)		Item	Cl	LI	SW	SL	Total
As the course progresses, students should showcase their mastery of Session Outcomes (SOs).		Approx. Hrs	05	00	01	04	10
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self-Learning (SL)
CO1-04BT401.1: Basic aspects of establishing a business in a competitive environment	SO1.1 Aims and objectives of entrepreneurship		Unit1MeaningofEntrepreneurshipDevelopmentCI1.1NeedsandImportanceofEntrepreneurship	SL1.1 Visit various reference books and study material to start the learning of Entrepreneurship.
	SOI.2 Concept of Needs and Importance of Entrepreneurship		CI1.2 Factors influencing entrepreneurship	SL1.2 Promotion of entrepreneurship
	SOI.3 Know The process of Promotion of entrepreneurship		CI1.3 Promotion of entrepreneurship	SL1.3 Learn about Factors influencing entrepreneurship
	SOI.4 Understand Factors influencing entrepreneurship		CI1.4 Factors influence entrepreneurship	SL1.4 Establishing a business in a competitive environment
	SOI.5 Understand Features of a successful Entrepreneurship		CI1.5 Features of a successful Entrepreneurship.	

Suggested Sessional Work (SW):anyone	SW1.1 Assignments	Interview one successful and one unsuccessful entrepreneur in your place/location. Identify five major characteristics of both
	SW1.2Mini Project	Meet one or two Government officials involved in the promotion of small enterprise. Ask them about the specific facilities the government offers to entrepreneurs to establish small-scale facilities. Also try to know the extent of use of these facilities by the entrepreneurs and major problems faced by them in this regard.
	SW1.3 Other Activities (Specify)	Case study –N.R. Narayana Murthy

				Item		Cl	LI	SW	SL	Total
				Appro	x. Hrs	05	00	01	02	08
Course	Session Outcomes (SOs)	Laboratory	Classroom Instruction	1	Self L	earnin	ig (SI)		
Outcome (CO)		Instruction	(CI)							
		(LI)								
CO2-04BT401.2:	SO2.1 To understand aims and objective of		Unit-II		SL2.1					
Apply the basic	enterprise.		CI2.1 Forms of Bu	isiness	Read t	the Pr	ocess	of	Proje	ct
understanding to			Organization.		Identif	icatior	ı			
examine the existing										
business ventures .										
	SO2.2 To describe various forms of business		CI2.2 Project Identifica	ation.	SL2.2	Learr	ı var	ious s	teps of	of
	organization.				Selecti	on of	the pr	oduct.		
	SO2.3 To explain project identification.		CI2.3 Selection of proj	ect.						
	SO2.4 To elaborate selection of product		CI2.4 Project formulat	ion.						
	SO2.5 Describe about various methods and		CI2.5 Assessment of	project						
	techniques used for project feasibility		feasibility.							

Suggested Sessional	SW2.1 Assignments	Suppose you propose two-three enterprise like travel agency in a tourist place like neonatal.
Work (SW):anyone		Elaborate form of ownership you will chose and why?
	SW2.2Mini Project	Selection of the product.
	SW2.3 Other Activities (Specify)	How an entrepreneurs do assessment of project feasibility

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	09

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction	Self-Learning (SL)
CO3-04BT401.3: Examine various business considerations such as marketing, financial and teaming etc.	SO3.1 Explain the importance of finance.		Unit-III CI3.1 Finance the enterprise Importance of finance.	SL3.1 On the basis of extent of performance, financial needs are classified into fixed capital and working capital.
	SO3.2 Define and describe loan and repayment.		CI3.2 General idea about loan and repayment.	SL3.2 Capital structure is composition of long-term and short-term loans.
	SO3.3 Describe the characteristics of business finance.		CI3.3 Characteristics of business finance.	
	SO3.4 Describe the fixes capital management.		CI3.4 Fixed capital management.	
	SO3.5 Explain role of working capital in business.		CI3.5 Working capital management.	
	SO3.6 Explain in detail Of inventory Define direct and indirect inventory.		CI3.6 Inventory management.	

Suggested Sessional	SW3.1 Assignments	Issue of debenture is source of short term loans.
Work (SW): anyone	SW3.2 Mini Project	Visit to an enterprise and find out its financial position whether it is over-capitalized or under –
		capitalized. Give your suggestion to correct the situation whatever be the case.
	SW3.3 Other	Find out some you tube videos based on financing the enterprise.
	Activities (Specify)	

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	00	01	03	12

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-04BT401.4: Assessing strategies for planning a business venture	SO4.1 Describe the Marketing management.		Unit-IV CI4.1 Marketing Management, Marketing mix	SL4.1 Learn about marketing management.
	SO4.2 Explain the Marketing mix.		CI4.2 Product management	SL4.2 Discuss various steps of marketing mix based on self-study
	SO4.3 Evaluate the product line		CI4.3 Product mix	SL4.3 Learn about various types of distribution channel involves in Marketing management.
	SO4.4 Define and describe the product mix.		CI4.4 Product line	
	SO4.5 Define the marketing research.		CI4.5 Stages of Life cycle.	
	SO4.6 Describe the marketing research.		CI4.6 Marketing research and importance of survey.	
	SO4.7 Stock management.		CI4.7 Physical distribution	
	SO4.8 Stock management.		CI4.8 stock management.	

Suggested Sessional	SW4.1 Assignments	Explain life cycle of product.
Work (SW): anyone	SW4.2 Mini Project	Meet an entrepreneur running a manufacturing enterprise. Ask him how he/she took decision on marketing mix
		and prepare systematic report on the same.
	SW4.3 Other	Find out some you tube videos based on Marketing Management.
	Activities (Specify)	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	03	10

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-04BT401.5: Create business ideas that can drive the innovative society	SO5.1 Explain the Meaning of international business.		Unit-V CI5.1 Meaning of international business,	SL5.1 Find out the role of International market in terms of business.
	SO5.2 Express the view of selection of product for international business.		CI5.2 Selection of product in for international business .	SL5.2 Explore the various kinds of selection method for product selection in international market.
	SO5.3 Able to execute to perform the cultivation of fungi.		CI5.3 Selection of product for international business	SL5.3 Read research on advancement in fungi
	SO5.4 Evaluate the various selection methods of product selection for		CI5.4 Selection of market for international business international business.	
	SO5.5Describe the exportfiancé process.SO5.6Describeaboutinstitutionssupportforexport.		CI5.5 Export financing, SL5.6 Institutional support for international business.	

Suggested Sessional	SW5.1 Assignments	Write about Institutional support for exports for international business.
Work (SW): anyone		
	SW5.2 Mini Project	Make a list of financial institute those support for export and also write about their polices for export
	SW5.3 Other	Find out some you tube videos based on International business.
	Activities (Specify)	

Course duration (in hours) to attain Course Outcomes:

Course Title: Entrepreneurship Development

Course Code: 04BT401 **Course Outcomes(COs) Class lecture** Laboratory Self-Learning Sessional work **Total Hours** (**CI**) Instruction (LI) (SL) (**SW**) (Li+CI+SL+SW) CO1-04BT401.1: Basic aspects of establishing a 5 0 4 1 10 business in a competitive environment CO2-04BT401.2: Apply the basic understanding to 5 0 2 8 1 examine the existing business ventures CO3-04BT401.3: Examine various business 6 0 2 9 1 considerations such as marketing, financial and teaming etc. CO4-04BT401.4: Assessing strategies for planning a 3 12 8 0 1 business venture CO5-04BT401.5: Create business ideas that can drive 6 0 3 10 1 the innovative society **Total Hours** 30 00 14 05 49

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Entrepreneurship Development

Course Code: 04BT401

Course Outcomes		n			
	Α	An	Ε	С	Total Marks
CO1-04BT4015.1: Understand basic aspects of establishing a business in a competitive environment.	2	1	1	1	5
CO2-04BT401.2: Apply the basic understanding to examine the existing business ventures.	2	4	2	2	10
CO3-04BT4015.3: Examine various business considerations such as marketing, financial and teaming etc.	3	5	5	2	15
CO4-04BT401.4: Assessing strategies for planning a business venture	2	3	3	2	10
CO5-04BT401.5: Create business ideas that can drive the innovative society	5	4	1	0	10
Total Marks	14	17	12	07	50

Legend: A, Apply; An, Analyze; E, Evaluate; C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Holt DH. Entrepreneurship: New Venture Creation
2	Kaplan JM Patterns of Entrepreneurship.
3	Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Industrial Visit.
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: Bachelor of Science B.Sc.(H)-Biotechnology Semester: IV Semester Course Title: Entrepreneurship Development Course Code: 04BT401

CO/PO Mapping															
Course Outcome		Program Outcomes (POs)							Program Specific Outcomes (PSOs)						
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-04BT4015.1: Understand basic aspects of establishing a business in a competitive environment.	3	3	1	1	-	-	2	1	1	3	3	2	2	2	2
CO2-04BT401.2: Apply the basic understanding to examine the existing business ventures.	1	1	2	2	2	-	1	1	-	2	3	2	2	2	1
CO3-04BT401.3: Examine various business considerations such as marketing, financial and teaming etc.	1	3	2	3	2	-	-	2	3	1	1	2	3	3	1
CO4-04BT401.4: Assessing strategies for planning a business venture.	2	3	3	2	2	2	-	1	1	2	1	-	1	1	3
CO5-04BT401.5: Create business ideas that can drive the innovative society.	2	-	2	-	1	3	2	2	1	3	2	2	3	2	3

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-04BT401.1: Understand basic aspects of establishing a business in a competitive environment	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		1.1,1.2,1.3,1.4,1.5	1SL-1,2,3,4
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO2-04BT401.2: Apply the basic understanding to examine the existing business ventures	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		2.1, 2.2, 2.3, 2.4, 2.5,	2SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO3-04BT401.3: Examine various business considerations such as marketing, financial and teaming etc.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6		3.1,3.2,3.3,3.4,3.5 3.6	3SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO4-04BT401.4: Assessing strategies for planning a business venture.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8		4.1,4.2,4.3,4.4,4.5, 4.6,4.7, 4.8	4SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO5-04BT401.5: Create business ideas that can drive the innovative society.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6		5.1,5.2,5.3,5.4,5.5 5.6	5SL-1,2,3

Program Name	Bachelor of Science (Hons.) in Biotechnology	Bachelor of Science (Hons.) in Biotechnology (B.Sc. (Hons.) BT)								
Semester	IV									
Course Code:	04BT402	04BT402								
Course title:	Basics of forensic science	Curriculum Developer: Chahana Desai, Teaching Associate								
Pre-requisite:	Students should have basic knowledge and understanding about forensic biology and concept of forensic science.									
Rationale:	 Students will develop an understanding evidence collection and preservation. Students will receive intensive hands-on Additionally, students will develop an legal profession. 	g of the scientific principles of crime scene investigation and reconstruction, including on training in forensic laboratory methodologies with respect to the analysis of evidence. understanding of the importance of the interaction between law enforcement, scientists and the								
Course Outcomes (COs):	CO1-04BT402.1:- Elucidate the overview of fe CO2-04BT402.2:- Acquire knowledge regard CO3-04BT402.3:- Applied knowledge about b CO4-04BT402.4:- To gain the knowledge about CO5-04BT402.5:- Elucidate the detailing of D	orensic science. ling causes of crime and types of injuries allistics and handwriting examination. ut toxicology and fingerprinting analysis. NA profiling and cyber security.								

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=2:0:0)	
Skill enhancement course (SEC)	04BT402	Basics of forensic science	2	0	1	1	4	2+0=2	

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

				Scheme of Assessment (Marks)						
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Progree Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	(PRA) Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
SEC	04BT402	Basics of Forensic science	15	20	10	5	50	50	100	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximat	te Hours					
levels, which students are anticipated to accomplish through various modes of instruction including	F						
Classroom Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning		Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs).		Approx. Hrs	06	00	01	01	08
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-04BT402.1:	SO1.1		Unit-1-Introduction to	SL1.1
Elucidate the overview of	Explain the concept and		forensic science	Read some articles about
forensic science.	principles of forensic		CI1.1 Introduction and	forensic studies.
	science.		principles of forensic	
			science,	
	SO1.2 Elucidate the		CI1.2 forensic science	
	functions and importance of		laboratory	
	forensic science laboratory			
	SO1.3 Elaborate the role of		CI1.3 FSL and its	
	FSL and its organization and		organization and service,	
	service.		-	
	SO1.4 Elucidate the various		CI1.4 tools and techniques	
	tools and techniques used in		in forensic science,	
	forensic science.			
	SO1.5 Elaborate the		CI1.5 branches of forensic	
	different branches of		science.	
	forensic science and its			
	involvement.			
	SO1.6 Elaborate the		CI1.6 branches of forensic	
	different branches of		science.	
	forensic science and its			
	involvement.			

Suggested Sessional	SW1.1 Assignments	Describe various principles of forensic science.				
Work (SW):anyone	SW1.2Mini Project	Elaborate different branches of forensic science with its role.				
	SW1.3 Other Activities (Specify)	Make a power point presentation on forensic science laboratory and its service.				

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate	Hours					
levels, which students are anticipated to accomplish through various modes of instruction					1		
including Classroom Instruction (CI). Laboratory Instruction (LI). Sessional Work (SW), and Self		Item	Cl	LI	SW	SL	Total
Learning (SL). As the course progresses, students should showcase their mastery of Session		Approx. Hrs	06	00	01	01	08
Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the							
course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-04BT402.2:	SO2.1		Unit-2 types of injuries and	SL2.1
Acquire knowledge regarding	Explain the different types of causes which leads to		deaths. CI2.1 Causes of crime	Note down the reasons which can lead to crime.
causes of crime and types of	crime.			
injuries				
	SO2.2 Elucidate the Role of		CI2.2 Role of modus	
	modus operandi in criminal		operandi in criminal	
	investigation.		investigation.	
	SO2.3 Elaborate the		CI2.3 Classification of	
	classification of injuries.		injuries	
	SO2.4 Elucidate the		CI2.4 Medico-legal aspects	
	medico-legal aspects of		of injuries.	
	injuries.			
	SO2.5 Explanation about		CI2.5 method of assessing	
	the method of assessing		various types of deaths.	
	various types of deaths.			
	SO2.5 Explanation about		CI2.5 method of assessing	
	the method of assessing		various types of deaths.	
	various types of deaths.			

Suggested Sessional	SW2.1 Assignments	Describe the Role of modus operandi in criminal investigation.
Work (SW):anyone	SW2.2Mini Project	Make a chart on classification of injuries.
	SW2.3 Other Activities (Specify)	Make Power point presentation on method of assessing various types of deaths

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	App	roximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) I aboratory Instruction (I I) Sessional Work (SW) and Self Learning (SL). As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	06	00	01	01	08
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-04BT402.3:	SO3.1	· · · ·	Unit-3 Application of	SL3.1 Read about various
Applied knowledge about	Elucidate the classification		ballistics and handwriting	examples of handwriting
ballistics and handwriting	of fire arms and explosives.		examination:	examination
examination.	-		CI3.1 Classification of fire	
			arms and explosives	
	SO3.2		CI3.2 introduction to	
	Explain about the internal,		internal, external and	
	external and terminal		terminal ballistics.	
	ballistics.			
	SO3.3		CI3.3 Chemical evidence for	
	Elaborate the chemical		explosives.	
	evidence for explosives.		_	
	SO3.4		CI3.4 General and	
	To learn the general and		individual characteristics of	
	individual characteristics of		handwriting,	
	handwriting.		_	
	SO3.5		CI3.5 examination of	
	Explanation about the		handwritings and analysis of	
	examination of handwritings		ink various samples.	
	and analysis of ink various		_	
	samples.			
	SO3.6		CI3.6 comparison of	
	Explanation about the		handwritings and analysis of	
	comparison of handwritings		ink various samples.	
	and analysis of ink various			
	samples			

Suggested Sessional	SW3.1 Assignments	Flow chart on fire arms and explosives
Work (SW): anyone	SW3.2 Mini Project	Describe the different characteristics of handwriting.
SW3.3 Other Prepare one Power point presentation on analysis of ink in handwriting analysis.		Prepare one Power point presentation on analysis of ink in handwriting analysis.
	Activities (Specify)	

This course syllabus illustrates the expected learning achievements, both at the course and session	d session Approximate Hours						
levels, which students are anticipated to accomplish through various modes of instruction including		_	~		~~~~	~~	
Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning		Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes		Approx. Hrs	06	00	01	01	08
(SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's							
conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-04BT402.4:	SO4.1 Elucidate about the		Unit-4overview about	SL4.1 Read about the
To gain the knowledge about	role of toxicologist		toxicology and	functions of toxicological
toxicology and fingerprinting			fingerprinting analysis	studies.
analysis.			CI4.1	
			Role of the toxicologist,	
	SO4.2 Elaborate about the		CI4.2 significance of	
	significance of toxicological		toxicological findings,	
	findings			
	SO4.3 Explanation about		CI4.3 Fundamental	
	the fundamental principles		principles of fingerprinting,	
	of fingerprinting.			
	SO4.4 To learn about the		CI4.4 classification of	
	detailed classification of		fingerprints,	
	fingerprints			
	SO4.5 Explanation about		CI4.5 development of finger	
	the development of finger		print,	
	print			
	SO4.6 Explanation about		CI4.6 science for personal	
	science for personal		identification,	
	identification			

Suggested Sessional	SW4.1 Assignments	Determine the various applications and importance of toxicological analysis
Work (SW): anyone	SW4.2 Mini Project	Flow chart on classification of fingerprints.
	SW4.3 Other Activities (Specify)	Make a Power point presentation on how the fingerprint development happens for personal identification
	(Speeny)	Identification.

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate Hours					
levels, which students are anticipated to accomplish through various modes of instruction					· · · · · · · · ·	
including Classroom Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self	Item	Cl	LI	SW	SL	Total
Learning (SL). As the course progresses, students should showcase their mastery of Session	Approx. Hrs	06	00	01	01	08
Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the						
course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-04BT402.5:	SO5.1		Unit-5 DNA fingerprinting	SL5.1 Basic knowledge
Elucidate the detailing of DNA	Elucidate the principle of		and cyber security:	about the hybridization
profiling and cyber security	DNA fingerprinting.		CI5.1 Principle of DNA	techniques.
			fingerprinting,	
	SO5.2 Elaborate the		CI5.2 application of DNA	
	application of DNA		profiling in forensic medicine,	
	profiling in forensic			
	medicine.			
	SO5.3 Describe the		CI5.3 Investigation Tools,	
	investigating tools used in		eDiscovery,,	
	forensic studies, eDiscovery.			
	SO5.4 Elucidate about the		CI5.4 Evidence Preservation	
	how Evidence Preservation			
	can be done?			
	SO5.5 Explanation about		CI5.5 Search and Seizure of	
	the Search and Seizure of		Computers,	
	Computers,			
	SO5.6 Elaborate about the		CI5.6 Introduction to Cyber	
	basic concept of Cyber		security	
	security.			

Suggested Sessional	SW5.1 Assignments	Principle and steps of DNA profiling.
Work (SW): anyone	SW5.2 Mini Project	Explanation about the search and seizure of computers.
	SW5.3 Other Activities (Specify)	Prepare power point presentation on cyber security.

Course duration (in hours) to attain Course Outcomes:

Course Title: Basics of forensic		Course Code: 04BT402				
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)	
CO1-04BT402.1: Elucidate theoverview of forensic	6	0	1	1	08	
science.						
CO2-04BT402.2: Acquire knowledge regarding causes of	6	0	1	1	08	
crime and types of injuries.						
CO3-04BT402.3: Applied knowledge about ballistics and handwriting examination.	6	0	1	1	08	
CO4-04BT402.4: To gain the knowledge about toxicology and fingerprinting analysis.	6	0	1	1	08	
CO5-04BT402.5: Elucidate the detailing of DNA	6	0	1	1	08	
Total Hours	20	00	05	05	40	
10tal fiours	50	00	05	05	40	

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Basics of forensic science

Course Code: 04B402

Course Outcomes		Marks Distribution				
	Α	An	Е	С	Total Marks	
CO1-04BT402.1: Elucidate theoverview of forensic science.	2	1	1	1	5	
CO2-04BT402.2: Acquire knowledge regarding causes of crime and types of injuries.	2	4	5	1	12	
CO3-04BT402.3: Applied knowledge about ballistics and handwriting examination.	3	5	5	1	14	
CO4-04BT402.4: To gain the knowledge about toxicology and fingerprinting analysis.	2	3	5	1	11	
CO5-04BT402.5: Elucidate the detailing of DNA fingerprinting and cyber security.	2	4	1	1	10	
Total Marks	11	17	17	05	50	

Legend:A, Apply; An, Analyze; E, Evaluate; C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details					
1	Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.					
2	B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select					
	Publishers, New Delhi (2501).					
3	M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi					
	(2502).					
4	S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques,					
	2nd Edition, CRC Press, Boca Raton (2505).					
5	W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC					
	Press, Boca Raton (1997).					
6	R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2504).					
7	W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press,					
	Boca Raton (2013).					

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Group Discussion
- 4. Role play
- 5. Demonstration
- 6. ICT Based teaching Learning
- 7. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) Biotechnology

Semester: IV Semester

Course Title: Basics of forensic science.

Course Code: 04BT402

Course Outcome (Cos)		Program Outcomes (POs)								Program Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-04BT402.1: Elucidate the overview	1	2	-	1	2	1	2	1	2	-	1	2	2	2	1
of forensic science.															
CO2-04BT402.2: Acquire knowledge regarding causes of crime and types of injuries.	-	1	1	-	-	-	1	-	1	1	-	-	1	1	2
CO3-04BT402.3: Applied knowledge about ballistics and handwriting examination.	1	1	2	1	-	1	1	1	1	2	1	-	3	1	1
CO4-04BT402.4: To gain the knowledge about toxicology and fingerprinting analysis.	1	1	1	-	2	1	1	1	1	1	-	2	1	1	3
CO5-04BT402.5: Elucidate the detailing of DNA fingerprinting and cyber security.	2	1	1	-	-	2	1	2	1	1	-	-	1	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	Cos	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6	CO1-04BT402.1: Elucidate the overview	SO1.1 SO1.2		1.1,1.2,1.3,1.4,1.5,1.6,	1SL-1
7,8,9,10,11,12	of foransic science	SO1.3 SO1.4			
	of forensie science.	SO1.5 SO1.6			
PSO 1,2, 3					
PO 1,2,3,4,5,6	CO2-04BT402.2: Acquire knowledge	SO2.1 SO2.2		2.1, 2.2, 2.3, 2.4, 2.5, 2.6,	2SL-1
7,8,9,10,11,12	regarding causes of crime and types of	SO2.3 SO2.4			
DGO 1 0 0	injuries.	SO2.5 SO2.6			
PSO 1,2, 3					
PO 1,2,3,4,5,6	CO3-04BT402.3: Applied knowledge	SO3.1 SO3.2		3.1,3.2,3.3,3.4,3.5,3.6,	3SL-1
7,8,9,10,11,12	about ballistics and handwriting	SO3.3 SO3.4			
	examination.	SO3.5 SO3.6			
PSO 1,2, 3					
PO 1,2,3,4,5,6	CO4-04BT402.4: To gain the knowledge	SO4.1 SO4.2		4.1,4.2,4.3,4.4, 4.5, 4.6,	4SL-1
7,8,9,10,11,12	about toxicology and fingerprinting	SO4.3 SO4.4			
	analysis.	SO4.5SO4.6			
PSO 1,2, 3	-				
PO 1,2,3,4,5,6	CO5-04BT402.5:Elucidate the detailing	SO5.1 SO5.2		5.1,5.2,5.3,5.4,5.5,5.6	5SL-1
7,8,9,10,11,12	of DNA fingerprinting and cyber	SO5.3 SO5.4			
	security.	SO5.5 SO5.6			
PSO 1,2, 3					

Program name	Bachelor of Science (B.Sc.)- Biotechnology					
Semester	V					
Course Code:	01BT501					
Course title:	Genetic Engineering & Technology Developer: Dr. Kamlesh Kumar Soni, Assistant Professor					
Pre-requisite:	Student should have basic knowledge biology and biotechnology					
Rationale:	The B.Sc. Biotechnology program's "Genetic Engineering & Technology" paper offers the chance to study the operation and use of the many genetic tools used in genetic engineering. This course will explore the fundamental and cutting-edge techniques for creating transgenics and using them for the good of humanity.					
CourseOutcomes (COs):	 CO1-01BT501 .1: Understand the essential molecular tools to the genetic engineering CO2-01BT501 .2: Advance the principle and application of different genetic transforming techniques CO3-01BT501 .3: Understand the need of genetic engineering to the animal technology CO4-01BT501 .4: Relative understanding of plant and animal biotechnology and their applications CO5-01BT501 .5: Basic principles and applications of various molecular techniques 					

Scheme of Studies:

	CourseCode	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)
MAJOR	01BT501	Genetic Engineering & Technology	4	4	1	3	12	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial(T) and others);

LI: Laboratory Instruction(Includes Practical performances in laboratory workshop, field or other instructional strategies);

SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

					Sch	eme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MAJOR	01BT501	Genetic Engineering & Technology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)							
				Progressive Assessment (PRA)							
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)		
MAJOR	01BT501-L	Genetic Engineering & Technology	35	5	5	5	50	50	100		

Course-Curriculum:	ApproximateHou	rs				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	03	22
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT501 .1: Understand the essential molecular tools to the genetic engineering	SO 1.1: Will be visualizing the working molecular tools	LI 1.1Isolation of chromosomal DNA from plant cells	Unit -1 CI 1.1:Introduction to Molecular tools	1.1: Study about the basic of molecular tools of genetic engineering
	SO 1.2 Learn the importance of tools	LI 1.2 Isolation of chromosomal DNA from E. coli	CI 1.2 Applications of molecular tools -	1.2: Learn about defence mechanism in lower organism
	SO 1.3 Understand the role of polymerases in RDT	LI 1.3 Isolation of chromosomal DNA from animal cell	CI 1.3 Polymerases,	1.3: study the fundamentals of molecular biology
	SO 1.4 Know the importance of molecular tools		CI 1.4 Restriction enzymes, ligases, alkaline phosphatase	
	SO 1.5: Copresence the knowledge about recombination methods		1.5Gene Recombination	
	SO 1.6 Learn how gene is transferred to other system		CI 1.6 Gene transfer	
	SO 1.7 Fundamental of Plasmid and its properties		CI 1.7 Plasmids	
	SO 1.8 Learn the types of vector used in RDT		CI1.8 Cloning vectors- concept and types	
	SO 1.9In depth study Plasmid and bacteriophage vector		CI1.9 Plasmids, Bacteriophage-derived vectors,	
	SO 1.10 In depth study artificial chromosome vector		CI1.10 artificial chromosomes vectors	
	SO 1.11 In depth study cosmid and phagmid		CI1.11 Cosmid, phasmid	
	SO 1.12 In depth study yeast vector		CI 1.12 Yeast vector	

Suggested Sessional Work	SW1.1 Assignments	Brief the different enzymes used in molecular cloning
(SW): anyone	SW1.2 Mini Project	Explain different types of vectors and their applications
	SW1.3 Other Activities (Specify)	Watch animation on cloning of a gene in expression vector

Course-Curriculum:	ApproximateHou	rs				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	03	22
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-01BT501 .2: Advance the	SO 2.1Will be understanding	LI 2.1Qualitative and	Unit-2	SL 2.1: Study about the
principle and application of	the fundamental differences	quantitative analysis of	CI 2.1Preparation and comparison of	genomic DNA and cDNA
different genetic transforming	on genomic	DNA using	Genomic and	library
techniques		spectrophotometer		
	SO 2.2 Will be understanding	LI 2.2 Vector	CI 2.2 Introduction to cDNA	SL 2.2: Gain basic information
	the fundamental differences	construction and cloning		transformation methods
	on cDNA library	of a gene		
		(demonstration)		
	SO 2.3 Learn how the cDNA	LI 2.2 demonstration of	CI 2.3 Preparation of cDNA library	SL 2.2: Gain basic information
	library is prepared	DNA Library		screening of recombinants
		preparation		
	SO 2.4 Will understand how		CI 2.4 Introduction to transformation-	
	direct method of			
	transformation is done		CL25 Microinication	
	SO 2.5 Learn principle of		CI 2.5 Microinjection,	
	micromjection and application			
	SO 2.6 In-depth of		CI 2.6Electroporation,	
	electroporation techniques			
	SO 2.7 detail understanding of		CI 2.7Ultrasonication,	
	Ultrasonication and its			
	applications			
	SO 2.8 Learn how the		CI 2.8 Chemical mediated method	
	ever the non-recombinants			
	SO 20 Learn about partiala		CL20 Partiala gun mathad	
	gun method		CI 2.7 Failucie gui memou	
	SO 2 10 explain linofection		CL2 10 Lipofection	
	SO 2.11 Explain macroinjection		CI 2.11 Macroiniection	
	SO 2.12 Learn how the		CI 2.12 Screening of recombinants	
	recombinants are screened		Ci 2.12 Sereening of recombinants	
	recombinants are sereened			

Suggested Sessional Work	SW1.1 Assignments	Explain the intron and exon and how cDNA differ from genomic DNA
(SW): anyone	SW1.2 Mini Project	Prepare the poster explaining all direct method of transformation
	SW1.3 Other Activities (Specify)	Explain how recombinants are selected

Course-Curriculum:		ApproximateHours				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are		-				
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	05	24
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-01BT501 .3: Understand the	SO 3.1Discuss about how DNA	LI 3.1: Screening of	Unit-3	SL 3.1Build-up the concept on the
need of genetic engineering to the	sequence is inserted or removed or	transformant	CI 3.1 Introduction to Genetic	cDNA and intron
animal technology	mutated		engineering in animals	
	SO 3.2 learn how the transgenic animals	LI 3.2Conformation	CI 3.2Production of transgenic	SL3.2Advance the knowledge that
	are produced	of transformed cells	animals	how retrovirus is useful tools
	SO 3.3 Understand the application of	LI 3.3 Role of	CI 3.3 Application of transgenic	SL 3.3 Clear the basic concept of the
	GM animals	selectable and	animals	gene regulation
		scorable marker		
	SO 3.4 Develop skill on retrovirus as		CI 3.4 Retrovirus	SL 3.4 Boost your knowledge on
	vectors to transfect the gene of interest			bacterial protein expression and
	into the target genome			purification
	SO 3.5Able to realize application of		CI 3.5 its application in genetic	
	Genetic Engineering		engineering	
	SO 3.6 fundamental on genetic		CI 3.6 Applications of Genetic	SL 3.4 Boost your knowledge on
	engineering for the therapeutic		Engineering	application of RDNA Technology
	products.			
	SO 3.7 Develop skill on how		CI 3.7: Therapeutic products	
	therapeutic products are produced		produced by genetic engineering- introduction	
	SO 3.8 Skill on how therapeutic		CI 3.8 Therapeutic products	
products are designed and developed			produced by genetic engineering	
	SO 3.8 Skill on how blood proteins are		CI 3.9 -blood proteins,	
	designed and developed			
	SO 3.8 Skill on how Human hormones		CI 3.10 human hormones,	
	are designed and developed			
	SO 3.8 Skill on how immune		CI 3.11 immune modulators (one	
	modulators are designed and developed		example each)	
	SO 3.8 Skill on how vaccines are		CI 3.12 Therapeutic products	
	designed and developed		produced by genetic engineering	
			-vaccines as example	

Suggested Sessional Work	Assignments:	Describe the insulin production by bacterial system						
(SW): anyone	Mini Project:	Draw structure of cloning of a gene of interest in Cosmid						
	Other Activities (Specify):	Literature survey on the application of genetic engineering on immune modulator:; case study						
Course-Curriculum:	ApproximateHours							
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This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are								
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total		
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	05	24		
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.								

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-01BT501 .4: Relative understanding of plant and animal biotechnology and their applications	SO 4.1: learning why plant genetic engineering is important	LI 4.1: Ti-Plasmid vector system (restriction digestion)	Unit-4 CI 4.1Genetic engineering in plants	SL 4.1Create a vector having a gene cloned on it (sketch)
	SO4.2: Discus how infections is associated with crown gall diseases in plant root	LI 4.2: <i>Agrobacterium</i> culture and growth conditions	CI4.2 Biology of Agrobacterium	SL4.2: Study the biology of <i>Agrobacterium</i>
	SO 4.3 Skill on how <i>Agrobacterium</i> is exploited to the scientific purpose	LI 4.3: Development of modified T-DNA (demonstration)	CI4.3 Application of <i>Agrobacterium tumefaciens</i> and <i>A. rhizogenes</i>	SL 4.3 Draw a Ti-Plasmid vector and label all the genes on it
	SO 4.4 Understand the importance of TiPlasmind and its application		CI 4.4 Ti plasmids,	SL 4.4: Literature the application of plant virus vector for transformation
	SO 4.4 Understand the structure of T DNA		CI 4.5 Structure of T-DNA,	SL 4.5: Literature the application of transgenic plants
	SO 4.5 Analyse the importance of vir genes		CI 4.6 Vir region in Ti-Plasmid	
	SO 4.5 Analyse mechanism of T DNA transfer		CI 4.7 T DNA transfer	
	SO 4.6Create various strategies of plant transformation		CI 4.8 Strategies for gene transfer to plant cells	
	SO 4.6 study transformation methods		CI 4.9 Direct gene transfer methods	
	SO 4.7 Create the viral as vector for the plant transformation		CI 4.10 Plant viral vector	
	SO 4.7 study different viral vector used for the plant transformation		CI 4.11 types and use	
	SO 4.5: Learn how plant can be raised against a particular stress e.g. Bt-Cotton		CI4.12 Application of Transgenic plants	

Suggested Sessional Work	Assignments:	Explain the Agrobacteriummediated plant transformation
(SW): anyone	Mini Project:	Literature the Bt cotton; name the gene and its mode of action against the insect
	Other Activities (Specify):	Think and deliver a presentation; how plant can be made drought stress resistant

Course-Curriculum:	ApproximateHour	rs				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are			-			
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	05	24
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-01BT501 .5: Basic principles and applications of various molecular techniques	SO5.1 learn the principle of PCR	LI 5.1: PCR; Gene amplification	Unit -5 CI 5.1: Polymerase chain reaction (PCR)- Principle	SL 5.1: Principle of PCR; understand
	SO 5.2 realize how PCR can be used for DNA amplification and creation of mutations	LI 5.2: Demonstration of Southern blotting	CI 5.2 Polymerase chain reaction (PCR)- Applications	SL5.2: Study the hybridization
	SO5.3 Visualize how probes binds and spot the gene position and copy number	LI 5.2: Demonstration of DNA fingerprinting	CI 5.3 Southern hybridization	SL 5.3: Study why each individual is different and what are the satellite DNA
	SO 5.4 Analyze the expression of RNA at particular stage or tissue.		CI 5.4 Northern hybridization	SL 5.4: Study different types of mutations & factors causes the mutagenesis
	SO5.5 Learn about western hybridization		CI 5.5 Western hybridization	SL 5.5: Learn in detail the Genetic Codes and protein structure
	SO 5.6 Learn how genome is mapped		CI 5.6 Genome mapping	
	SO 5.7 Understand how fingerprinting is used in forensic		CI 5.7 DNA fingerprinting	
	SO 5.8 explore steps of fingerprinting		CI 5.8 steps and application	
	SO 5.9 Understand about mutagens and how the create mutation		. CI 5.9 Introduction to mutagenesis	
	SO 5.10 skill on how mutations are created		CI 5.10 Random Site-directed mutagenesis	
	SO 5.11 building the concept of protein engineering		CI 5.11 Protein engineering concepts	
	SO 5.12 protein engineering and their application in welfare		CI 5.12 Applications of Protein engineering	

Suggested Sessional	Assignments:	In details list the application of PCR
Work (SW): Anyone	Mini Project:	Discuss about the blotting techniques and their applications in detection
	Other Activities (Specify):	Literature and presentation; protein engineering and its application; a case study

Course duration (in hours) to attain Course Outcomes

(Course title: Genetic Engineering & Technology)

(Course code: 01BT501)

Course Outcomes(COs)	Class lecture(CI)	LaboratoryInstruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-01BT501 .1: Understand the essential	12	6	3	1	22
molecular tools to the genetic engineering					
CO2-01BT501 .2: Advance the principle and	12	6	3	1	22
application of different genetic transforming					
techniques classifications					
CO3-01BT501 .3: Understand the need of	12	6	5	1	24
genetic engineering to the animal technology					
CO4-01BT501 .4: Relative understanding of	12	6	5	1	24
plant and animal biotechnology and their					
applications					
CO5-01BT501 .5: Basic principles and	12	6	5	1	24
applications of various molecular techniques					
Total Hours	60	30	21	05	116

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:								
Course title: Genetic Engineering & Technology) (Course code:)								
Course Outcomes	Marks Distribution Total							
	Α	An	Ε	C	Marks			
CO1-01BT501 .1: Understand the essential molecular tools to the genetic engineering	2	1	1	1	5			
CO2-01BT501 .2: Advance the principle and application of different genetic transforming techniques classifications	2	4	2	2	10			
CO3-01BT501 .3: Understand the need of genetic engineering to the animal technology	3	5	5	2	15			
CO4-01BT501 .4: Relative understanding of plant and animal biotechnology and their applications	2	3	3	2	10			
CO5-01BT501 .5: Basic principles and applications of various molecular techniques	5	4	1	0	10			
Total Marks	14	17	12	07	50			
Legend: A-Apply, A- Analyze, E- Evaluate, C- Create								

Suggested learning Resources:

S.no.	Title	Author	Publisher	Edition & Year
1	Gene Cloning and DNA Analysis	Brown TA	Blackwell Publishing, Oxford, U.K	6& 2010
2	Biotechnology: Applying the Genetic Revolution	Clark DP and Pasternik NJ	Elsevier Academic Press, USA	2 & 2015
3	Principles of Gene Manipulation and Genomics	Primrose SB and Twyman RM	Blackwell Publishing, Oxford, U.K	7 & 2006
4	Molecular Cloning-A Laboratory Manual	Sambrook J and Russell D	Cold Spring Harbor Laboratory Press	4 & 2012

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Cement Plant
- 7. Demonstration

8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)

9. Brainstorming

CO, PO and PSO Mapping

Program Title: B. Sc. Biotechnology, 5thSem Course Code: 01BT501 Course Title: Genetic Engineering & Technology

CO/PO Mapping															
Course Outcome		Program Outcomes (POs)						Program Specific Outcomes (PSOs)							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-01BT501 .1: Understand the essential molecular tools to the genetic engineering	3	3	1	2	2	3	2	2	1	3	3	3	2	2	3
CO2-01BT501 .2: Advance the principle and application of different genetic transforming techniques classifications	3	2	1	2	2	3	3	2	-	2	3	3	3	3	3
CO3-01BT501 .3: Understand the need of genetic engineering to the animal technology	2	3	2	2	3	3	3	2	1	3	1	3	2	2	3
CO4-01BT501 .4: Relative understanding of plant and animal biotechnology and their applications	2	3	3	3	3	3	3	2	1	3	1	3	3	3	3
CO5-01BT501 .5: Basic principles and applications of various molecular techniques	3	3	2	3	3	3	3	2	1	3	1	3	3	3	3
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Course Curricul	um Map:				
POs & PSOs No.	COs No	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-01BT501 .1: Understand the essential molecular tools to the genetic engineering	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI1, LI2 LI3,	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8,1.9, 1.10,1.11, 1.12	1 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO2-01BT501 .2: Advance the principle and application of different genetic transforming techniques classifications	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI1, LI2 LI3,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9, 2.10, 2.11, 2.12	2 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO3-01BT501 .3: Understand the need of genetic engineering to the animal technology	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI1, LI2 LI3	3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	3 SL-1,2,3,4,5
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO4-01BT501 .4: Relative understanding of plant and animal biotechnology and their applications	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI1, LI2 LI3,	4.1,4.2,4.3,4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10,4.11,4.12	4 SL-1,2,3,4,5
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO5-01BT501 .5: Basic principles and applications of various molecular techniques	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI1, LI2, LI3,	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,5.10,5.11 5.12	5 SL-1,2,3,4,5

Program Name	B.Sc. (Hons.) in Biotechnology							
Semester	V							
Course Code:	05BT501							
Course title:	Environmental Biotechnology	Curriculum Developer: Mr. Paras Koshe, Assistant Professor						
Pre-requisite:	Student should have basic knowledge of Environmental science and Biotechnology.							
Rationale:	The Environmental Biotechnology course aims to introduce and elaborate the fundamental concepts and applications of biotechnology in all aspects of environment including its protection, restoration and sustainability. Considering the rising challenges of climate change, energy and environmental crisis, this course will emphasize upon the recent development of biotechnology for harnessing microbial potential in environmental applications. The course is structured to provide the students with fundamental concepts of environmental biotechnology, highlighting the importance of microbial ecology, their metabolism, and methods for their characterization and scopes for implementation. Bioremediation and biodegradation principles, processes and applications will be discussed along with advanced applications in wastewater, oil recovery, biohydrometallurgy, biofuel, carbon storage and capture, etc. This course will offer the students a broad sense of understanding on how modern biotechnology is developed to achieve better environmental protection and sustainability through the use of microbes and microbial communities in pollution abatement to mitigation of climate change, bioenergy, biomaterial to any use discovery.							
Course Outcomes (COs):	CO1-05BT501. 1. Explain the use and environment CO2-05BT501. 2. Understand the role of bioremed CO3- 05BT501 3. Interpretate the mechanism of bio CO4 05BT501 4. Explain waste treatment of munic	al impact of conventional and modern fuels, iation in cleaning of waste from environment odegradation of pesticides and other toxic chemicals by micro-organisms sipal waste and Industrial effluents and use and types of biofertilizer and nitrogen fixation						
	CO5-05BT501. 5. Learn about the process of biole	eaching and environmental significance of genetically modified organisms.						

Scheme of Studies:

Board of Study Course Code		Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)
Discipline Specific Core Course	05BT501	Environmental Biotechnology	3	2	1	3	9	3+1=4

Legends:CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.

Scheme of Assessment: Theory

				Scheme of Assessment (Marks)					
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Discipline Specific Core Course	05BT501	Environmental Biotechnology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					Progressive As	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Discipline Specific Core Course	05BT501-L	Environmental Biotechnology	35	5	5	5	50	50	100

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Course Curriculum

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Appro	oximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom	-						
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	09	04	01	05	19
achievement of Course Outcomes (COs) upon the course's conclusion.	_						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT501. 1 . Explain the use and environmental impact of conventional and modern fuels,	SO1.1 Define various types of energy sources,	LI1 Isolation and Characterization of Bacteria from Crude Petroleum Oil Contaminated Soil	CI1.1 Conventional fuels and their environmental impact	SL1.1 Role of Biotechnology in environment
	SO1.2 Focus on conventional energy sources like firewood	LI1.2 Growth Response of Bacteria on Petroleum Fuel (Diesel)	CI1.2 Firewood, Plant, Animal,	SL1.2 Types of energy sources used in your locality (Area)
	SO1.3 Explain the importance and use of water as energy source		CI1.3 Water, Coal and Gas.	
	SO1.4 Provide importance of modern fuel		CI1.4 Modern fuels and their environmental impact	SL1.3 Learn some recent modern fuels produced by biotech and compare cost
	SO1.5 Illustrate the types and use of methanogenic bacteria		CI1.5 Methanogenic bacteria	SL1.4 visit any biogas production plant and try to learn it practically
	SO1.6 Define biogas and its components		CI1.6 biogas production	SL1.5 Use of ethanol as energy source and try to find out limitation of ethanol production
	SO1.7 Explain Microbial hydrogen production		CI1.7 Microbial hydrogen production	
	SO1.8 . Over viewing Ethanol production		CI1.8 Conversion of sugars to ethanol.	
	SO1.9. Demonstrate and procedure of Gasohol experiment		CI1.9 Gasohol experiment	

Suggested Sessional	SW1.1 Assignments	i. Write about the Environmental biotechnology and its role in human welfare.				
Work (SW): anyone		ii. Write about modern fuels and latest technology and their impact on environment.				
	SW1.2 Mini Project	Which types of energy sources are more used .in your area? Visit any Biogas plant and make a rough				
		sketch of Biogas production?				
	SW1.3 Other Activities (Specify)	isit any fermentation plant and make a rough sketch of ethanol production				

							Item		Cl	LI	SW	SL	Total
	-						Appro	ox. Hrs	09	06	01	04	20
Course	Sessio	on Outcomes (SOs)	Labo	ratory Instructio	on (LI)	Classroom Instruction (C	I)	Self Le	arning	(SL)			
Outcome													
(CO)													
CO2-05BT501. 2.	SO2 .1	Understand Concept of	LI2.1	Determination	i of	CI2. 1 In -situ bioreme	ediation	SL2.1	Underst	and	the	t	oasic
Understand the role of	B	ioremediation and its types.	disso	olved oxygen	of water	techniques.	knowled	lge of	bio	legrada	tion	and	
bioremediation in			sam	ple.				correlat	e with b	iorem	ediatior	1.	
cleaning of waste from													
environment													
	SO2.2	2 Outline different methods for	LI2.2	Determination	i of	CI2.2 Ex-situ bioremed	diation	SL2.2	Observe	dif	erent	types	of
	tł	ne Ex-situ bioremediation	biolo	ogical oxygen den	nand	techniques.	solid waste. And their impacts.						
	te	echniques.							~				
	SO2	B Elucidate the process of	LI2.3	Determination of	of chemical	CI2.3 Bioremediation of	so1l	SL2.3 (jain kr	lowled	lge ab	out s	ome
	Bioremediation of soil			gen demand (CO	D) of water	contaminated with oil spills other method such			n as	land	fills,		
contaminated with oil spills			sam	ple.				memera	liton etc	•			
	SO2.4	4 Elucidate the process of				CI2.4 Bioremediation of	f soil	SL2.4 E	Explorin	g the	concept	of 5	R's
	Bioremediation of soil					contaminated with oil spills	and dia	sposal	of di	fferent	types	of	
	С	ontaminated with oil spills.						waste					
	SO2.5	5 Understand the use of				. CI2.5 heavy metals							
	micro	organism in the degradation and											
	remov	al of heavy metals.											
	SO2.	6 Understand the use of				CI2.6. Detergents							
	micro	organism in the degradation and											
	remov	al of Detergents.											
	SO2 .7	7 Explain degradation of lignin				CI2.7 Degradation of	lignin						
	using	microbes.				using microbes							
	SO2. 8	S Explain degradation of cellulose				CI2.8 Degradation of cell	lulose						
	using	microbes.				Using microbes							
	502.	• Define phyto-remediation and				Turnes and its applications	auton:						
Suggested Constant I	Ins rol	SW2 1 Aggiggmeents		Comporative et-	du Dionama d	i ypes and its applications,	2						
Suggested Sessional W	огк	Svv2.1 Assignments		Write about diff	uy Diorenied	radiation methods that are us	1.	our city					
(5 **). unyone		SW2 2 Mini Project		Make a poster on Bioremediation techniques									
		SW2.3 Other Activities (Specify)		Analyze the role	of Plants in	bioremediation							
	SW2.3 Other Activities (Specify)			Analyze the role of Plants in bioremediation									

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	02	01	04	16

Course Outcome (CO)	Session Outco	omes (SOs)	Laboratory	Class room Instruction	Self-Learning (SL)		
CO3 05PT501 3	SO3 1 Expla	in the role of	Instruction (LI)	(CI) Unit 2 Diadagnadation:	SI 3.1 Explore the basic concepts of		
Interpretate the mechani biodegradation of pesticid other toxic chemicals by organisms	sm of Bioremediatio les and micro-	n in cleaning.	effect of heavy metal on the growth of microorganism	CI 3.	bioremediation and its types .correlate with unit 1 and energy generation from bioremediation		
	SO3.2 Under bioremediation	stand the use of n in removal of		CI 3.2 Degradation of pesticides by micro-	SL3.2 Learn different other techniques used in bioremediation of soil and water.		
	so3.3 Under bioremediation toxic chemical	nicro-organisms stand the use of n in removal of		organisms CI 3.3 Degradation of pesticides by micro- organisms			
	SO3.4 Outlin Degradation o by micro-orga	te the process of f toxic chemicals nisms		CI 3.4, Degradation of toxic chemicals by micro- organisms	.SL3.3 Find out new approaches of bioremediation and use of microorganisms in bioremediation		
	SO3.5 Outlin Degradation of by micro-organ	e the process of f toxic chemicals nisms		CI 3.5 Degradation of toxic chemicals by micro- organisms			
	SO3.6 Illustra of Biodegrada hydrocarbons	te the mechanism tion of chlorinated		CI 3. Biodegradation of chlorinated hydrocarbons			
	SO3.7 Illustra of Biodegrada hydrocarbons	te the mechanism tion of chlorinated		CI 3.7 Biodegradation of chlorinated hydrocarbons			
	SO3.8 Explai of xenobiotic of	n Biodegradation compounds.		CI 3.8 Biodegradation of xenobiotic compounds.			
	SO3.9 Learn a Bioremediatio	bout the utility of n.		CI 3.9 Importance of Biodegradation.			
Suggested Sessional Work (SW): anyoneSV	W3.1 Assignments	•	Explain diagrammatical Write about different tyr	ly about in situ and ex situ biore bes of Bio indicators.	mediation techniques with examples.		
S	W3.2 Mini Project	How bioreactors	How bioreactors are used in bioremediation. Explain different types of bioreactors used.				
SV (S	W3.3 Other Activities pecify)	Find out some Bi Also find microo	oremediation sites in you rganism and plant species	r area or nearby cities, s found in your lab or area whicl	h can be used as bio indicators.		

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	03	01	04	17

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4 05BT501 4. Explain waste	SO4.1	LI4.1 Isolation of Rhyzobium	Unit-IV	SL4.1 Observing the physical
treatment of municipal waste	To learn the Treatment of municipal		CI 41 Transformer of more ising 1	and chemical properties of
and Industrial effluents and use	waste and Industrial effluents		CI 4.1 Treatment of municipal	water. And focus on save
and types of biofertilizer and			waste and Industrial effluents	water.
nitrogen fixation				
	SO4.2	LI4.2 Isolation of Azotobector	CI 4.2 Treatment of municipal	SL4.2 Understanding the role
	To learn the Treatment of municipal		waste and Industrial effluents	bio fertilizers and bio pesticides
	waste and Industrial effluents			in crop improvement
	SO4.3 Define biofertilizers		CI 4. Bio-fertilizers	
	SO4.4 Elucidate the production of		CI 4.4. Bio-fertilizers	
	Biofertilizer from different micro			
	organism			
	SO4.5 Explain the types of		CI 4.5. Bio-fertilizers	
	biofertilizers			
	SO4.6 Discuss the Role of symbiotic		CI 4.6 Role of symbiotic and	
	and asymbiotic nitrogen fixing		asymbiotic nitrogen fixing bacteria	
	bacteria in the enrichment of soil.		in the enrichment of soil.	
	SO4.7 Discuss the Role of symbiotic		CI 4.7 Role of symbiotic and	
	and asymbiotic nitrogen fixing		asymbiotic nitrogen fixing bacteria	
	bacteria in the enrichment of soil.		in the enrichment of soil.	
	SO4.8 Explain algal biofertilizers		CI 4.8 Algal biofertilizers	
	SO4.9 Explain fungal		CI 4.9 fungal biofertilizers (VAM	1
	biofertilizers(VAM)			

Suggested Sessional	SW4.1 Assignments	1. Explain Treatment of municipal waste and Industrial effluents.
Work (SW): anyone		2. Describe bio fertilizer in detail.
	SW4.2 Mini Project	Try to find out the earthworm varieties found in your area and find most variety used in vermicomposting, write an
		article for the same.
	SW4.3 Other Activities	Make comparative study between bio fertilizer and chemical fertilizer.
	(Specify)	

Item	Cl	LI	SW	SL	Total	
Approx. Hrs	09	00	01	04	14	

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction(LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-05BT501. 5 . Learn about the process of bioleaching and environmental significance of genetically modified organisms.	SO5.1 Analyze role of microorganism in bioleaching		Unit-V CI5.1 Bioleaching	SL5.1 Learn the steps of bioleaching Identify strain of microorganism used for bioleaching and try to culture and extract.
	SO5.2 Explain principles and process of bioleaching		CI5.2 Principles and process	SL5.2 Study role of RDT in the production of GMO's
	SO5.3 Analyze bioleaching of important metals and role of microorganism in bioleaching		CI5.3 Enrichment of ores by microorganisms (Gold, Copper and Uranium).	SL5.3 Learn about transgenic plants
	SO5.4 Analyze bioleaching of important metals and role of microorganism in bioleaching.		CI5.4 Enrichment of ores by microorganisms (Gold, Copper and Uranium	SL5.4 Learn about transgenic animals.
	SO5.5 Focus on Environmental significance of genetically modified microbes, plants and animals		CI5.5 Environmental significance of genetically modified microbes, plants and animals	
	SO5.5 study significance of genetically modified microbes,		CI5.6 Environmental significance of genetically modified microbes,	
	SO5.5 assess significance of genetically modified plants		CI5.7 Environmental significance of genetically modified plants	
	SO5.5 explore significance of genetically modified m animals		CI5.8 Environmental significance of genetically modified animals	
	SO.5.6 Learn the demerits of GMO's		CI5.9 Disadvantages of using GMO's	

Suggested Sessional	SW5.1 Assignments	1. Describe the process of Bioleaching.
Work (SW): anyone	SW5.2 Mini Project	Make a chart showing Enrichment of ores by microorganisms (Gold, Copper and Uranium
	SW5.3 Other	Prepare one article on the bioleaching and also focus on diamond mining.
	Activities (Specify)	

Course duration (in hours) to attain Course Outcomes:

Course Title: Environmental Biotechno	logy			Course Code: 05BT501			
Course Outcomes (COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours		
	(CI)	Instruction (LI)	(SL)	(SW)	(Li+CI+SL+SW)		
CO1-05BT501. 1. Explain the use and environmental impact of	9	4	5	1	19		
conventional and modern fuels,							
CO2-05BT501. 2. Understand the role of bioremediation in	9	6	4	1	20		
cleaning of waste from environment							
CO3- 05BT501 3. Interpretate the mechanism of biodegradation	9	2	4	1	16		
of pesticides and other toxic chemicals by micro-organisms							
CO4 05BT501 4. Explain waste treatment of municipal waste	9	3	4	1	17		
and Industrial effluents and use and types of bio fertilizer and							
nitrogen fixation							
CO5-05BT501. 5. Learn about the process of bioleaching and environmental significance of genetically modified organisms	9	0	4	1	14		
Total Hours	45	15	21	05	86		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Environmental Biotechnology

Course Code: 05BT501

Course Outcomes		Total Marles			
	Α	An	Е	С	Total Marks
CO1-05BT501. 1. Explain the use and environmental impact of conventional and modern fuels,	2	1	1	1	5
CO2-05BT501. 2. Understand the role of bioremediation in cleaning of waste from environment	2	4	2	2	10
CO3- 05BT501 3. Interpretate the mechanism of biodegradation of pesticides and other toxic chemicals by	3	5	5	2	15
micro-organisms					
CO4 05BT501 4. Explain waste treatment of municipal waste and Industrial effluents and use and types of	2	3	3	2	10
biofertilizer and nitrogen fixation					
CO5-05BT501. 5. Learn about the process of bioleaching and environmental significance of genetically	5	4	1	0	10
modified organisms					
Total Marks	14	17	12	07	50

Legend: A, Apply; An, Analyze; E, Evaluate; C, Create Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Environmental Microbiology, W.D. Grant & P.E. Long, Blakie, Glassgow and London.
2	 Environmental Biotechnology by Bruce Rittmann and Perry McCarty
3	• Environmental biotechnology, 1995 S.N.Jogdand. Himalaya Publishing House, Bombay, Delhi, Nagpur.
4	• Bioremediation 1994 Baker, K.H.and Herson, D.S. McGraw Hill, Inc.New York.
5	Environmental Microbiology, W.D. Grant & P.E. Long, Blakie, Glassgow and London.
6	Environmental Science, S.C. Santra
7	Environmental Biotechnology, Pradipta Kumar Mohapatra
8	Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

Program Name: B.Sc. Biotechnology (Honors) Semester: V Semester Course Title: Environmental Biotechnology Course Code: 05BT501

Course Outcome (Cos)		Program Outcomes (POs)									Program Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-05BT501. 1. Explain the use and environmental impact of conventional and modern fuels,	2	-	-	1	2	2	-	-	1	2	2	-	2	2	1
CO2-05BT501. 2. Understand the role of bioremediation in cleaning of waste from environment	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
CO3- 05BT501 3 . Interpretate the mechanism of biodegradation of pesticides and other toxic chemicals by micro-organisms	-	1	1	1	-	-	1	1	1	-	-	1	1	1	1
CO4 05BT501 4. Explain waste treatment of municipal waste and Industrial effluents and use and types of bio fertilizer and nitrogen fixation	-	1	1	-	2	-	1	1	-	2	-	1	1	1	3
CO5-05BT501. 5. Learn about the process of bioleaching and environmental significance of genetically modified organisms	1	1	1	-	-	1	1	1	-	-	1	1	1	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction	Classroom	Self-Learning (SL)
			(LI)	Instruction (CI)	
PO 1,2,3,4,5, 6,	CO1-05BT501. 1. Explain the use and	SO1.1 SO1.2 SO1.3	LI 1	1.1,1.2,1.3,1.4,1.5	1SL-1,2,3,4,5
7,8,9,10,11, 12	environmental impact of conventional and	SO1.4 SO1.5 SO1.6	LI 2	1.6 1.7 1.8 1.9	
PSO 1.2.3	environmental impact of conventional and	SO1.7 SO1.8 SO1.9			
	modern fuels,				
PO 1,2,3,4,5, 6,	CO2-05BT501. 2. Understand the role of	SO2.1 SO2.2 SO2.3	LI 1	2.1, 2.2, 2.3, 2.4,	2SL-1,2,3,4,
7,8,9,10,11, 12	bioromodiation in classing of wasta from	SO2.4 SO2.5 SO2.6	LI 2	2.5, 2.6, 2.7 2.8 2.9	
PSO 1.2.3	bioremediation in cleaning of waste from	SO2.7 SO2.8 SO2.9	LI 3		
	environment				
PO 1,2,3,4,5, 6,	CO3- 05BT501 3. Interpretate the mechanism of	SO3.1 SO3.2 SO3.3	LI 1	3.1,3.2,3.3,3.4,3.5	3SL-1,2,3,4
7,8,9,10,11, 12	biodegradation of posticides and other toxic	SO3.4 SO3.5 SO3.6	LI 2	3.6 3.7 3.8 3.9	
PSO 1.2.3	biodegradation of pesticides and other toxic	SO3.7 SO3.8 SO3.9			
	chemicals by micro-organisms				
PO 1,2,3,4,5, 6,	CO4 05BT501 4. Explain waste treatment of	SO4.1 SO4.2 SO4.3	LI 1	4.1,4.2,4.3,4.4 4.5	4SL-1,2,3,4
7,8,9,10,11, 12	I	SO4.4 SO4.5 SO4.6	LI 2	4.6 4.7 4.8 4.8 4.9	
PSO 1.2.3	municipal waste and Industrial effluents and use	SO4.7 SO4.8 SO4.9			
	and types of bio fertilizer and nitrogen fixation				
PO 1.2.3.4.5. 6	CO5-05BT501. 5. Learn about the process of	SO5.1 SO5.2 SO5.3		5.1,5.2,5.3,5.4,5.5	5SL-1,2,3,4
7.8.9.10.11.12	bioleaching and environmental significance of	SO5.4 SO5.5 SO5.6		5.6 5.7 5.8 5.9	1 1-1
PSO 1,2,3	genetically modified organisms	SO5.7 SO5.8 SO5.9			

Program Name	Bachelor of Science (Hons.) in Biotechnology	Bachelor of Science (Hons.) in Biotechnology								
Semester	V	V								
CourseCode:	05BT502									
Coursetitle:	Food Biotechnology Curriculum Developer: Mr. Piyush Kant Rai, Assistant Professor									
Pre-requisite:	Student should have basic knowledge of Biotechnology, Microbiology and Biochemistry needed for food analysis.									
Rationale:	The Food Biotechnology course in a B.Sc comprehensive knowledge and practical s provide essential skills for enhancing food and sustainability to meet the demands of	The Food Biotechnology course in a B.Sc. Hons. Biotechnology program serves a crucial role by providing students with comprehensive knowledge and practical skills in the study of food ingredients and quality control. Food biotechnology is provide essential skills for enhancing food quality, safety, and nutritional value, while also increasing agricultural productivity and sustainability to meet the demands of a growing global population.								
CourseOutcomes (COs):	CO1-05BT502.1: Familiarization with the bas CO2-05BT502.2: Acquired Skills to analyze be CO3-05BT502.3: Equipped to comprehend the CO4-05BT502.4: Recognize various methods CO5-05BT502.5: Explore role of the microbes	ic concepts of microorganism involved in food processing and food spoilage. eneficial and harmful impact of microorganisms on food and food ingredients fundamentals of microorganism used for development of functional food used for microbiological examination of food and food ingredients s on the basis of their morphological characteristics.								

Scheme of Studies:

Board of Study								
	Course Code	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits (C) (L:T:P=3:0:1)
Discipline Specific Core Course	05BT502	Food Biotechnology	3	2	1	3	9	3+1=4

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Discipline Specific Core Course	05BT502	Food Biotechnology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Discipline Specific Core Course	05BT502-L	Food Biotechnology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session	Approxim	ateHours					
levels, which students are anticipated to accomplish through various modes of instruction, including							
Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning		Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs).		Approx.Hrs	09	04	01	03	17
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-05BT502.1: Familiarization with the basic concepts of	SO1.1 Introduction to Microbial Ecology in Food	LI1.1 Observe the effects of different factors on microbial growth in a food sample (e.g., varying pH, temperature).	CI1.1 Introduction to Microbial Ecology in Food	SL1.1 Remember intrinsic factors affecting the growth of microbes
in food processing and food spoilage.	SO1.2 Intrinsic Factors Affecting Microbial Growth	LI1.2 Measure microbial growth in milk samples under different storage conditions.	CI1.2 Intrinsic Factors Affecting Microbial Growth	SL1.2 Self-paced learning to understand the spoilage of milk
	SO1.3 Extrinsic Factors Affecting Microbial Growth		CI1.3 Extrinsic Factors Affecting Microbial Growth	SL1.3 Revise microbial ecology in food
	SO1.4 Microbial Spoilage of Milk		CI1.4 Microbial Spoilage of Milk	
	SO1.5 Microbial Spoilage of Meat		CI1.5 Microbial Spoilage of Meat	
	SO1.6 Microbial Spoilage of Plant Products		CI1.6 Microbial Spoilage of Plant Products	
	SO1.7 Impact of Storage Conditions on Microbial Growth		CI1.7 Role of Storage Conditions in Food Microbiology	
	SO1.8 Introduction to Food Preservation Techniques		CI1.8 Overview of Food Preservation Techniques	
	SO1.9 Application of Microbial Knowledge in Food Safety		CI1.9 Applying Microbial Knowledge in Food Safety	

Suggested Sessional Work (SW):anyone	SW1.1 Assignments	Design mini-project research a specific microbial spoilage problem in a food product of choice and present findings, including the microorganism involved, spoilage mechanisms, and prevention strategies.
	SW1.2Mini Project	Group Assignment –microbial spoilage
	SW1.3 Other Activities (Specify)	Evaluate students based on their technique, accuracy, and lab equipment skills.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	4	1	3	17

Course	SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction	Self-Learning (SL)
Outcome (CO)			(CI)	
CO2-05BT502.2:	SO2.1 Introduction to Foodborne	LI2.1 Analyze common food	CI2.1 Introduction to	SL2.1 Study the history and
Acquired Skills to	Diseases	samples for the presence of	Foodborne Diseases	significance of foodborne diseases
analyze beneficial and		bacterial contaminants.		6
harmful impact of	SO2.2 Bacterial Agents of	LI2.2 Isolate and identify	CI2.2 Bacterial Agents of	SL2.2 Learn about the
microorganisms on food	Foodborne Illness - Clostridium	Clostridium species from food	Foodborne Illness:	pathogenicity and control of
and food ingredients		samples.	Clostridium	Clostridium in food
	SO2.3 Bacterial Agents of	The second se	CI2.3 Bacterial Agents of	SL2.3 Study the risk factors for
	Foodborne Illness - Listeria		Foodborne Illness: Listeria	Listeria contamination in food
	SO2.4 Bacterial Agents of		CI2.4 Bacterial Agents of	
	Foodborne Illness - Salmonella		Foodborne Illness: Salmonella	
	SO2.5 Bacterial Agents of		Cl2.5 Bacterial Agents of	
	Foodborne Illness - Shigella		Foodborne Illness: Shigella	
	SO2.6 Bacterial Agents of		CI2.6 Bacterial Agents of	
	Foodborne Illness -		Foodborne Illness:	
	Staphylococcus		Staphylococcus	
	SO2./ Bacterial Agents of		CI2./ Bacterial Agents of	
	Foodborne Illness - Vibrio		Foodborne Illness: Vibrio	
	SO2.8 Non-Bacterial Agents of		CI2.8 Non-Bacterial Agents of	
	Foodborne Illness - Helminthes		Foodborne Illness: Helminthes	
	and Protozoa		and Protozoa	
	SO2.9 Toxigenic Algae, Fungi.		CI2.9 Toxigenic Algae. Fungi.	
	and Viruses in Foodborne Illness		and Viruses in Foodborne	
			Illness	

Suggested Sessional	SW2.1 Assignments	Write about the Staphylococcus: Characteristics, toxins (enterotoxins), diseases
Work (SW):anyone		(staphylococcal food poisoning), sources, and prevention.
	SW2.2Mini Project	Make a taxonomy table of Bacterial Agents of Foodborne Illness
	SW2.3 Other Activities (Specify)	Find out some you tube videos based on the pathogens, clinical manifestations,.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	4	1	3	17

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction	Self-Learning(SL)
CO3-05BT502.3: Equipped to	SO3.1 Introduction to	LI3.1 Prepare a basic	CI3.1 Introduction to	SL3.1 Study the historical and
comprehend the fundamentals of	Fermented Foods	fermented food product (e.g.,	Fermented Foods	cultural significance of
microorganism used for		yogurt) in the lab and observe		fermented foods
development of functional food		microbial activity.		
	SO3.2 Fermented Milk	LI3.2 Analyze the microbial	CI3.2 Fermented Milk	SL3.2 Explore the health
	Products	content in different fermented	Products	benefits of fermented milk
		milk products.		products
	SO3.3 Cheese Fermentation		CI3.3 Cheese Fermentation	SL3.3 Learn about the types of
				cheese and their microbial
				processes
	SO3.4 Fermented		CI3.4 Fermented	Î
	Vegetables - Sauerkraut		Vegetables: Sauerkraut	
	SO3.5 Fermented Meat		CI3.5 Fermented Meat	
	Products		Products	
	SO3.6 Fermented Beverages		CI3.6 Fermented Beverages:	
	- Beer		Beer	
	SO3.7 Vinegar Production		CI3.7 Vinegar Production	
	SO3.8 Mould Fermentation		CI3.8 Mould Fermentation	
	SO3.9 Advancements in		CI3.9 Advancements in	
	Fermentation Technology		Fermentation Technology	

Suggested Sessional	SW3.1 Assignments	Rememberfermentation
Work (SW): anyone	SW3.2 Mini Project	Prepare a flow chart of how Alcoholic and Acetic Acid Fermentation occur
	SW3.3 Other Activities (Specify)	Explore online tutorials and resources on meat processing.

Itom	C1	ΙI	SW	SI	Total
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Approxims	0)	4	1	5	15

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Classroom Instruction(CI)	Self-Learning(SL)
		Instruction(LI)		
CO4-05BT502.4: Recognize	SO4.1 Introduction to	LI4.1 Perform a direct	CI4.1 Introduction to	SL4.1 Study the
various methods used for	Microbiological Examination of	microscopic examination of	Microbiological Examination of	significance of
microbiological examination	Foods	a food sample to observe	Foods	microbiological
of food and food ingredients		microbial content.		examination in food safety
	SO4.2 Culture Techniques in Food		CI4.2 Culture Techniques in Food	SL4.2 Learn about different
	Microbiology		Microbiology	culture media used in food
				microbiology
	SO4.3 Most Probable Number		CI4.3 Most Probable Number	SL4.3 Explore the
	(MPN) Method		(MPN) Method	applications of the MPN
				method in water and food
				testing
	SO4.4 Dye-Reduction Assay		CI4.4 Dye-Reduction Assay	
	SO4.5 Immunological Methods in		CI4.5 Immunological Methods in	
	Food Microbiology		Food Microbiology	
	SO4.6 Advanced Techniques in		CI4.6 Advanced Techniques in	
	Food Microbiology		Food Microbiology	
	SO4.7 Rapid Methods for		CI4.7 Rapid Methods for Microbial	
	Microbial Detection		Detection	
	SO4.8 Quality Assurance in		CI4.8 Quality Assurance in	
	Microbiological Testing		Microbiological Testing	
	SO4.9 Case Studies on Foodborne		CI4.9 Case Studies on Foodborne	
	Outbreaks		Outbreaks	

Suggested Sessional	SW4.1 Assignments	Various culture techniques
Work (SW): anyone	SW4.2 Mini Project	Prepare the chart for Most Probable Number (MPN) Count
	SW4.3 Other Activities (Specify)	Understand dye reduction assay

Approx.Hrs	09	1	1	3	14
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Course	SessionOutcomes(SOs)	LaboratoryInstruction(LI)	ClassroomInstruction(CI)	Self-Learning(SL)
Outcome				
(CO)				
CO5-05BT502.5:	SO5.1 Introduction to Food	LI5.1 Perform a lab	CI5.1 Introduction to Food	SL5.1 Study the history and
Explore role of the	Preservation	experiment to study the	Preservation	evolution of food preservation
microbes on the		effects of physical		techniques
basis of their		preservation methods on food		
morphological		samples.		
characteristics.	SO5.2 Physical Methods of Food		CI5.2 Physical Methods of	SL5.2 Learn about different
	Preservation		Food Preservation	physical preservation methods
				(e.g., pasteurization, irradiation)
	SO5.3 Chemical Methods of		C15.3 Chemical Methods of	SL5.3 Understand the
	Food Preservation		Food Preservation	mechanisms and applications of
	SO5 4 Dialogical Mathada of		CI5 4 Diplograph Mathada of	various chemical preservatives
	SO3.4 Diological Methods of		CI3.4 Biological Methods of	
	SO5.5 Quality Control in Food		CI5 5 Quality Control in Food	
	Preservation		Preservation	
	SO5.6 Microbiological Criteria		CI5.6 Microbiological Criteria	
	for Food Safety		for Food Safety	
	SO5 7 Good Manufacturing		CI5 7 Good Manufacturing	
	Practices (GMP)		Practices (GMP)	
	SO5.8 Hazard Analysis and		CI5.8 Hazard Analysis and	
	Critical Control Points (HACCP)		Critical Control Points	
			(HACCP)	
	SO5.9 Recordkeeping and		CI5.9 Recordkeeping and	
	Documentation in Food Safety		Documentation in Food Safety	

Suggested Sessional	SW5.1 Assignments	illustrate the role of quality control for Industrial Bioproducts
Work (SW): anyone	SW5.2 Mini Project	Make a tabulated record of HACCP
	SW5.3 Other	Rewrite the HACCP
	Activities (Specify)	

Course duration (in hours) to attain Course Outcomes:

Course Title: Food Biotechnology

Course Code: 05BT502

Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-05BT502.1: Familiarization with the basic concepts	9	4	3	1	17
of microorganism involved in food processing and food					
spoilage.					
CO2-05BT502.2: Acquired Skills to analyze beneficial	9	4	3	1	17
and harmful impact of microorganisms on food and food					
ingredients					
CO3. Identify microbes for the development of functional	9	4	3	1	17
food					
CO4-05BT502.4: Recognize various methods used for	9	2	3	1	15
microbiological examination of food and food ingredients					
CO5-05BT502.5: Explore role of the microbes on the	9	1	3	1	14
basis of their morphological characteristics.					
Total Hours	45	15	15	5	80

End-semester Assessment Scheme for setting up question papers and assessments to evaluate the Course Outcome:

Course Title: Food Biotechnology

Course Code:05BT502

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-05BT502.1: Familiarization with the basic concepts of microorganism involved in food	02	03	04	1	10
processing and food spoilage.					
CO2-05BT502.2: Acquired Skills to analyze beneficial and harmful impact of microorganisms	02	05	02	1	10
on food and food ingredients					
CO3. Identify microbes for the development of functional food	04	04	01	1	10
CO4-05BT502.4: Recognize various methods used for microbiological examination of food and	03	04	02	1	10
food ingredients					
CO5-05BT502.5: Explore role of the microbes on the basis of their morphological	04	03	02	1	11
characteristics.					
Total Marks	15	19	11	05	51

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S. No.	Title/Author/Publisher details
1	Prescott, Harley and Klein, 'Microbiology', MC Graw Hill, International Edition.
2	Willian C. Fraizier and Dennis C. Westhoff, 'Food Microbiology', Tata McGraw Hill Publishing Company, New Delhi.
3	Perry Johnson-Green, Fergus M. ClydesdaleIntroduction to Food BiotechnologyContemporary Food Science 2002
4	Food BiotechnologyWPI PublishingS.C. Bhatia 2017
5	Food Biotechnology KNORR D.TAYLOR & FRANCIS 2017

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Roleplay
- 6. Visit to Research lab (BSL-1)
- 7. Demonstration
- 8. ICT Based Teaching Learning
- 9. Brainstorming

Program Name: B. Tech. Biotechnology Semester:5th Sem Course Title: Food Biotechnology Course Code: **05BT502**

CO/PO/PSO Mapping															
Course Outcome (Cos)					I	Program	Outcom	es (POs))				Program Specific		
												-	Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-05BT502.1: Familiarization with	-												-		
the basic concepts of microorganism		1	_	1	1	2	1	_	3	1	3	1		1	_
involved in food processing and food		1	-	1	1	4	I	-	5	1	5	1		1	-
spoilage.															
CO2-05BT502.2: Acquired Skills to	-												-		
analyze beneficial and harmful impact of		1	- I	_	_	_	3	_	3	2	3	3		1	_
microorganisms on food and food		-					5				5	5		-	
ingredients															
CO3. Identify microbes for the	-	2	1	1	_	_	3	_	3	1	3	3	-	2	1
development of functional food		-	-	-					č	•	0	Ŭ		-	-
CO4-05BT502.4: Recognize various	1	1											1	1	
methods used for microbiological			1	-	2	2	2	3	-	1	3	3			1
examination of food and food ingredients															
CO5-05BT502.5: Explore role of the	1	1											1	1	
microbes on the basis of their			2	-	-	2	3	3	-	2	3	3			2
morphological characteristics.															

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning
No.			Instruction		(SL)
			(LI)		
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO1-05BT502.1: Familiarization with the basic concepts of microorganism involved in food processing and food spoilage.	SO1.1 SO1.2 SO1.3 SO1.4,SO1.5, SO1.6 SO1.7 SO1.8 SO1.9	IL 1 IL 2	1.1,1.2,1.3,1.4 ,1.5,1.6,1.7,1.8,1.9	1SL-1,2,3
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO2-05BT502.2: Acquired Skills to analyze beneficial and harmful impact of microorganisms on food and food ingredients	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5,SO2.6,SO2.7,SO2.8,SO2.9	IL 1 IL 2	2.1, 2.2, 2.3, 2.4,2.5,2.6,2.7,2.8,2.9	2SL-1,2,3
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO3-05BT502.3: Identify microbes for the development of functional food	SO3.1 SO3.2 SO3.3 SO3.4 ,3.5,SO3.6,SO3.7,SO3.8,SO3.9	IL 1 IL 2	3.1,3.2,3.3,3.4.3.5,3.6,3.7,3.8,3.9	3SL-1,2,3
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO4-05BT502.4: Recognize various methods used for microbiological examination of food and food ingredients	SO4.1 SO4.2 SO4.3 SO4.4 ,SO4.5,SO4.6,SO4.7,SO4.8,SO4.9	IL 1 IL 2	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	4SL-1,2,3
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO5-05BT502.5: Explore role of the microbes on the basis of their morphological characteristics.	SO5.1 SO5.2 SO5.3 SO5.4 ,SO5.5,SO5.6,SO5.7,SO5.8,SO5.9	IL 1 IL 2	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	5SL-1,2,3

Program Name	Bachelor of Science (Hons.) -Biotechnology							
Semester	V	V						
Course Code:	04BT501							
Course title:	Biosafety, Bioethics, IPRs and Patenting	Curriculum Developer: Dr. Deepak Mishra, Professor						
Pre-requisite:	Student should have basic knowledge of Bi	otechnology, Genetic Engineering and Research.						
Rationale:	The paper on Biosafety, Bioethics, IPRs and P ensure the responsible and ethical use of biotec in research to the protection of intellectual pro- biological materials, especially those with haz where biological research is conducted. Bioeth and welfare. It covers informed consent, priv genetic engineering and cloning. IPRs incentive	atenting in a B Sc. (Hons.) Biotechnology program is interconnected concepts that serve to chnology and biological resources. They encompass various aspects, from safety and ethics perty. The primary goal biosafety is to ensure the safe handling, transport, and disposal of vardous potential. This is crucial in laboratories, research facilities, and industrial settings ics guides decision-making, ensuring that scientific progress respects human rights, dignity, vacy, research ethics, animal welfare, and issues surrounding emerging technologies like ze innovation by allowing researchers and inventors to profit from their work.						
Course Outcomes (COs):	rse Outcomes CO1-04BT501.1: Familiarization with the basic concepts, key principles and regulations of biosafety in biotechnological research Os: CO2-04BT501.2: Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biot CO3-04BT501.3: Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws.							
	CO4-04BT501.4: Recognize various methods CO5-04BT501.5: Explore role of regulatory fi	related to patents and the patenting process law and regulations in India. ramework for recombinant DNA research, Biotechnology and food safety laws.						

Scheme of Studies:

Board of Study								
	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=2:0:1)
Skill Enhancement course	04BT501	Biosafety, Bioethics, IPRs and Patenting	2	2	1	5	10	2+1=3

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

			Scheme of Assessment (Marks)								
								End	Total Marks		
Board of	Course Code	Course Title	Class/Home	Class Test 2	Seminar	Class	Total Marks	Semester			
Study	Course Code	Course 11tle	Assignment	(2 best out		Attendance		Assessment			
			5 number	of 3)	(SA)	<	(CA+CT+SA+AT)	(ESA)	(PRA+ ESA)		
			3 marks each	10 marks each (CT)		(AT)	()				
C1 '11			(CA)								
Skill Enhancement course	04BT501	Biosafety, Bioethics, IPRs and Patenting	15	20	10	5	50	50	100		

Scheme of Assessment: Practical

				Progressive Assessment (PRA)							
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)		
Skill Enhancement course	t 04BT501-L	Biosafety, Bioethics, IPRs and Patenting	35	5	5	5	50	50	100		

Course-Curriculum:

This course syllabus illustrates the expected learning achievements,	Approximate	Hours	S									
both at the course and session levels, which students are anticipated	Item	Cl	LI	SW	SL	То	talltem	Cl	LI	SW	SL	Total
Classroom Instruction (CI), Laboratory Instruction (LI), Sessional	Approx. Hrs	08	02	01	05	16	Approx. Hrs	05	04	01	05	15
Work (SW), and Self Learning (SL). As the course progresses,												
students should showcase their mastery of Session Outcomes (SOs),												
culminating in the overall achievement of Course Outcomes (COs)												
upon the course's conclusion.												

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-04BT501.1: Familiarizati with the basic concepts, key princip and regulations of biosafety biotechnological research.	on SO1.1 Define and Describe concept, History and objectives of Biosafety	LI1.1 Case study on risk assessment of lab	Unit-1 Cl1.1 Biosafety: Introduction, Historical prospective, objectives,	SL1.1 Search various reference books and study material to start the learning of Biosafety
	SO1.2 Study of risk assessment and its regulation		CI1.2 risk assessment in biotechnological research and their regulation	
	SO1.3 Study the concept of containment		CI1.3 physical and biological contaminants	SL1.2 Examine biosafety in your institution's lab
	SO1.4 Study planned introduction of GMOs		CI1.4, field trial and planned introduction of GMOs,	
	SO1.5 Describe the biosafety guidelines		CI1.5 Biosafety guidelines in India	SL1.3 Classify your lab based on biosafety level
	SO1.6 Explain biosafety level of microbial research		CI1.6 Biosafety levels for microbial researches.	
SO1.7 Explain biosafety level of plant research			CI1.7 Biosafety levels for Plant researches	SL1.4 To prepare the biosafety manual for your lab
	SO1.8 . Explain biosafety level of animal research		CI1.8 Biosafety levels for animal researches.	SL1.5 To implement guideline in biotech laboratory.
Suggested Sessional S	W1.1 Assignments	Describe in detail	biosafety guidelines for regulation of F	RDT research in India.
Work (SW):anyone	W1.2Mini Project	Prepare biosafety	symbols and implement in your laborat	tory.
S	W1.3 Other Activities (Speci	fy) Preparation of bios	safety manual for biotechnology labora	atory.

Course outcome (CO)	Session Outcomes (SOs)	Laborat	tory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-04BT501.2: Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biotechnology.	SO2.1 Explore the concept bioethics and ethical issue of biotechnology	LI2.1 Ca Health E	se Study on Women thics	Unit-II CI2.1 Bioethics: Introduction, Ethical issues related to biotechnology, Ethical concerns of gene cloning	SL2.1 Search various books and resources for study the bioethics.
	SO2.2 Reflecting impact of biotech research in society	LI2.2 Ca Negliger	se Study on Medical nce	CI2.2 legal and socioeconomic impacts of biotechnology	SL2.2 study about failure of biotech products- case study
	SO2.3 Explain health and safety issues of biotech			CI2.3 health and safety issues	SL2.3 to learn about control measures for biotech research
	SO2.4 Assessing the benefits of cloning			CI2.4 possible benefits of successful cloning	SL2.4 standardize the protocol for successful cloning
	SO2.5 Explaining hazards of GMOs on environment			Cl2.5 hazards of environmental engineering	SL2.5 to learn hazards of cloning
Suggested Sessional Work (SW):anyone	SW2.1 Assignments SW2.2Mini Project SW2.3 Other Activities (St	Assess the impact on RDT research on human and environment. Designing of poster for showing benefits of cloning Specify) To perform case studies on GMOs and their impact.			

Item	Cl	LI	SW	SL	Total
Approx. Hrs	67	04	₿₩	₿₽	† 7tal
Approx. Hrs	05	05	01	05	16

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning(SL)
CO3-04BT501.3: Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws.	SO3.1 Explain the role of IPRsconcept and types	LI3.1 Case Study on clinical trial of drugs	Unit-III CI3.1 Intellectual Property Rights- Introduction, types	SL3.1 Collection of books and study materials for IPRs
	SO3.2 Assessing the different types of IPRs		CI3.2 trade secret patent, copyright, plant variety protection	SL3.2 Study different types of intellectual property
	SO3.3 Describe about WIPO GATT and Trips	LI3.2 preparation of business plan	CI3.3 WIPO, GATT TRIPs,:	SL3.3 categorization of different types of intellectual property
	SO3.4 Explaining concept of PBR		CI3.4 plant breeder's rights	SL3.4 Study of role of WIPO for IPR protection
	SO3.5 Describe about PPVFR Act		CI3.5 protection of plant varieties and former's right act (2001),	SL3.5 Assess law and legislation for IPRs

Suggested Sessional	SW3.1 Assignments	Describe in detail about different types of intellectual properties.
Work (SW): anyone	SW3.2 Mini Project	Describe the role of different Laws for protection of intellectual property.
	SW3.3 Other Activities	Prepare a list of plant varieties protected through PBR Act and PPVFR Act.
	(Specify)	

Suggested Sessional S	SW4.1 Assignments	4.1 Assignments Explain about patent and patent processing procedure.						
Work (SW): anyone	SW4.2 Mini Project	Study the sile	tudy the silent features of different law of patenting worldwide					
Course Outcome (CO)	WISESSION Outcome Activities (Specify)	s(Bropare one an	ticle op international status of Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)			
CO4-04BT501.4:	SO4.1		LI4.1 Proxy Filling of	Unit-IV	SL4.1			
Recognize variou methods related to patent and the patenting process law and regulations in India.	us Exploring the ts Patents and Patent ss in	concept of ting process	Process Patent	CI4.1 Patents and patent processing: Introduction Essential requirements	Learn about different categories of Patents			
	SO4.2 Explaining the concept of patent law		LI4.2 Proxy filling of Product Patent	CI4.2 International scenario of patents				
	SO4.3 Explaining the role of patent for biologics.			CI4.3 patenting of biological materials	SL4.2 Compare Rules of different countries			
	SO4.4 Evaluate impact of patent in india			CI4.4 significance of patents in India	SL4.3 Learn about various criteria for patentnig			
	SO4.5 Describe patenting.	the impact of		CI4.5 Patent application, Procedures and granting	SL4.4 Case studies related to patenting in India			
	SO4.6 Describe 1970	the patent law		CI4.6 Patent Act (1970)	SL4.5 Case studies related to biological patents			
	SO4.7 Describe 2002	the patent Act		CI4.7 Patent (Amendments) Act (2002).				

Course Outcome	Session Outcomes(SOs)	Laboratory	Classroom	Self-
(CO)		Instruction(LI)	Instruction(CI)	Learning(SL)

CO5-04BT501.5:	SO5.1 Define the	Unit-V	SL5.1 learn
Explore role of	concept of regulation of	CI5.1 Regulatory	about basic
regulatory	RDT research	framework in India	concept &
framework for		governing GMOs	requirement of
recombinant DNA			GMOs
research,			development
Biotechnology and			1
food safety laws.			
	SO5.2 Study the	CI5.2 Recombina	SL5.2Review
	Recombinant DNA	nt DNA Guidelines	concept of RDT
	Guideline 1990	(1990)	research
	SO5.3 Elaborate	CI5.3 Revised	SL5.3learn
	Revised Guideline for	Guidelines for	how to apply
	Research in	Research in	Law to
	Transgenic Plants	Transgenic Plants	regulate food
	(1998)	(1998)	products
	SO5.4 Elaborate the	CI5.4 Prevention	SL5.4 Learn
	role of Prevention Food	Food Adulteration	about novel
	Adulteration Act (1955)	Act (1955)	characters of
			GM Plants
	SO5.5 Elaborate the	CI5.5 Food Safety	SL5.5 Learn
	role of Food Safety and	and Standards Bill	about Role of
	Standards Bill (2005	(2005)	FSSAI

Item	Cl	LI	SW	SL	Total
Approx.Hrs	05	00	01	05	11

Suggested Sessional	SW5.1 Assignments	Explain general characteristics and silent features of RDNA laws.
Work (SW): anyone	SW5.2 Mini Project	Describe the role of Law and legislations for development of new varieties.
	SW5.3 Other Activities (Specify)	Prepare a detail document on international Food law and regulations

Course duration (in hours) to attain Course Outcomes:

Course Title: Biosafety, Bioethics and IPRs		Course Code:04BT501			
Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-04BT501.1: Familiarization with the basic concepts,	8	2	5	1	16
key principles and regulations of biosafety in					
biotechnological research.					
CO2-04BT501.2: Acquired Skills to analyze and address	5	4	5	1	15
ethical, legal, and socioeconomic, health and safety					
implications of biotechnology					
CO3-04BT501.3: Equipped to comprehend the	5	5	5	1	16
fundamentals of IPRs, including the legal frameworks and					
laws.					
CO4-04BT501.4: Recognize various methods related to	7	4	5	1	17
patents and the patenting process law and regulations in					
India					
CO5-04BT501.5: Explore role of regulatory framework	5	0	5	1	11
for recombinant DNA research, Biotechnology and food					
safety laws.					
Total Hours	30	15	25	05	75

Course Title: Biosafety Bioethics and IPRs

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Biosafety, Bioethics and IPRs	Course Code: 04BT501				
Course Outcomes	Marks Distribution				
	А	An	E	С	Total Marks
CO1-04BT501.1: Familiarization with the basic concepts, key principles and regulations of	2	1	1	1	5
biosafety in biotechnological research.					
CO2-04BT501.2: Acquired Skills to analyze and address ethical, legal, and socioeconomic,	2	4	2	2	10
health and safety implications of biotechnology					
CO3-04BT501.3: Equipped to comprehend the fundamentals of IPRs, including the legal	2	3	3	2	10
frameworks and laws.					
CO4-04BT501.4: Recognize various methods related to patents and the patenting process law	3	5	5	2	15
and regulations in India					
CO5-04BT501.5: Explore role of regulatory framework for recombinant DNA research,	5	4	1	0	10
Biotechnology and food safety laws.					
Total Marks	14	17	12	07	50
				•	•

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create
Suggested learning Resources:

(a) Books:

(b)

S. No.	Title/Author/Publisher details
1	Sateesh MK (2010) Bioethics and Bio safety, I. K. International Pvt Ltd.
2	Sree Krishna V (2007) Bioethics and Bio safety in Biotechnology, New age international publishers
3	The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
4	Intellectual property rights – Ganguli – Tat McGraw-Hill
5	Biotechnology-B. D. Singh- Kalyani Publications

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

Program Name: B.Sc. Hons Biotechnology **Semester:** V Semester **Course Title:** Biosafety, Bioethics and IPRs **Course Code:** 04BT501

Course Outcome (Cos)		Program Outcomes (POs)									Program Specific Outcomes (PSOs)		cific Os)		
	PO1	PO	PO3	PO	PO5	PO6	PO	PO8	PO	PO10	PO11	PO1	PSO1	PSO2	PSO3
		2		4			7		9			2			
CO1-04BT501.1: Familiarization with the	1	1	2	2	3	1	2	3	2	1	2	3	2	2	3
basic concepts, key principles and															
regulations of biosafety in biotechnological															
research.															
CO2-04BT501.2: Acquired Skills to	1	1	1	1	2	1	2	2	1	2	2	2	2	3	3
analyze and address ethical, legal, and															
socioeconomic, health and safety															
implications of biotechnology															
CO3-04BT501.3: Equipped to	1	1	2	2	2	1	3	2	2	1	2	2	1	2	3
comprehend the fundamentals of IPRs,															
including the legal frameworks and laws.															
CO4-04BT501.4: Recognize various	1	1	2	1	3	1	3	3	2	2	1	3	1	2	3
methods related to patents and the															
patenting process law and regulations in															
India															
CO5-04BT501.5: Explore role of	1	1	2	1	3	1	3	3	1	2	2	3	1	2	2
regulatory framework for recombinant															
DNA research, Biotechnology and food															
safety laws.															

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO1-04BT501.1: Familiarization with the basic concepts, key principles and regulations of biosafety in biotechnological research.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8	1.1	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8,	1SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO2-04BT501.2: Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biotechnology	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	2.1, 2.2	2.1, 2.2, 2.3, 2.4, 2.5,	2SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO3-04BT501.3: Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	3.1,3.2	3.1,3.2,3.3,3.4,3.5,	3SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO4-04BT501.4: Recognize various methods related to patents and the patenting process law and regulations in India	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7	4.1,4.2	4.1,4.2,4.3,4.4, 4.5, 4.6, 4.7,	4SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	CO5-04BT501.5: Explore role of regulatory framework for recombinant DNA research, Biotechnology and food safety laws.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		5.1,5.2,5.3,5.4,5.5,	5SL-1,2,3,4,5

Program Name	Bachelor of Science (Hons.) in Biotechnology	Bachelor of Science (Hons.) in Biotechnology (B.Sc. (Hons.) BT)				
Semester	/					
Course Code:	5BT402					
Course title:	Oga Science Curriculum Developer: Dr. Dileep Kumar Tiwari, Assistant Professor					
Pre-requisite:	Student should have basic knowledge of Applications of Yoga and Meditation and its concepts					
Rationale:	The Yoga Science course in a B.Sc. Hons understanding of Yoga and its original text Yo which they should have knowledge of its basic	The Yoga Science course in a B.Sc. Hons. Biotechnology program serves a crucial role by providing students with a legal understanding of Yoga and its original text Yoga. At the same time, they should also have adequate knowledge of Yoga and Meditationin which they should have knowledge of its basic principles and elements.				
Course Outcomes	CO1-05BT402.1:- Elucidate the overview of Yoga Science					
(COs):	CO2-05BT402.2:- Acquire knowledge regarding Yoga and Pranayam with practices of Bandha and Mudra					
	CO3-05BT402.3:- Applied knowledge about y	oga and Meditation				

Scheme of Studies:

					Scheme of	fstudies (Hou	rs/Week)	
Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=0:0:2)
Skill enhancement course (SEC)	05BT402	Yoga Science	0	4	1	1	4	0+1=1

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Practical

					S	cheme of Assessn	nent (Marks)		
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
SEC	05BT402	Yoga Science	35	5	5	5	50	50	100

This course syllabus illustrates the expected learning achievements, both at the course and session	Approxima	te Hours					
levels, which students are anticipated to accomplish through various modes of instruction including			-				
Classroom Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning		Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs).		Approx. Hrs	00	10	01	01	12
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT402.1:- Elucidate the overview of Yoga Science	SO1.1 Explain the concept and principles of yoga	Unit-1. Introduction to Yoga and Yogic Practices LI 1.1 Yoga: Etymology, definitions, aim, objectives and misconceptions		SL1.1 Read some articles about Yoga
	history of yoga	history and development		
	SO1.3 Elaborate the rules of yoga	LI 1.3 . Rules and regulations to be followed by Yoga ractitioners		
	SO1.4 Elucidate the various yoga practices	LI 1.4 Introduction to Yoga practices		
	SO1.5 Elaborate the different steps of yoga sadhana	LI 1.5 Shatkarma: meaning, purpose and their significance in Yoga Sadhana		
	SO1.6 Elaborate the different yogic loosening practices.	LI 1.6. Introduction to Yogic Loosening practices and Surya Namaskar		

Suggested Sessional	SW1.1 Assignments	Describe various principles of yoga science.
Work (SW):anyone	SW1.2Mini Project	Elaborate different branches of yoga with its role.
,	SW1.3 Other Activities (Specify)	Make a demonstration on yoga.

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate	Hours					
levels, which students are anticipated to accomplish through various modes of instruction			1	1			
including Classroom Instruction (CI). Laboratory Instruction (LI). Sessional Work (SW), and Self		Item	Cl	LI	SW	SL	Total
Learning (SL). As the course progresses, students should showcase their mastery of Session		Approx. Hrs	00	10	01	01	12
Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the							
course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-05BT402.2:- Acquire knowledge regarding Yoga and Pranayam with practices of Bandha and Mudra	SO2.1 Explain the different types of yoga practices SO2.2 Elucidate the Role of doop broathing in yoga	Unit-2.0: Yogic Practices. Breathing Practices and Pranayama LI 2.1. Sectional Breathing (Abdominal, Thoracic and Clavicular) LI 2.2. Yogic Deep		SL2.1 Note down the impact of yoga in life.
	SO2.3 Elaborate the concept of puraka, Rechaka and Kumbhaka	LI 2.3.Concept of Puraka, Rechaka and Kumbhaka		
	SO2.4 Elucidate the bandha and mudra	LI 2.4. Concept of Bandha and Mudra		
	SO2.5 Explanation about the anuloma viloma SO2.5 Explanation about the shitali and bhamari .	LI 2.6 Shitali. Bhramari		

Suggested Sessional	SW2.1 Assignments	Describe the Role of yoga mudra.
Work (SW):anyone	SW2.2Mini Project	Make a chart on classification of yoga practices
	SW2.3 Other Activities (Specify)	Describe methods of prranayam

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	App	roximate Hours	5				
which students are anticipated to accomplish through various modes of instruction including Classroom			I				
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	00	10	01	01	12
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcom	ne (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-05BT402.3:-	Applied	SO3.1 Elucidate the	Unit-3 Practices leading to		SL3.1 Read about various
knowledge about	yoga and	meditation concept	Meditation		examples of meditation
Meditation			LI 3.1.Recitation of		
			Pranava Mantra		
		SO3.2 Explain about the	LI 3.2. Recitation of		
		prayers.	Hymns, in vocations and		
			prayers		
		SO3.3 Elaborate the Anter	LI 3.3 Anter Maun		
		Maun			
		SO3.4 To learn the general	LI 3.4 Breath Meditation		
		about breath meditation			
		SO3.5 Explanation about	LI 3.5 0m Dhyana		
		om dhyana	5		

Suggested Sessional	SW3.1 Assignments	Flow chart on different types of meditation						
Work (SW): anyone	SW3.2 Mini Project	Describe the different characteristics of meditation						
	SW3.3 Other	Demonstration on meditation						
	Activities (Specify)							

Course duration (in hours) to attain Course Outcomes:

Course Title: Yoga Sci	ence	Course Code: 05BT402							
Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours				
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)				
CO1-05BT402.1:- Elucidate the overview of Yoga	0	10	1	1	12				
Science									
CO2-05BT402.2:- Acquire knowledge regarding Yoga	0	10	1	1	12				
and Pranayam with practices of Bandha and Mudra.									
CO3-05BT402.3:- Applied knowledge about yoga and	0	10	1	1	12				
Meditation									
Total Hours	00	30	03	03	36				

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Yoga Science

Course Code: 04B402

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-05BT402.1:- Elucidate the overview of Yoga Science	3	8	7	2	20
CO2-05BT402.2:- Acquire knowledge regarding Yoga and Pranayam with practices of	3	4	5	2	14
Bandha and Mudra.					
CO3-05BT402.3:- Applied knowledge about yoga and Meditation	4	5	5	2	16
Total Marks	10	17	17	06	50
I OTAL MIARKS	10	17	17	UO	50

Legend:A, Apply; An, Analyze; E, Evaluate; C, Create

Suggested learning Resources:

(a) Books: Title/Author/Publisher details S.No. Singh S.P. & yogi Mukesh ,Foundation of yoga , standard publication , new Delhi ,2010 1 2 Swami dherendrabrhamchari, yogasanavigyaan, dherendra yoga prakshan, new Delhi 1966 3 Sarswati, swami satyananda, asan pranayama mudra bandha, yogprakshan trust munger, 2013 4 H.R. nagendra, asan pranayama mudra bandha, swami Vivekananda yogprakshan, banglore 2002 IshwerBhardwaj, saralyogashan, satyam publication house, new Delhi 2018 5 Shri ram chauhaan, mudra rahasya, bhartiyeyogsansthan, new delhi 2014 6 DrVishwanath Prasad sangha, dhyanyog, bhartiyeyogsansthan, new delhi 1987 7 ShriDeshraj , Dhyansadhna , bhartiyeyogsansthan , new delhi 2015 8 9 bhartiyeyogsansthan, new delhi 2014

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Group Discussion
- 4. Role play
- 5. Demonstration
- 6. ICT Based teaching Learning
- 7. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) Biotechnology

Semester: IV Semester

Course Title: Yoga Science. Course Code: 05BT402

Course Outcome (Cos)		Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-05BT402.1:- Elucidate the overview	1	2	-	1	2	1	2	1	2	-	1	2	2	2	1
of Yoga Science															
CO2-05BT402.2:- Acquire knowledge	-	1	1	-	-	-	1	-	1	1	-	-	1	1	2
regarding Yoga and Pranayam with															
practices of Bandha and Mudra.															
CO3-05BT402.3:- Applied knowledge	1	1	2	1	-	1	1	1	1	2	1	-	3	1	1
about yoga and Meditation															

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

POs & PSOs No.	Cos	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6	CO1-05BT402.1:- Elucidate the	SO1.1 SO1.2	1.1,1.2,1.3,1.4,1.5,1.6,		1SL-1
7,8,9,10,11,12	anomion of Vaga Science	SO1.3 SO1.4			
	overview of Yoga Science	SO1.5 SO1.6			
PSO 1,2, 3					
PO 1,2,3,4,5,6	CO2-05BT402.2:- Acquire knowledge	SO2.1 SO2.2	2.1, 2.2,		2SL-1
7,8,9,10,11,12	regarding Yoga and Pranayam with	SO2.3 SO2.4	2.3,2.4,2.5,2.6,		
	practices of Bandha and Mudra.	SO2.5 SO2.6			
PSO 1,2, 3	-				
PO 1,2,3,4,5,6	CO3-05BT402.3:- Applied knowledge	SO3.1 SO3.2	3.1,3.2,3.3,3.4,3.5,		3SL-1
7,8,9,10,11,12	about yoga and Meditation	SO3.3 SO3.4			
		SO3.5			
PSO 1,2, 3					

Program name	Bachelor of Science (B.Sc.) - Biotechnology							
Semester	VI							
Course Code:	01BT601							
Course title:	Immunology & Immune TechnologyDeveloper: Dr. Kamlesh Kumar Soni, Assistant Professor							
Pre-requisite:	Student should have basic knowledge biology and biochemistry							
Rationale:	The paper on "Immunology and Immune Techno application of numerous cells involve in defense re- different stresses. This subject offers the students the	The paper on "Immunology and Immune Technology" in B.Sc. Biotechnology program give the opportunity to predict the working principle and application of numerous cells involve in defense responses. This subject will build up the basic and advanced mechanism of immune responses during the different stresses. This subject offers the students the opportunity to advance the knowledge of immunology						
Course Outcomes (COs):	CO1-01BT601 .1: Understand the essential of imm CO1-01BT601 .2: Know the fundamentals of immu CO1-01BT601 .3: In-depth study about action of in CO1-01BT601 .4: Elaborate the various immunode CO1-01BT601 .5: Basic principles and applications	une system cells to the organism moglobulins, antigens, and their classifications mune responses and their genetic regulations ficiency related diseases and functionality of immune system s of various immunization techniques as well as the various vaccinations						

Scheme of Studies:

		le CourseTitle			Total Credits(C)			
Board ofStudy	Course Code		Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	(L:T:P=4:0:2)
MAJOR	01BT601	Immunology & Immune Technology	3	1	1	3	8	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial(T) and others);

LI: Laboratory Instruction(Includes Practical performances in laboratory workshop, field or other instructional strategies);

SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

				Scheme of Assessment (Marks)										
					Progressive Ass	essment (PRA)								
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)					
MAJOR	01BT601	Immunology & Immune Technology	15	20	10	5	50	50	100					

Scheme of Assessment: Practical

					ment (Marks)				
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MAJOR	01BT601-L	Immunology & Immune Technology	35	5	5	5	50	50	100

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT601 .1: Understand the essential of immune system cells to the organism	SO 1.1: Able to define the immune system	LI 1.1: Demonstration of T-cell mediated immunity diagrammatically and with the help of animation in detail	Unit 1: CI 1.1:History and major milestones of Immunology	SL1.1: Study about the basic of immune systems
	SO1.2: Understanding fundamental of immune system	LI 1.2:Differential leucocytes count	CI 1.2: General concepts of the immune system	SL1.2: Learn about defense mechanism in lower organism
	SO1.3: In depth study about the non-specific immune systems	LI 1.3:Blood Group Determination	CI 1.3: Innate immunity	SL 1.3: Read the working principle of non-specific immune system
	SO 1.4 In details on immune responses		CI 1.4 Adaptive immunity	SL 1.4: study the 1 st line of defence
	SO1.5: Categorizing the primary and secondary responses		CI 1.5: Primary immune response,	SL 1.5: Compare the B-cells and T-cells
	SO 1.6 learn how secondary response works		CI 1.6 Secondary immune response	
	SO 1.7 Know how the blood cells are produced		CI 1.7 Haematopoiesis	
	SO1.8: Basic and advanced understanding of B and T cells.		CI 1.8: Structure, properties of the immune cells	
	SO 1.9 Know about types of Lymphoid organs		CI 1.9 Types of Lymphoid Organs	
	SO 1.10 Know structure of Primary Lymphoid Organs		CI 1.10 Structure of Primary Lymphoid Organs	
	SO 1.11 Know structure of Secondary Lymphoid Organs		CI 1.11 Structure of Secondary Lymphoid Organs	
	SO 1.12 Know how the immune systems work		CI 1.12 Function of Lymphoid Organs	

Suggested Sessional Work	SW1.1 Assignments	Describe in details the action of B-cells on defence system
(SW): anyone	SW1.2 Mini Project	Draw well labelled diagram of different lymphoid organs
	SW1.3 Other Activities (Specify)	Watch animation on mode of action of first line of defence

Unit-II:						
Course-Curriculum:	Approximate Hou	ırs				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are				-		
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx. Hrs	12	06	01	04	23
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Laboratory Self-Learning (SL) **Course outcome (CO) Session Outcomes (SOs) Class room Instruction (CI)** Instruction (LI) CO1-01BT601 .2: Know the SO2.1: Discuss the properties LI 2.1: Demonstration CI 2.1: Antigens: Properties SL2.1: Fundamental structure of fundamentals of immunoglobulins, of antigens of Antibody-antigen immunoglobins antigens, and their classifications interaction SO2.2: Discuss the types of CI 2.2 Types SL 2.2: Basic information about antigens Protein-protein interaction SO 2.3 Know how small LI 2.2: Total leucocytes CI 2.3: Haptens and Adjuvants SL 2.3: Read the working molecules induces the principle of non-specific immune count immunity system SO 2.4: Build up the concept LI 2.3: Determination of CI 2.4: Antibodies: SL 2.4: Read in details about the of antibody BT and CT monoclonal and polyclonal antibody SO 2.5: Build up the concept CI 2.5: Antibodies: Types, classes of antibody SO 2.6: Build up the concept CI 2.6: Molecular structure of Immunoabout the antibody's structures globulins SO 2.7 Know how antibodies work CI 2.7 function of Antibody SO 2.8 Know how binding CI 2.8 Allotypes & idiotypes and inheritance occurs SO 2.9: Summarizing the CI 2.9Humoral immune responses mode of action of B-cells SO 2.10: Know how T-Cells CI 2.10 Cellular immune response in defence response works SO 2.11: Learn mechanism of CI 2.11: Complement System complement system SO 2.12 Study to know why CI 2.12 Introduction to cytokines cytokines are important

Suggested Sessional Work	SW1.1 Assignments	Discuss about cytokines and their role in immune responses
(SW): anyone	SW1.2 Mini Project	Draw well labelled diagram of immunoglobin and mention their types
	SW1.3 Other Activities (Specify)	Watch animation on Antibody-antigen interaction mechanism

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	04	23

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT601 .3: In-depth study	SO3.1: Discuss about how immune cell	LI 3.1: Total RBC	CI 3.1: Genome organization and	SL3.1: Figure out the fundamental
about action of immune responses	are activated	count	rearrangements during B-	differences between humoral and
and their genetic regulations			lymphocyte differentiation	cell mediated immune responses
	SO3.2: Learn About B cell	LI 3.2: RID	CI 3.2: B-lymphocyte differentiation	SL3.2: Advance the knowledge of
	differentiation			regulation of B & T cell on
				exposure to the antigens
	SO 3.3 Learn how antibody affinity	LI 3.3: RIA	CI 3.3: Antibody affinity	SL 3.3: Clear the basic concept of
	works			the gene regulation
	SO 3.4 Linking different fundamental		CI 3.4: maturation	SL 3.4: Boost your knowledge on
	differences among the Antibodies			antibody-antigen interaction
	_			mechanism
	SO 3.3: Able to visualize how the class		CI 3.5: Antibody class switching,	
	switching occurs			
	SO 3.6: Learn how antibody capture		CI 3.6: Antibody diversity	
	the specific antigen send them to trash			
	SO 3.7 How gene get assembled		CI 3.7 Regulation of	
			immunoglobulin gene expression	
	SO 3.8 learn about clonal selection		CI 3.8 clonal selection theory	
	theory			
	SO 3.9: Discuss germ line Hypothesis		CI 3.9: germ line Hypothesis	
	SO 3.10: Explain somatic mutation		CI 3.10: somatic mutation	
	Hypothesis		Hypothesis	
	SO 3.11: How T cell receptor works		CI 3.11: T cell receptor	
	SO 3.12: Discuss Assembly of T-cell		CI 3.12: Assembly of T-cell receptor	
	receptor genes by somatic		genes by somatic recombination	
	recombination			

Suggested Sessional Work	Assignments:	Describe in hybridoma technology
(SW): anyone	Mini Project:	Draw structure of different types of antibodies
	Other Activities (Specify):	Watch animation on explaining the functionality of cell mediated immune system

Unit IV:						
Course-Curriculum:	Approximate Hou	rs				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	04	23
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT601 .4: Elaborate the various immunodeficiency related diseases and functionality of immune system	SO4.1: Discuss about the cell surface protein and their role on foreign recognition	LI 4.1: Separation of serum from blood	CI 4.1: Major Histocompatibility complexes	SL4.1: Study the MHCs
	SO 4.2 How MHC I functions	LI 4.2: Double immunodiffusion test	CI 4.2 Class I MHC	SL 4.2: Learn what are the interferons
	SO 4.3 Learn how MHC II is different from MHC I	LI4.3: VDRL Test	CI 4.3 Class II MHC	SL 4.3: Study the MAMPs and PAMPs
	SO 4.4 Learn how antigens are processed and cleaned		CI 4.4 Antigen processing	SL 4.4: Study the nature of HIV and why is it not curable so far
	SO 4.5: Discus how infections is associated with interferons and role of interferons to protect the body from pathogen		CI 4.5: Immunity to infection	
	SO 4.6 How various organ have mechanism to activate the immunity		CI 4.6 Immunity to different organisms	
	SO 4.7: How pathogen escape from recognition by the host's immune system by alternating the structure of the recognized MAMPs		CI 4.7: Pathogen defence strategies	
	SO 4 8: Discuss various immune attacking diseases		CI 4.8: avoidance of recognition	
	SO 4.9: Learn about Autoimmune diseases		CI 4.9: Autoimmune diseases	
	SO 4.10: Illustrate about Primary Immunodeficiency		CI 4.10: Primary Immunodeficiency	
	SO 4.11: Explain Secondary Immunodeficiency		CI 4.11: Secondary Immunodeficiency	
	SO 4.12: Discuss about AIDS		CI 4.12: AIDS	

Suggested Sessional Work	Assignments:	Elaborate the function of MHCs
(SW): anyone	Mini Project:	Describe the AIDS in details
	Other Activities (Specify):	Make a poster explaining how pathogen make fool and escape from host immune machineries

Unit-V:						
Course-Curriculum:	ApproximateHour	s				
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	Cl	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Approx.Hrs	12	06	01	02	21
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT601 .5: Basic principles and applications of various	SO5.1: Explain body fight against the infection	5.1: Demonstration of ELISA	CI 5.1: Vaccines	SL 5.1: Apply idea of Infection to suppress the immunity to human health
immunization techniques as well as the various vaccinations	SO 5.2 Know how the vaccination is done	5.1: Demonstration of RIA	CI 5.2 Vaccination	SL 5.2: Rerevise the ELSIA for several diseases' diagnosis
	SO 5.3 How small molecules participate in immunity	5.1: Demonstration of Immunoelectrophoresis	CI 5.3 Adjuvants, cytokines,	
	SO 5.4 How DNA is exploited to make vaccine		CI 5.4DNA vaccines,	
	SO 5.5 Explain Recombinant vaccines,		CI 5.5 Recombinant vaccines,	
	SO 5.6 Explain bacterial vaccines and viral vaccines,		CI 5.6 bacterial vaccines, viral vaccines,	
	SO 5.7 Discuss about vaccines to other infectious agents		CI 5.7 vaccines to other infectious agents	
	SO 5.8: Explore Passive immunization		CI 5.8: Passive immunization	
	SO 5.9 Explore Active immunization		CI 5.9 Active immunization	
	SO 5.10 know about immunodiagnostics		CI 5.10 Introduction to immunodiagnostics	
	SO 5.11 Learn about RIA		CI 5.11 RIA	
	SO 5.12 learn about ELISA		CI 5.12: ELISA	

Suggested Sessional	Assignments:	Detail explanation of principle of vaccine production
Work (SW): Anyone	Mini Project:	Discuss about the western blotting techniques and it application in infection detection
	Other Activities (Specify):	How ELISA functioning differ from RIA; Study in details

Course duration (in hours) to attain Course Outcomes

(Course true: minumology& minume recimology) (Course code:)	(Course title: Immunology & Immune Technology) (Course code:)
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Course Outcomes(COs)	Class lecture(CI)	LaboratoryInstruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-01BT601 .1: Understand the essential of immune system cells to the organism	12	06	5	1	24
CO1-01BT601 .2: Know the fundamentals of immunoglobulins, antigens, and their classifications	12	06	4	1	23
CO1-01BT601 .3: : In-depth study about the action of immune responses and their regulations	12	06	4	1	23
CO1-01BT601 .4: Elaborate the various immunodeficiency related diseases and functionality of immune system	12	06	4	1	23
CO1-01BT601 .5: Recognize the various immunization techniques as well as the various vaccinations	12	06	2	1	21
Total Hours	60	30	19	05	114

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:									
Course title: Immunology& Immune Technology) (Course code:)									
Course Outcomes		Marks Distribution Total							
	А	An	Ε	С	Marks				
CO1-01BT601.1: Understand the essential of immune system cells to the organism	2	1	1	1	5				
CO1-01BT601 .2: Know the fundamentals of immunoglobulins, antigens, and their classifications	2	4	2	2	10				
CO1-01BT601 .3: : In-depth study about the action of immune responses and their regulations	3	5	5	2	15				
CO1-01BT601.4: Elaborate the various immunodeficiency related diseases and functionality of immune system	2	3	3	2	10				
CO1-01BT601.5: Recognize the various immunization techniques as well as the various vaccinations	5	4	1	0	10				
Total Marks	14	17	12	07	50				
Legend: A-Apply, A- Analyze, E- Evaluate, C- Create									

Suggested learning Resources:

	S.no.	Title	Author	Publisher	Edition & Year
	1	Cellular and Molecular Immunology	Abbas AK, Lichtman AH, Pillai S.	Saunders Publication, Philadelphia	10& 2019
Ī	2	Roitt's Essential Immunology	Delves P, Martin S, Burton D, Roitt IM.	Wiley- Blackwell Scientific Publication, Oxford	13& 2017
	3	Kuby Immunology	Jenni Punt, Sharon Stranford, Patricia Jones	Macmillan · Imprint, WH Allen	8& 2018

Suggested instructions/Implementation strategies:

- Improved lecture
 Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Cement Plant
- 7. Demonstration
- 8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
- 9. Brainstorming

CO, PO and PSO Mapping

Program Title: B. Sc. Biotechnology, 6thSem Course Code: 01BT601 Course Title: Immunology& Immune Technology

			CO/	/PO Ma	pping											
Course Outcome					Р		Program Specific Outcomes (PSOs)									
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1-01BT601.1: Understand the essential of immune system cells to the organism	3	3	2	1	-	1	1	1	2	1	2	2	2	2	3	
CO1-01BT601 .2: Know the fundamentals of immunoglobulins, antigens, and their classifications	3	1	1	2	2	1	1	1	-	2	3	2	2	2	3	
CO1-01BT601 .3: : In-depth study about the action of immune responses and their regulations	3	3	3	1	-	-	2	-	3	1	1	2	3	3	3	
CO1-01BT601 .4: Elaborate the various immunodeficiency related diseases and functionality of immune system	2	3	3	2	2	2	2	1	1	2	-	1	2	2	3	
CO1-01BT601 .5: Recognize the various immunization techniques as well as the various vaccinations	2	2	2	-	1	2	3	2	1	2	1	2	2	1	3	
Legends: CO/PO/PSO Mapping R	lange:	Low,	1; Meo	dium, 2	2; High	1, 3										

Program Title: B. Sc. Biotechnology, 6th Sem Course Code: 01BT601 Course Title: Immunology& Immune Technology

Course Curriculum Map:					
POs & PSOs No.	COs No	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-01BT601 .1: Understand the essential of immune system cells to the organism	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	SL-1,2,3,4,5
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO1-01BT601 .2: Know the fundamentals of immunoglobulins, antigens, and their classifications	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8	2.1, 2.2, 2.3,	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	SL-1,2,3,4
PSO 1,2, 3		SO2.9 SO2.10 SO2.11 SO2.12			
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO1-01BT601 .3: : In-depth study about the action of immune responses and their regulations	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	SL-1,2,3,4
PSO 1,2, 3		SO3.9 SO3.10 SO3.11 SO3.12			
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO1-01BT601 .4: Elaborate the various immunodeficiency related diseases and functionality of immune system	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	4 SL-1,2,3,4
PSO 1,2, 3		SO4.9 SO4.10 SO4.11 SO4.12			
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO1-01BT601 .5: Recognize the various immunization techniques as well as the various vaccinations	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 S05.9 SO5.10	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	5 SL-1,2
PSU 1,2, 3		SO5.11 SO5.12			

Program name	Bachelor of Science (B. Sc.(Hons))- Biotechno	Bachelor of Science (B. Sc.(Hons))- Biotechnology						
Semester	VI th							
Course Code:	05BT601							
Course title:	Animal Biotechnology	Curriculum Developer: Dr. Monika Soni, Assistant Professor						
Pre-requisite:	Students should have basic knowledge of animal biotechnology							
Rationale:	Animal Biotechnology explores genetic manip aims to enhance livestock production, devel encompasses ethical considerations, environme food security, medical breakthroughs, and sus prevention, and biopharmaceutical production technology to address global challenges while	nimal Biotechnology explores genetic manipulation, reproductive technologies, and molecular biology applications in animals. The subject ms to enhance livestock production, develop disease-resistant breeds, and advance medical research through transgenic animals. It noompasses ethical considerations, environmental impact assessment, and regulatory frameworks. This multidisciplinary field contributes to bod security, medical breakthroughs, and sustainable agriculture. The focus is on innovative techniques for genetic enhancement, disease revention, and biopharmaceutical production in animals. As a dynamic field, Animal Biotechnology integrates biology, genetics, and achnology to address global challenges while promoting responsible and sustainable practices in animal science						
Course Outcomes (COs):	 CO1-05BT601.1: To demonstrate the proficiency in animal biotechnology techniques and laboratory managements. CO2-05BT601.2: To demonstrate the competence in animal cell culture techniques and bioprocessing. CO3-05BT601.3: To understand the transgenesis and gene transfer methods in animals. CO4-05BT601.4: To understand the animal propagation techniques and as well as the stem cells technology. CO5-05BT601.5: To understand the genetic modification in medicine, gene therapy, and engineering technology. 							

Scheme of Studies:

					Scheme of	studies (Hou	urs/Week) Total Study Hours(CI+LI+SW+S 7	
Board of StudyCouMajor (DSC)05	Course Code	Course Title	CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)
Major (DSC)	05BT601	Animal Biotechnology	2	2	1	2	7	3+1=4

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note:
 SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcomestication.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					S	cheme of Assessme	nt (Marks)		
					Progressive As	ssessment (PRA)			
Board of StudyCourse CodeCourse CodeMajor (DSC)05BT601 Bio			Class Test				End	Total Marks	
	Board of Study Code C Major (DSC) 05BT601 Bio		Class/Home	2	Seminar one	Class Attendance	Total Marks	Semester	
Board of	Course	Course Title	Assignment	(2 best out)				Assessment	
Study	Code		3 marks each	01 5) 10 marks	(SA)	(AT)	(CA+CT+SA+AT)	(ESA)	(PRA+ESA)
Board of StudyCourse CodeMajor (DSC)05BT601		(CA)	each (CT)						
Major (DSC)	05BT601	Animal Biotechnology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

			Progressive A	ssessment (PRA)			
Course Title	Class/Home Assignment 5 number 7 marks each	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
	(CA)						
Animal	35	5	5	5	50	50	100
	Course Title Animal Biotechnology	Course Title Course Title Course Title Class/Home Assignment 5 number 7 marks each (CA) Animal Biotechnology	Course TitleClass/Home Assignment 5 number 7 marks each (CA)Viva Voce IAnimal Biotechnology355	Course TitleClass/Home Assignment 5 number 7 marks each (CA)Viva Voce IViva Voce IIAnimal Biotechnology3555	Course TitleClass/Home Assignment 5 number 7 marks each (CA)Viva Voce IViva Voce IIClass Attendance (AT)Animal Biotechnology35555	Course TitleClass/Home Assignment 5 number 7 marks each (CA)Viva Voce IViva Voce IIClass Attendance (AT)Total MarksAnimal Biotechnology355550	Course TitleClass/Home Assignment 5 number 7 marks each (CA)Viva Voce IViva Voce IIClass Attendance (AT)Total MarksEnd Semester Assessment (ESA)Animal Biotechnology355555050

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are							
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction							1
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Item	CI	LI	SW	SL	Total	l
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approx. Hours	9	4	1	5	19	

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO1-05BT601.1: To demonstrate the proficiency in animal biotechnology techniques and laboratory managements.	SO1.1 Explain in detail introduction of animal biotechnology and its applications.		CI1.1 Brief detail of introduction of animal biotechnology and its applications.	SL1.1 Search various reference books and other study material to start the learning about animal tissue culture and animal biotechnology.
	SO1.2 Explain the history of animal biotechnology.		CI1.2 Brief detail of history of animal biotechnology.	SL1.2 Explore the historical evolution and recent advancements in animal biotechnology.
	SO1.3 Describe the basic laboratory techniques in animal biotechnology.		CI1.3 Study the basic laboratory techniques in animal biotechnology.	SL1.3 Understand the essential infrastructure and equipment needed for an animal biotechnology laboratory.
	SO1.4 Explain in detail the cell culture media.	LI1.1 To prepare and sterilize the cell culture media.	CI1.4 Study the cell culture media.	SL1.4 Learn about the formulation and sterilization of culture media used in animal cell culture experiments.
	SO1.5 Describe and define the sterilization techniques		CI1.5 Study the sterilization techniques.	
	SO1.6 Explain in detail to primary and secondary cell culture method.	LI1.2 To isolate and culture primary cells from animal tissues.	CI1.6 Brief in detail to primary and secondary cell culture method.	SL1.5 Acquire proficiency in isolating and culturing primary cells from animal tissues.
	SO1.7 Explain in detail the recent advances in animal biotechnology research.		CI1.7 Discuss the recent advances in animal biotechnology research.	
	SO1.8 Describe the ethical considerations in animal biotechnology.		CI1.8 Discuss the ethical considerations in animal biotechnology.	
	SO1.9 Explain in detail the future directions and opportunities in animal biotechnology.		CI1.9 Discuss the future directions and opportunities in animal biotechnology.	

Suggested Sessional Work	SW1.1 Assignments	Describe in detail the history of animal biotechnology.
(SW): anyone	SW1.2 Mini Project	Describe and define the cell culture methods.
SW1.3 Other Activities (Specify)		Explain the process of media preparation and sterilization.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are		1				
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Item	CI	LI	SW	SL	Total
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	А ТТ	0	4	1	~	10
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approx. Hours	9	4	I	5	19

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO2-05BT601.2: To demonstrate the competence in animal cell culture techniques and	SO2.1 Describe and define the cell culture contaminants.	LI2.1 To identify and prevent the common cell culture contaminants.	CI2.1 Brief detail of introduction to cell culture contaminants.	SL2.1 Search various reference books and other study material to start the learning about cell culture.
bioprocessing	SO2.2 Explain in detail the cell cloning and selection methods.		CI2.2 Discuss the cell cloning and selection methods.	
	SO2.3 Describe the transfection and transformation of cells.	LI2.2 To perform a transfection experiment and analyse the efficiency of gene transfer in cultured cells.	CI2.3 Study the transfection and transformation of cells.	SL2.2 Gain proficiency in transfection and transformation methods used to introduce foreign DNA into cultured cells.
	SO2.4 Explain in detail the scaling up of animal cell culture.		CI2.4 Study the scaling up of animal cell culture.	SL2.3 Acquire knowledge of the principles and techniques involved in scaling up animal cell cultures for large-scale production.
	SO2.5 Explain in detail the preservation of animal cells.		CI2.5 Study the preservation of animal cells.	SL2.4 Familiarize yourself with methods for preserving and characterizing animal cells in culture for research and biotechnology applications.
	SO2.6 Explain in detail the characterization of animal cells.		CI2.6 Study the characterization of animal cells.	
	SO2.7 Explain in detail the cytotoxicity assays in cell culture.		CI2.7 Describe the cytotoxicity assays in cell culture.	SL2.5 Develop proficiency in performing cytotoxicity and viability assays to assess the effects of compounds or treatments on cultured cells.
	SO2.8 Explain in detail the viability assays in cell culture.		CI2.8 Describe the viability assays in cell culture.	
	SO2.9 Describe the integration and applications in cell culture.		CI2.9 Discuss the integration and applications in cell culture.	

Suggested Sessional Work (SW):	SW2.1 Assignments	Describe and define the cell cloning and selection methods.		
anyone	SW2.2 Mini Project	Detail study of scaling up of animal cell culture.		
	SW2.3 Other Activities (Specify)	Study one review article on cell cytotoxicity and viability assays.		

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	_	-			~	
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Item	CI	LI	SW	SL	Total
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approx Hours	0	1	1	2	16
	Approx. Hours	2	4	1	4	10

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO3-05BT601.3: To understand the transgenesis and gene transfer methods in animals.	SO3. 1Explain in detail introduction to transgenesis and its applications.		CI3.1 Brief details of introduction to transgenesisand its applications.	SL3.1 Search various reference books and other study material to start the learning abouttransgenesis and gene transfer methods.
	SO3.2 Explain in detail the transgenic animals' model-		CI3.2 Study the transgenic animals' model- mice and cow.	
	SO3.3 Explain in detail the transgenic animals' model- pig and sheep.		CI3.3 Study the transgenic animals' model- pig and sheep.	
	SO3.4 Explain in detail the transgenic animals' model- goat and bird.		CI3.4 Study the transgenic animals' model- goat and bird.	
	SO3.5 Explain in detail the transgenic animals' model- insects.		CI3.5 Study the transgenic animals' model-insects.	
	SO3.6 Explain in detail the embryo transfer techniques.	LI3.1 To practice embryo transfer techniques for the production of transgenic animals.	CI3.6 Brief detail of embryo transfer techniques.	SL3.2 Explore the different methods used to transfer genes into animals and their mechanisms and applications.
	SO3.7 Explain in detail the gene transfer methods in animals-microinjection.	LI3.2 To demonstrate the microinjection technique for introducing foreign DNA into animal embryos.	CI3.7 Study the gene transfer methods in animals- microinjection.	
	SO3.8 Explain in detail the gene transfer methods in animals-embryonic stem cell gene transfer.		CI3.8 Study the gene transfer methods in animals- embryonic stem cell gene transfer.	
	SO3.9 Explain in detail the gene transfer methods in animals-retrovirus mediated gene transfer.		CI3.9 Study the gene transfer methods in animals- retrovirus mediated gene transfer.	

Suggested Sessional Work	SW3.1 Assignments	Describe the transgenesis and its applications.
(SW): anyone	SW3.2 Mini Project	Describe the gene transfer methods in animals.
	SW3.3 Other Activities (Specify)	Explain in detail embryo transfer techniques.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are						
anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction	Itam	CI	тт	CW	CT	Tatal
(LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of	Item	U		S W	SL	Total
Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approx. Hours	9	2	1	4	16

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4-05BT601.4: To understand the animal propagation techniques and as	SO4. 1 Explain in detail fundamentals of animal reproduction.		CI4.1 Brief detailof fundamentals of animal reproduction.	SL4.1 to start the learning about animal propagation and stem cells technology.
well as the stem cells technology	SO4.2 Explain in detail the artificial insemination techniques.		CI4.2 Study the artificial insemination techniques.	SL4.2 To explores the principles and techniques of artificial insemination (AI) in animals.
	SO4.3 Discuss the advantages and challenges of artificial insemination.	LI4.1 To the principles and procedures of artificial insemination in animals.	CI4.3 Discuss the advantages and challenges of artificial insemination.	
	SO4.4 Describe and define the animal cloning.		CI4.4 Study the principle and techniques of animal cloning.	SL4.3 To independently explore the principles and methodologies of animal cloning
	SO4.5 Explain in detail the applications of animal cloning.		CI4.5 Discuss the applications of animal cloning.	
	SO4.6 Describe and define the stem cells technology.		CI4.6 Brief in detail to introduction of stem cells technology.	SL4.4 To explores the principles, methods, and applications of stem cell technology.
	SO4.7 Explain in detail the stem cells culture techniques.		CI4.7 Study the stem cells culture techniques.	
	SO4.8 Explain the applications of stem cells technology.		CI4.8 Discuss the applications of stem cells technology.	
	SO4.9 Discuss the ethical and regulatory considerations in reproductive technologies and stem cell research.		CI4.9 Discuss the ethical and regulatory considerations in reproductive technologies and stem cell research.	

Suggested Sessional Work	SW4.1 Assignments	Describe the animal cloning and its applications.
(SW): anyone	SW4.2 Mini Project	Explain in detail to stem cells technology and their applications.
	SW4.3 Other Activities (Specify)	Write a one review article on artificial insemination in animal cells.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which						
students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI),	T.	OT		CIT	CT.	T ()
Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should	Item	CI	LI	SW	SL	Total
showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes	Approx. Hours	9	1	1	3	14
(COs) upon the course's conclusion.						

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5-05BT601.5: To understand the genetic modification in medicine, gene therapy, and engineering	SO5.1 Explain in detail the introduction to genetic modifications in medicine.		CI5.1 Brief in detail of introduction to genetic modifications in medicine.	SL5.1 Search various reference books and other study material to start the learning about genetic modifications and gene therapy.
technology.	SO5.2 Explain in detail the types of gene therapy.		CI5.2 Study the types of gene therapy.	SL5.2 Explore the various types of gene therapy approaches and their applications in medicine.
	SO5.3 Explain in detail the vectors in gene therapy.	LI5.1 To analyze and compare the characteristics of viral and non-viral vectors used in gene therapy.	CI5.3 Study the vectors in gene therapy.	
	SO5.4 Explain in detail molecular genetic engineering.		CI5.4 Detail explanation of molecular genetic engineering.	SL5.3 Explore the molecular engineering techniques utilized in genetic modification
	SO5.5 Explain in detail human genetic engineering.		CI5.5 Detail explanation of human genetic engineering.	
	SO5.6 Describe and define the gene therapy for genetic disorders.		CI5.6 Study the gene therapy for genetic disorders.	
	SO5.7 Explain in detail the gene therapy for cancer.		CI5.7 Study the gene therapy for cancer.	
	SO5.8 Discuss the ethical issues in genetic modification.		CI5.8 Discuss the ethical issues in genetic modification.	
	SO5.9 Discuss the regulatory frameworks towards genetic modification and gene therapy.		CI5.9 Discuss the regulatory frameworks and future directions towards genetic modification and gene therapy.	

Suggested Sessional Work	SW5.1 Assignments	Explain in detail genetic modifications in medicine.
(SW): anyone	SW5.2 Mini Project	Describe in the detail the gene therapy.
	SW5.3 Other Activities (Specify)	One case research study on gene therapy for genetic disorder.

Course duration (in hours) to attain Course Outcomes:

Course Title: Animal Biotechnology		Course Code: 05B	T601		
Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-05BT601.1 : To demonstrate the proficiency in animal biotechnology techniques and laboratory managements.	9	4	5	1	19
CO2-05BT601.2 : To demonstrate the competence in animal cell culture techniques and bioprocessing.	9	4	5	1	19
CO3-05BT601.3 : To understand the transgenesis and gene transfer methods in animals.	9	4	2	1	16
CO4-05BT601.4 : To understand the animal propagation techniques and as well as the stem cells technology.	9	2	4	1	16
CO5-05BT601.5 : To understand the genetic modification in medicine, gene therapy, and engineering technology.	9	1	3	1	14
Total Hours	45	15	19	05	84

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Animal Biotechnology

Course Code: 05BT601

Legend:R, Remember; U, Understand; A, Apply; A, Analyze

Course Outcomes		Marks Di	Total Marks		
	R	U	Α	Α	
CO1-05BT601.1 : To demonstrate the proficiency in animal biotechnology techniques and laboratory	2	2	3	2	9
managements.					
CO2-05BT601.2 : To demonstrate the competence in animal cell culture techniques and bioprocessing.	2	3	3	2	10
CO3-05BT601.3 : To understand the transgenesis and gene transfer methods in animals.	2	2	3	4	11
CO4-05BT601.4 : To understand the animal propagation techniques and as well as the stem cells	2	2	3	3	10
technology.					
CO5-05BT601.5 : To understand the genetic modification in medicine, gene therapy, and engineering	2	2	2	4	10
technology.					
Total Marks	10	11	14	15	50

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	Ranga M.M., Animal Biotechnology. Agrobios India Limited, 2002.
2.	Ramadass P, Meera Rani S., Text Book of Animal Biotechnology. Akshara Printers, 1997.
3.	R. Ian Freshney, Culture of Animal cells, A Manual of basic technique 4th Edition 2002.
4.	Masters J.R.W., Animal Cell Culture: Practical Approach. Oxford University Press, 2000.
5.	Eapen Cherian, G Nandhini, Anil Kurian., Stem Cells. Jaypee Brothers Medical Publishers (P) Ltd. 2011.

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to animal biotechnology lab and stem cells biology lab
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biotechnology

Semester: VIth Semester

Course Title: Animal Biotechnology

CO/PO/PSO Mapping															
Course Outcome (Cos)		Program Outcomes (POs)										Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
СО1-05ВТ601.1: То	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
demonstrate the proficiency in															
animal biotechnology techniques															
and laboratory managements.															
СО2-05ВТ601.2: То	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
demonstrate the competence in															
animal cell culture techniques															
and bioprocessing.															
CO3-05BT601.3: To understand	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
the transgenesis and gene															
transfer methods in animals.															
CO4-05BT601.4: To understand	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
the animal propagation															
techniques and as well as the															
stem cells technology.															
CO5-05BT601.5: To understand	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2
the genetic modification in															
medicine, gene therapy, and															
engineering technology.															

Course Code: 05BT601

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
PO1,2,3,4,5,6,7,8,9,	CO1-05BT601.1: To demonstrate the	SO1.1 SO1.2	LI 1	1.1,1.2,1.3,1.4,1.5	1SL-1,2,3,4,5
10,11,12	proficiency in animal biotechnology	SO1.3 SO1.4	LI2	1.6,1.7,1.8,1.9	
	techniques and laboratory managements.	SO1.5 SO1.6			
PSO 1,2,3		SO1.7 SO1.8			
		SO1.9			
PO1,2,3,4,5,6,7,8,9,	CO2-05BT601.2: To demonstrate the	SO2.1 SO2.2	LI 1	2.1,2.2,2.3,2.4,2.5,	2SL-1,2,3,4,5
10,11,12	competence in animal cell culture techniques	SO2.3 SO2.4	LI2	2.6,2.7,2.8,2.9	
	and bioprocessing.	SO2.5 SO2.6			
PSO 1,2,3		SO2.7 SO2.8			
		SO2.9			
PO1,2,3,4,5,6,7,8,9,	CO3-05BT601.3: To understand the	SO3.1 SO3.2	LI 1	3.1,3.2,3.3,3.4,3.5,	3SL-1,2
10,11,12	transgenesis and gene transfer methods in	SO3.3 SO3.4	LI 2	3.6,3.7,3.8,3.9	
	animals.	SO3.5 SO3.6			
PSO 1,2,3		SO3.7 SO3.8			
		SO3.9			
PO1,2,3,4,5,6,7,8,9,	CO4-05BT601.4: To understand the animal	SO4.1 SO4.2	LI 1	4.1,4.2,4.3,4.4,4.5,	4SL-1,2,3,4
10,11,12	propagation techniques and as well as the	SO4.3 SO4.4		4.6,4.7,4.8,4.9	
	stem cells technology.	SO4.5 SO4.6			
PSO 1,2,3		SO4.7 SO4.8			
		SO4.9			
PO1,2,3,4,5,6,7,8,9,	CO5-05BT601.5: To understand the genetic	SO5.1 SO5.2	LI 1	5.1,5.2,5.3,5.4,5.5,	5SL-1,2,3
10,11,12	modification in medicine, gene therapy, and	SO5.3 SO5.4		5.6,5.7,5.8,5.9	
	engineering technology.	SO5.5 SO5.6			
PSO 1,2,3		SO5.7 SO5.8			
		SO5.9			

Program Name	Bachelor of Science (Hons.) in Biotechnology	Bachelor of Science (Hons.) in Biotechnology (B.Sc. (Hons.) BT)						
Semester	VI	VI						
CourseCode:	05BT602							
Coursetitle:	Agriculture Biotechnology	Curriculum Developer: Chahana Desai, Teaching Associate						
Pre-requisite:	Students should have basic knowledge and understanding about traditional agricultural practices and concept of genetic engineering.							
Rationale:	 The objectives of the Agricultural Bioto applications of biotechnology in the fie The course aims to equip students with enhancing crop productivity, improving Additionally, the course seeks to foster and societal implications associated with 	ech course are to provide students with a comprehensive understanding of the principles and ld of agriculture. the knowledge and skills necessary to utilize biotechnological tools and techniques for g plant genetics, and developing sustainable agricultural practices. critical thinking and ethical awareness among students regarding the potential benefits, risks, th agricultural biotechnology.						
CourseOutcomes (COs):	CO1-05BT602.1: Elucidate the overview of Bi CO1-05BT602.2- Acquire knowledge regardi CO1-05BT602.3- Applied knowledge about tra CO1-05BT602.4- To gain the knowledge abou CO1-05BT602.5- Elucidate the characteristics	otechnology in agriculture. ng transgenesis and genetic engineering ansgenesis and transgenic technology. t biopesticides and different types of biofertilizers with its importance and characteristics. and anatomy of mushrooms.						

Scheme of Studies:

Board of Study	Course Code	CourseTitle	Cl LI SW SL Hours		Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)		
Major (DSC)	05BT602	Agriculture Biotechnology	3	2	1	2	8	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

				Scheme of Assessment (Marks)						
					Progressive Ass	essment (PRA)				
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
Major (DSC)	05BT602	Agriculture Biotechnology	15	20	10	5	50	50	100	

Scheme of Assessment: Practical

			Progressive Assessment (PRA)						
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major (DSC)	05BT602-L	Agriculture Biotechnology	35	5	5	5	50	50	100

This course syllabus illustrates the expected learning achievements, both at the	ApproximateHours						
course and session levels, which students are anticipated to accomplish through	E.	- .	01	* *	CIT	CT.	m 1
various modes of instruction including Classroom Instruction (CI). Laboratory		Item	CI	LI	SW	SL	Total
Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course		Approx.Hrs	09	04	01	02	16
progresses, students should showcase their mastery of Session Outcomes (SOs),							
culminating in the overall achievement of Course Outcomes (COs) upon the							
course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT602.1	SO1.1 Explain the concept of	LI1.1	Unit-1-Introduction to	SL1.1 Find out some
Elucidate theoverview of	agriculture biotechnology	Preparation of artificial	agriculture biotechnology	examples of
Biotechnology in agriculture.		seeds.	CI1.1 Introduction to	Germplasm conservation.
			Agricultural biotechnology,	-
	SO1.2 Determine thebasics of	LI1.1Isolation of	CI1.2 Historical perspective,	SL1.2 Detailing about major
	historical perspective,	Azotobactor		crop plants.
	SO1.3 Determine benefits &		CI1.3 Benefits and	
	applications of biotech. in		Applications,	
	agriculture.			
	SO1.4 Elaborate the risks		CI1.4 Risk Associated with	
	associated with agriculture		Agriculture Biotechnology	
	biotechnology.			
	SO1.5 Elucidate the major		CI1.5 Major crop plants and	
	crop plants and their		their improvement	
	improvement strategies.			
	SO1.6 Elaborate the plant		CI1.6 Plant Breeding	
	breeding methods		methods.	
	SO1.7 Explanation about the		CI1.7 Molecular Breeding	
	concept of molecular breeding			
	SO1.8 To learn about the		CI1.8 Germplasm	
	concept, methods and		Conservation	
	importance of germplasm			
	conservation			
	SO1.9 Explanation about the		CI1.9 Seed bank	
	concept and applications of			
	seed bank			

Suggested Sessional	SW1.1 Assignments	Describe various risks associated with agriculture biotechnology.				
Work (SW):anyone	SW1.2Mini Project	Elaborate various types of major crop plant improvements techniques.				
	SW1.3 Other Activities (Specify)	Make a power point presentation on plant breeding methods.				
This course syllabus illustrates the expected learning achievements, both at the course and session levels,	ApproximateHours					
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which students are anticipated to accomplish through various modes of instruction including Classroom						
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the	Item	Cl	LI	SW	SL	Total
course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in	Approx. Hrs	09	04	01	03	17
the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT602.2	SO2.1 Explain the	LI2.1	Unit-2 Genetic	SL2.1
Acquire knowledgeregarding	introduction of genetic	Isolation of plant genomic	Engineering in Crop	Note down the structure of
transconosis and constin	engineering in crop plants.	DNA (Pea shoot tip –	Plants:	DNA
transgenesis and genetic		CTAB,)	CI2.1 Genetic Engineering	
engineering			in Crop Plants: Introduction,	
	SO2.2 Elucidate the	LI2.1	CI2.2 Agro bacterium, Ti	SL2.2 Read the latest
	structure and functions of	Isolation of plant genomic	and Ri Plasmid,	research on genetic
	agrobacterium, Ti and Ri	DNA (Cauliflower –SDS)		engineering.
	plasmid.			
	SO2.3 Elaborate the		CI2.3 structure of T-DNA, Vir	SL2.3 Write down few
	structure of T-DNA and		gene	points on recombinant DNA
	functions of Vir genes.			technology
	SO2.4 Elucidate mechanism		CI2.4 Mechanism of T-	
	of T-DNA transfer		DNA Transfer,	
	SO2.5 Explanation about		CI2.5 Ti plasmid derived	
	the Ti plasmid derived		vector systems	
	vector systems			
	SO2.6 To learn about the		CI2.6 Physical methods of	
	various physical methods of		transferring genes to plants -	
	transferring genes to plants-		Microprojectile bombardment,	
	SO2.7 Explanation about		CI2.7 Electroporation,	
	the mechanism and function			
	of electroporation method.			
	SO2.8 Elucidate the various		CI2.8 Plant Viral vectors	
	plant viral vectors			
	SO2.8 Elucidate		CI2.9 Recombinant	
	recombinant selection		selection.	

Suggested Sessional	SW2.1 Assignments	Describe the mechanism of T-DNA transfer.
Work (SW):anyone	SW2.2Mini Project	Structure of T-DNA, Ti plasmid and Ri plasmid.
	SW2.3 Other Activities (Specify)	Make Power point presentation on physical methods of gene transfer,

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	App	roximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	09	04	01	03	17
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT602.3	SO3.1 Elucidate the various	LI3.1Isolation of	Unit-3 Application of	SL3.1
Applied knowledge about	applications of transgenic	Rhyzobium	Transgenic Technology:	Find out the impact of
transgenesis and transgenic	technology		CI3.1 Applications of	herbicides on plants
technology.			Transgenic Technology	
	SO3.2 Explain about the	LI3.2Demonstration of	CI3.2development of	SL3.2 Read the process of
	development of herbicide	Biofertilizers Production	herbicide tolerance,	manufacturing of golden
	tolerance mechanism.			rice.
	SO3.3 Elaborate the		CI3.3insect/pest resistance-	SL3.3 Read about the edible
	mechanism of insect/pest		bt-cotton, disease resistance,	vaccines experiemnts.
	resistance			
	SO3.4 Elaborate mechanism		CI3.4 drought resistance	
	of drought resistance.			
	SO3.5 Explane production		CI3.5Production of	
	and importance of golden		therapeutic molecule in	
	rice		plants- Golden Rice,	
	SO3.6 Elucidate mechanism		CI3.6 Ediblevaccines,	
	of edible vaccines production			
	SO3.7 Explane about how		CI3.7 Improvement in seed	
	the seed quality improved		quality-	
	with different strategies.			
	SO3.8 Elaborate mechanism,		CI3.8 Delaying fruit	
	of delaying fruit ripening		ripening,	
	SO3.8 Elaborate Flavr Savr		CI3.9 Flavr Savr Tomato.	
	Tomato.			

Suggested Sessional	SW3.1 Assignments	Flow chart on production of golden rice.
Work (SW): anyone	SW3.2 Mini Project	Describe the importance of transgenesis.
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on delaying fruit ripening.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	ApproximateHours					
which students are anticipated to accomplish through various modes of instruction including Classroom	Itom	Cl	ΤT	SW	SI	Total
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course	Item	CI		5 W	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the	Approx.Hrs	09	02	01	02	14
overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT602.4 To gain the	SO4.1 Elucidate about the	LI4.1 Isolation of phosphate	Unit-4Biopesticides used in	SL4.1
knowledge about biopesticides and	fungal and bacterial pesticides.	solubilizing microorganisms	Agriculture	List down the impacts of
different types of biofertilizers with		from soil sample.	CI4.1 bacterial, fungal	chemical pesticides.
its importance and characteristics.			pesticides.	
	SO4.2 Elaborate about the		CI4.2 Integrated pest	SL4.2 Read the role of
	integrated pest management.		management,	integrated pest management
	SO4.3 Explanation different		CI4.3 Biofertilizers in	
	types of biofertilizers		agriculture	
	SO4.4 Explanation rhizobium,		CI4.4 rhizobium, azatobactor,	
	azatobactor, mycorrhiza		mycorrhiza	
	SO4.5 To learn method, types		CI4.5 Vermicomposting	
	& vermicomposting			
	SO4.6 Explanation mechanism		CI4.6 Microbial agents for	
	of Microbial agents for control		control of Plant diseases,.	
	of Plant diseases.			
	SO4.7 Elucidate the mode of		CI4.7 Plant diseases-mode of	
	infection of different types of		infection,	
	plant diseases.			
	SO4.8 Explanation about the		CI4.8 dispersal of plant	
	dispersal of plant pathogen		pathogens	
	SO4.9 Elaborate about the		CI4.9 Control of plant	
	control of pathogen		pathogen	

Suggested Sessional	SW4.1 Assignments	Determine the various applications and importance of biopesticides
Work (SW): anyone	SW4.2 Mini Project	Explain mode of infection of plant pathogens.
	SW4.3 Other Activities (Specify)	Make a Power point presentation on vermicomposting technology.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,
which students are anticipated to accomplish through various modes of instruction including Classroom
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall
achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	01	01	02	13

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT602 5	SO5 1		Unit_5 Mushroom Production	SI 5 1 Basic knowledge
Elucidate the characteristics and	Flucidate the structure and	LIJ.I Testing of antagonism	CI5 Untroduction Anatomy	shout requirement of
anatomy of mushrooms	function of adible and	resting of antagonism.	edible and poisonous	microbiology laboratory
anatomy of musifoonis.	poisonous mushrooms		mushrooms	incrobiology laboratory.
	SO5 2 Elaborata madicinal		CI5 2 modicinal value	SI 5.2 Importance of
	soluce of mushrooms		CI5.2 medicinal value,	SL3.2 Importance of
	values of filustitooffis		CIE 2 Life analogf aultimated	musmooms m various neids.
	SUS.5 Describe file cycle of		CI5.5 Life cycleof cultivated	
	cultivated mushrooms.		mushrooms,	
	SO5.4 Elucidate the		CI5.4 maintenance of pure	
	maintenance of pure culture,		culture, Preparation of substrate	
	Preparation of substrate for		for mushroom cultivation,	
	mushroom cultivation.			
	SO5.5 Explanation about		CI5.5 preparation of spawn.	
	the preparation of spawn.			
	SO5.6 Elaborate Cultivation		CI5.6 Cultivation technology of	
	technology of Agaricus		Agaricus bisporus	
	bisporus,			
	SO5.7 aborate Cultivation		CI5.7 Cultivation technology of	
	technology of <i>Pleurotus sp.</i> ,		Pleurotus sp.,	
	SO5.8 Elucidate the post		CI5.8 post-harvest processing	
	harvest processing			
	har too processing			
	SO5.9 Elucidate the value		CI5.9 value addition	
	addition			

Suggested Sessional	SW5.1 Assignments	Life cycle of cultivated mushrooms
Work (SW): anyone	SW5.2 Mini Project	Explanation about required instruments and glassware for mushroom cultivation.
	SW5.3 Other Activities (Specify)	Prepare power point presentation on procedure for mushroom cultivation.

Course duration (in hours) to attain Course Outcomes:

a

Course Title: Agriculture Biotechn	Course Code:05BT602				
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-05BT602.1 Elucidate theoverview of biotechnology	9	4	1	2	16
in agriculture.					
CO1-05BT602.2Acquire knowledge regarding	9	4	1	3	17
transgenesis and genetic engineering.					
CO1-05BT602.3 Applied knowledge about transgenesis and transgenic technology.	9	4	1	3	17
CO1-05BT602.4 To gain the knowledge about biopesticides and different types of biofertilizers with its importance and characteristics.	9	2	1	2	14
CO1-05BT602.5Elucidate the characteristics and anatomy	9	1	1	2	13
of mushrooms.					
Total Hours	45	15	05	12	77

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Agriculture biotechnology

Course Code:05BT602

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-05BT602.1 Elucidate theoverview of biotechnology in agriculture.	2	1	1	1	5
CO1-05BT602.2 Acquire knowledge regarding transgenesis and genetic engineering.	2	4	5	1	12
CO1-05BT602.3 Applied knowledge about transgenesis and transgenic technology.	3	5	5	1	14
CO1-05BT602.4 To gain the knowledge about biopesticides and different types of biofertilizers with its importance and characteristics.	2	3	5	1	11
CO1-05BT602.5Elucidate the characteristics and anatomy of mushrooms.	2	4	1	1	10
Total Marks	11	17	17	05	50

Legend:A, Apply; An, Analyze; E, Evaluate; C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Biotechnology fundamental and application (4th edition) - S.S.Purohit.
2	Plant Biotechnology – B.D.Singh
3	Plants, Genes and agriculture by Maartein, J.Christpeels, David E.Sdava.
4	Crop Biotechnology by P.R.Yadav, Rajiv Tyagi.
5	Plant Biotechnology by Chawla. Gendel,

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Group Discussion
- 4. Role play
- 5. Demonstration
- 6. ICT Based teaching Learning
- 7. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) biotechnology Semester: VI Semester Course Title: Agriculture Biotechnology. Course Code: 05BT602

CO/PO Mapping															
Course Outcome		Program Outcomes (POs)			Program Specific Outcomes (PSOs)										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-05BT602.1 Elucidate the overview of biotechnology in agriculture	-	-	-	1	2	2	2	-	1	2	2	3	3	2	1
CO1-05BT602.2 Acquire knowledge regarding transgenesis and genetic engineering	-	-	-	-	-	-	3	-	2	2	3	3	2	1	2
CO1-05BT602.3 Applied knowledge about transgenesis and transgenic technology.	-	1	1	1	-	-	2	-	3	1	1	2	1	2	1
CO1-05BT602.4 To gain the knowledge about biopesticides and different types of biofertilizers with its importance and characteristics	-	1	1	-	2	2	2	3	-	1	-	-	2	2	3
CO1-05BT602.5 Elucidate the characteristics and anatomy of mushrooms.	1	1	1	-	-	2	3	3	1	2	2	2	2	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	Cos	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-05BT602.1- Elucidate theoverview of biotechnology in agriculture.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	LI 1 LI 2	1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8, 1.9	1SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-05BT602.2- Acquire knowledge regarding transgenesis and genetic engineering	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	LI 1 LI 2	2.1, 2.2, 2.3,2.4,2.5,2.6,2.7,2.8, 2.9	2SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-05BT602.3- Applied knowledge about transgenesis and transgenic technology.	SO3.1 SO3.2 SO3.3 SO3.4SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	LI 1 LI 2	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-05BT602.4- To gain the knowledge about biopesticides and different types of biofertilizers with its importance and characteristics.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	LI 1	4.1,4.2,4.3,4.4, 4.5, 4.6,4.6,4.7,4.8, 4.9	4SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO1-05BT602.5- Elucidate the characteristics and anatomy of mushrooms.	SO5.1 SO5.2 SO5.3 SO5.4SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI 1	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8, 5.9	5SL-1,2

Program Name	B.Sc. (Hons.) in Biotechnology						
Semester	VI	٧I					
Course Code:	05BT603 &05BT603-L						
Course title:	Nano Biotechnology	Nano Biotechnology Curriculum Developer: Arpit Srivastava, Assistant Professor					
Pre-requisite:	Students should have basic knowledge of Physic	ical & Biological Science					
Rationale:	Nano Biotechnology is a rather young discipli within the last years that universities at all Predictions say that NT will change our lives will provide an overview over NT. It will show effects can be active thus leading to unique pro- course by making reference to chemistry, phys- already in use today or as they are planned for the	Nano Biotechnology is a rather young discipline, which came up in the nineties. Nevertheless, Nanotech has gained so much importance within the last years that universities at all rankings have introduced or are going to introduce Nanotechnology teaching programs. Predictions say that NT will change our lives and society more than computer technology and electricity have done together. The course will provide an overview over NT. It will show that the nano regime is so different from other regimes because both classical and quantum effects can be active thus leading to unique properties of nano devices. It is a highly interdisciplinary science, which will be reflected in the course by making reference to chemistry, physics, biology, pharmacy, and nano-engineering. Applications of Nanotechnology, as they are already in use today or as they are planned for the future, will be discussed.					
Course Outcomes (COs):	CO1-05BT603.1. Explain fundamentals of Nat CO2-05BT603.2. Define the role of biotechnol CO3-05BT603.3. Comprehend the working me CO4-05BT603.4. Interpretate the mechanism of CO5-05BT603.5. Examine the mechanism of r	CO1-05BT603.1. Explain fundamentals of Nanotechnology CO2-05BT603.2. Define the role of biotechnology in nanoscience CO3-05BT603.3. Comprehend the working mechanism of nanoparticles in cancer treatment CO4-05BT603.4. Interpretate the mechanism of drug delivery and designing CO5-05BT603.5. Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.					

Scheme of Studies:

					Total Credits(C)			
Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	(L:T:P=3:0:1)
Major (DSC)	05BT603	Nano Biotechnology	3	2	1	5	11	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major (DSC)	05BT603	Nano Biotechnology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major (DSC)	05BT603-L	Nano Biotechnology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, **Approximate Hours** which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the Item Cl SW SL Total LI Approx. Hrs 09 04 01 05 19 course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)05BT603-L	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT603.1	SO1.1 Summarize concept	LI1.1 Basic instruments	Unit-1 Fundamental	SL1.1 Nanoscale
Explain fundamentals of	of Nanotechnology	used in nanotechnology	Concepts	comparison
Nanotechnology			CI1.1 Concept of	_
			Nanoscience, introduction to	
			Nanotechnology	
	SO1.2 Define Basic	LI1.2 To observe the	CI1.2 Nanomechanics-	SL1.2 Other Nanodevices
	terminology, scope and	working of different kinds of	Nanotribology	around you
	application	microscope	Scanning probe microscopy	
	SO1.3 Provide use of	*	CI1.3 Nanomaterials and its	SL1.3 Use of nanoscience in
	nanotechnology		handling	biology
			6	
	SO1.4 Overviewing of		CI1.4 Nanofuture, nano-	SL1.4 Nanotechnology
	various tools of		fying Electronics	natural occurrence.
	nanotechnology			
	SO1.5 Overviewing nano		CI1.5 Nanofibres, nanopore	SL1.5 Use of different nano
	assisted techniques		and nanotubes	assisted devices
	SO1.6 Explain the term		CI1.6 Nanopores and its	
	Nanopores		application	
	SO1.7 Define CNTs and		CI1.7 Carbon Nanotubes	
	types			
	SO1.8 Elaborate the concept		CI1.8 Nanobots	
	of Nanobots			
	SO1.9 Elaborate application		CI1.9 its application	
	of Nanobots			

Suggested Sessional	SW1.1 Assignments	Describe in detail about the Nanoparticles
Work (SW):anyone	SW1.2Mini Project	Draw a well labelled diagram of a microscope
	SW1.3 Other Activities (Specify)	Write an article on "Latest research in the field of Nanotechnology"

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which	h Approximate Hours						
students are anticipated to accomplish through various modes of instruction including Classroom Instruction							
(CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course progresses		Item	Cl	LI	SW	SL	Total
students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of		Approx. Hrs	09	04	01	03	17
Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)05BT603-L	Class room Instruction (CI)	Self-Learning (SL)
CO2-05BT603.2	SO2.1 Expalin Concept of	LI2.1 Working of a	CI2.1 Introduction to	SL2.1 List down the
Define the role of biotechnology	nanomaterials	microscope	Nanoscience	nanoparticle which is present
in nanoscience		_	Techniques used in	around you
			Nanobiotechnology	
	SO2.2 Relate the concept of how	LI2.2 Study of Electron	CI2.2 Optical	SL2.2 Find some literature
	nanomaterials been categorized.	Microscope database	Microscopy	on Atomic Force
		(EMD)		Microscopy
	SO2.3 Outline difference between		CI2.3 MALDI-TOF,	SL2.3 List down the various
	silver and gold nanoparticles		Production of	kinds of nano-fertilizers used
			nanoparticles.	in India
	SO2.4 Analyzing the working of		CI2.4 Nanoparticles	
	Electron microscope and Atomic		agglomeration and	
	Force Microscopy		applications	
	SO2.5 Describe the		CI2.5 Nano-aerogels	
	physicochemical properties and			
	working of nano-aerogels			
	SO2.6 Explain technical aspects		CI2.6 Nano fertilizers	
	of nano fertilization			
	SO2.7 Demonstrate the working		CI2.7 Atomic	
	of AF microscope		ForceMicroscopy	
	SO2.8 Demonstrate the working		CI2.8 SEM	
	of SEM		Microscopy	
	SO2.9 Demonstrate the working		CI2.9 TEM	
	of TEM		Microscopy	

Suggested Sessional	SW2.1 Assignments	Make a table to distinguish different nanoparticles with their biological applications
Work (SW):anyone	SW2.2Mini Project	Write down the protocol for the production of Nanoparticle in laboratory
	SW2.3 Other Activities (Specify)	Attain at least one seminar or online talk on Nanotechnology and its applications

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Appro	oximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	09	04	01	05	19
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)05BT603-L	Class room Instruction (CI)	Self-Learning (SL)
CO3-05BT603.3	SO3.1 Explain the role of	LI3.1 To retrieve the	Unit-3	SL3.1 Explore the research of
Comprehend the working	Nanotechnology in cancer	oncological based data	CI3.1 Cancer and current	Nano-oncology
mechanism of nanoparticles in		from Cancer Genome	approach to its cure through	
Cancer treatment		Atlas	nanoparticles (CDDS, Cancer	
			Drug Delivery System)	
	SO3.2 Learn the concept of	LI3.2 Bioformulation of	CI3.2 Characteristics of	SL3.2 Learn novel nano-tools
	cancer drug delivery	microbial consortia	tumor tissues	used in drug delivery
	SO3.3		CI3.3 Physio-chemical	SL3.3 Find out new nano-
	Define the working of anti-		properties of nanoparticles in	materials with biocompatibility
	cancerous drugs		cancer therapy	
	SO3.4		CI3.4 Site specific delivery	SL3.4 Learn the basic
	Elaborate the working of		of therapeutic drugs	mechanism of tumor formation
	nanomaterial as carrier molecule			
	SO3.5		CI3.5 Technique to deliver	SL3.5 Find out the disadvantages
	Analyse the role of nanomaterial		chemotherapeutic agents	associated with chemotherapy
	in site specific drug delivery		using nanoparticles	
	SO3.6 Explain Drug delivery to		CI3.6 Drug delivery to	
	tumor		tumor	
	SO3.7 Define chemotherapy		CI3.7 Chemotherapy	
	SO3.8 Explain aspects of nano-		CI3.8 Nano-Radiotherapy	
	radiotherapy			
	SO3.9 Explain aspects of nano-		CI3.9 its application	
	radiotherapy			

Suggested Sessional	SW3.1 Assignments	Make a table to distinguish different nanoparticles with their biological applications
Work (SW):anyone	SW3.2Mini Project	Write down the protocol for the production of Nanoparticle in laboratory
	SW3.3 Other Activities (Specify)	Attain at least one seminar or online talk on Nanotechnology and its applications

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	, Approximate Hours						
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course	Ite	m	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall	Ap	prox. Hrs	09	02	01	05	17
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)05BT603-L	Class room Instruction (CI)	Self-Learning (SL)
CO4-05BT603.4	SO4.1	LI4.1	Unit-4	SL4.1
Interpretate the mechanism of	Observing the role of Viral	To retrieve the oncological	CI4.1 Non-viral Gene	Read the novel papers
drug delivery and nanoparticle-	and Non-viral gene therapy	based data from Cancer	Therapy with nanoparticles:	relevant to non-viral gene
based designing		Genome Atlas	Introduction	therapy
	SO4.2 Comprehend the		CI4.2 Hyperthermia	SL4.2 Find out the
	working of novel non-viral			microorganism becoming
	gene therapy			lethal due to MDR conditions
	SO4.3 Analyze the working		CI4.3 Nanoparticles to	SL4.3 Find out new
	of anti-cancerous drugs		circumvent MDR	nanomaterials with
				biocompatibility
	SO4.4 Recognize the various		CI4.4 Potential problems	SL4.4 Discover out
	applications of		using nanoparticles	disadvantages associated
	nanotechnology in other fields			with nanoparticles
	SO4.5 Discover the applications		CI4.5 Application of	SL4.5 Explore common
	of Nanotechnology in		Nanotechnology in	application of
	Agriculture		Agriculture	nanotechnology in given
				fields
	SO4.6 Explain the role of		CI4.6 Application of	
	nanotech in biomedical		Nanotechnology in	
	science		Biomedical science	
	SO4.7 Determine the role of		CI4.7Application of	
	nanotech in biotechnology		Nanotechnology in	
			Biotechnology	
	SO4.8 Interpret the role of		CI4.8 Controlled delivery of	
	controlled delivery of		chemotherapeutic drugs	
	chemo- drugs			
	SO4.9 Interpret application		CI4.9 its application	
	of controlled delivery of			
	chemo- drugs			

Suggested Sessional	SW4.1 Assignments	Write an article on "Role of Nanoparticles in Non-Viral Gene Therapy"
Work (SW):anyone	SW4.2Mini Project	List down the conditions of MDR, XDR and TDR in microbes
	SW4.3 Other Activities (Specify)	Make a presentation on Non-Viral Gene therapy techniques

This course syllabus illustrates the expected learning achievements, both at the course and session levels,					
which students are anticipated to accomplish through various modes of instruction including Classroom					
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course					
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall					
achievement of Course Outcomes (COs) upon the course's conclusion.					

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	01	01	05	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)05BT603-L	Class room Instruction (CI)	Self-Learning (SL)
CO5-05BT603.5 To Examine	SO5.1 Identify different	LI5.1 To retrieve the	CI5.1 Introduction to	SL5.1 Find out the role of
the mechanism of nano-sensors	classes of biosensors and	oncological based data from	Biosensors, types and	Biosensors
& demonstrate the significance	describe their functioning	Cancer Genome Atlas	working of biosensors	
of biosensors in industries.	principles			
	SO5.2 Recognize		CI5.2 Importance of	SL5.2 Explore the various
	limitations of biosensors in		biosensors, parts of	kinds of biosensors
	real-life applications		biosensors and its function	
	SO5.3 Analyze the principles		CI5.3 Membrane Biosensors	SL5.3 Read research on
	and concepts of transducers		Based on Ion Channel	advancement in biosensors
	and their application in		Gating	
	biosensor design			
	SO5.4 Define the		CI5.4 Nanofabrication,	SL5.4 Observe the natural
	fundamentals of diagnostic		medicine-Potential	biosensors around us
	devices and biomarker		Biomedical Applications	
	testing in biological fluids			
	SO5.5 Discover the		CI5.5 Applications of	SL5.5 Find out the meaning
	Applications of Polymer		Polymer Nanostructures	of Biomimicry
	Nanostructures			
	SO5.6 Explain nanosensors		CI5.6 Types of Nanosensors	
	in detail			
	SO5.7 Derive LAB-On-A-		CI5.7 LAB-On-A-CHIP	
	CHIP			
	SO5.8 Determine Channel		CI5.8 Channel Gating	
	Gating Biomimetic		Biomimetic Membranes	
	Membranes			
	SO5.9 Applications of		CI5.9 its Application	
	Channel Gating Biomimetic			
	Membranes			

Suggested Sessional	SW5.1 Assignments	Write an article on "Role of Biosensors and its mechanism"			
Work (SW):anyone	SW5.2Mini Project	List down the principles of biosensors and Nanosensors			
-	SW5.3 Other Activities (Specify)	Make a presentation on Lab-On-A-Chip technique with applications			

Course duration (in hours) to attain Course Outcomes:

Course Title: Nano Biotechnology

Course Code:05BT603

	- 61								
Course Outcomes(COs)	Class lecture	Laboratory	Sessional work	Self-Learning	Total Hours				
	(CI)	Instruction(LI)	(SW)	(SL)	(Li+CI+SW+SL)				
CO1-05BT603.1: Explain fundamentals of	9	4	1	5	19				
Nanotechnology									
CO2-05BT603.2: Define the role of biotechnology in	9	4	1	3	17				
nanoscience									
CO3-05BT6033: To Comprehend the working mechanism	9	4	1	5	19				
of nanoparticles in Cancer treatment									
CO4-05BT603.4: Interpretate the mechanism of drug	9	2	1	5	17				
delivery and nanoparticle-based designing									
CO4-05BT603.5: To Examine the mechanism of nano-	9	1	1	5	16				
sensors & demonstrate the significance of biosensors in									
industries.									
Total Hours	45	15	05	23	88				

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Nano Biotechnology

Course Code:05BT603

Comme Octomore		T-4-1 M			
Course Outcomes	Α	An	Ε	С	I otal Marks
CO1-05BT603.1: Explain fundamentals of Nanotechnology	2	1	1	1	5
CO2-05BT603.2: Define the role of biotechnology in nanoscience	3	4	2	1	10
CO3-05BT6033: To Comprehend the working mechanism of nanoparticles in Cancer treatment	4	5	5	1	15
CO4-05BT603.4: Interpretate the mechanism of drug delivery and nanoparticle-based designing	3	4	3	0	10
CO4-05BT603.5: To Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.	5	4	1	0	10
Total Marks	17	18	12	03	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

Books:

S. No.	Title/Author/Publisher details
1	Bharat Bhushan., Nanotribology and Nanomechanics - An introduction, Springer.
2	Mark, Ratner Daniel Ratner, Nanobiotechnology- next big idea.
3	Challa S.S.R.Kumar, Joseph Hornes, Carola Leuschner, Nanofabrication towards Biomedical applications.
4	Pharmaceutical Nanobiotechnology for Targeted Therapy, Hamed Barabadi, Ebrahim Mostafavi, Muthupandian Saravanan, Springer 2022
5	Charles P. Poole, Jr., Frank J. Owens; "Introduction to Nanotechnology", John Wiley& Sons, 2003,
6	Biotechnology – Questioning The Reasons, Ed 1 & 2, Book Rivers Publication, India, 2022

(a) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Demonstration
- 7. ICT Based teaching Learning
- 8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Biotechnology Semester: VI Semester Course Title: Nano Biotechnology Course Code: 05BT603

CO/PO Mapping															
Course Outcome		Program Outcomes (POs)									Program Specific Outcomes (PSOs)				
COs	PO1	01 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12							PSO1	PSO2	PSO3				
CO1-05BT603.1: Explain fundamentals of Nanotechnology	-	-	-	1	2	2	2	-	1	2	2	3	3	3	1
CO2-05BT603.2: Define the role of biotechnology in nanoscience	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
CO3-05BT6033: To Comprehend the working mechanism of nanoparticles in Cancer treatment	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
CO4-05BT603.4: Interpretate the mechanism of drug delivery and nanoparticle-based designing	-	1	1	-	2	2	2	3	-	1	-	-	1	2	2
CO4-05BT603.5: To Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.	1	1	1	-	-	2	3	3	1	2	2	2	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO1-05BT603.1: Explain fundamentals of Nanotechnology	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8	LI 1 LI 2	1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8, 1.9	1SL-1,2,3,4,5
PSO 1,2, 3 PO 1,2,3,4,5,6 7 8 9 10 11 12	CO2-05BT603.2: Define the role of biotechnology in nanoscience	SO1.9 SO2.1 SO2.2 SO2.3 SO2.4	LI 1 LI 2	2.1, 2.2, 2.3,2.4,2.5,2.6,2.7,2.8, 2.9	
PSO 1,2, 3		SO2.5 SO2.6 SO2.7 SO2.8 SO2.9			2SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO3-05BT6033: To Comprehend the working mechanism of nanoparticles in Cancer treatment	SO3.1 SO3.2 SO3.3 SO3.4SO3.5	LI 1 LI 2	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2,3,4,5
PSO 1,2, 3		SO3.6 SO3.7 SO3.8 SO3.9			
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO4-05BT603.4: Interpretate the mechanism of drug delivery and nanoparticle-based designing	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	LI 1	4.1,4.2,4.3,4.4, 4.5, 4.6,4.6,4.7,4.8, 4.9	4SL-1,2,3,4,5
PSO 1,2, 3		SO4.7 SO4.8 SO4.9			
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	CO4-05BT603.5: To Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.	SO5.1 SO5.2 SO5.3 SO5.4SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI 1	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8, 5.9	5SL-1,2,3,4,5

Program Name	B.Sc. Biotechnology						
Semester	VI						
Course Code:	05BT604						
Course title:	BIOSTATISTICS Curriculum Developer: Dr. Keerti Samdariya, Assistant Professor						
Pre-requisite:	Student should have basic knowledge of biostatistics, their role, and their application in the biological field.						
Rationale:	The paper on BIOSTATISTICS in a B.Sc. I systems.Biostatistics pertains to the acquisition mathematical hypotheses, biological models, a useful study outcomes.	The paper on BIOSTATISTICS in a B.Sc. Biotechnology program explores the role of biostatistics and their activity in biological systems. Biostatistics pertains to the acquisition and interpretation of quantitative information in medical research. Finding the correct mathematical hypotheses, biological models, and statistical tests is essential for adequate study designs as a mandatory prerequisite for useful study outcomes					
Course Outcomes (COs):	CO1-05BT604.1: Describe the roles biostatistic CO2-05BT604.2: Apply basic statistical concer CO3-05BT604.3: Demonstrate basic analytical CO4-05BT604.4: Interpret results of commonl CO5-05BT604.5: Demonstrate statistical reaso	cs serves in the discipline of public health. pts commonly used in public health and Health Sciences techniques to generate results y used statistical analyses in written summaries ning skills accurately and contextually					

Scheme of Studies:

Board of Study	Course Code	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)
Major (DSC)	05BT604	Biostatistics	3	2	1	2	8	3+1=4

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

 Note:
 SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major (DSC)	05BT604	Biostatistics	15	20	10	5	50	50	100

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)					
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major (DSC)	05BT604-L	Biostatistics	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	02	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-05BT604.1 Describe the	SO 1.1 Explain the concept of	LI 1.1 Calculate and form a	CI 1.1 Biostatistics-	SL1.1
roles biostatistics serves in the	Biostatistics	frequency distribution	Definitions, Historical Resume	Understand the role of
discipline of public health.				biostatistics
	SO 1.2 Illustrate application	LI 1.2	CI 1.2 Biostatistics-	SL1.2
	of Biostatistics	Calculate the	Applications.	Learn the Methods of
		sampling errors		Sampling.
	SO 1.3 Explain Methods of		CI 1.3 Methods of Sampling	
	Sampling			
	SO 1.4 study the random		CI 1.4 random Sampling,	
	Sampling,			
	SO 1.5 study the Non		CI 1.5 Non random	
	random Sampling,		Sampling,	
	SO 1.6 study the Sampling		CI 1.6 Sampling Errors, non-	
	Errors, non-sampling errors.		sampling errors.	
	SO 1.7 Explain Presentation		CI 1.7 Presentation of data:	
	of data:			
	SO 1.8 Illustrate Types of		CI 1.8 Types of data,	
	data,			
	SO 1.9 Explain Data		CI 1.9 Data collection,	
	collection, Frequency		Frequency distribution	
	distribution			

Suggested Sessional Work	SW3.1 Assignments	Differentiate between Random Sampling and Non-random sampling and give Importance of
(SW): anyone		biostatistics and their applications.
	SW3.2 Mini Project	Measures of central Tendency by suitable examples.
	SW3.3 Other Activities (Specify)	Find out some you tube videos based on history, methods, and application of biostatistics.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Approxim	ate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom	r						
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the		Item	Cl	LI	SW	SL	Total
course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in		Approx.Hrs	09	06	01	02	18
the overall achievement of Course Outcomes (COs) upon the course's conclusion.							_

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO2-05BT604.2 - Extend	SO2.1 Explain about measures	LI 2.1 focuses on the	Unit 2	SL2.1 Understand the role of
practical skills in laboratory	of central tendency	Calculation of mean, Median,	CI 2.1 Measures of Central	mean median and mode.
techniques and methods for		and Mode	Tendency	
producing, purifying, and				
analyzing pharmaceutical	SO2.2 illustrate about	LI 2.2 To explain the Merits	CI 2.2 Calculation of mean.	SL2.2 Learn mean deviation
biotechnology products	calculation of mean	and demerits of Mean,		by numerically.
		Median, and Mode		
	SO2.3 illustrate about	LI 2.3 List out formulations	CI 2.3 Calculation of Median	
	calculation of median	of mean median and mode.		
	SO2.4 Elucidate calculation of		CI 2.4 Calculation of Mode	
	mode			
	SO2.5 explain merits of Mean,		CI 2.5 Merits of Mean, Median	
	Median and Mode		and Mode	
	SO2.6 explain demerits of		CI 2.6 demerits of Mean, Median	
	Mean, Median and Mode.		and Mode	
	SO2.7 Explain Measures of		CI2.7 Measures of Dispersion-	
	Dispersion- Range,.		Range,	
	SO2.8 Illustrate Mean		CI2.8, Mean deviation,	
	deviation,			
	SO2.9 Explain Standard		CI2.9 Standard deviation.	
	deviation.			

Suggested Sessional	SW2.1 Assignments	Calculate mean median and mode by related questions.
Work (SW): anyone	SW2.2 Mini Project	Measures of central Tendency by suitable examples.
	SW2.3 Other Activities (Specify)	Find out some YouTube videos based on the calculation method of mean median and mode.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Approximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom						
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course	Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall	Approx. Hrs	09	04	01	02	16
achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO3-05BT604.3	SO3.1 Summarize the concept of	LI 1.1 Basics of probability	CI3.1 Definition of probability,	SL3.1 Understand the
Demonstrate basic	probability			role of probability
analytical techniques to				theorems.
generate results				
	SO3.2 Explain theorems of	LI 1.2 Working of any Addition	CI3.2 Theorems of Probability	SL3.2 Learn the
	Probability	rule and multiplication rule		application of
				probability
	SO3.3 Provide use of the Addition		CI3.3 Addition rule, and	
	rule of probability		multiplication rule.	
	SO3.4 Apply the multiplication rule.		CI3.4 Apply multiplication rule.	
	SO3.5 Analyse probability		. CI3.5 Probability distribution	
	distribution-			
	SO3.6 Analyse Binomial		CI3.6 Binomial distribution,	
	distribution,			
	SO3.7 Explain Poisson distribution,		CI3.7 Poisson distribution,	
	SO3.8 Explain Normal distribution.		CI3.8 Normal distribution.	
	CI3.9 Illustrate Applications of		CI3.9 Applications of probability	
	probability			

Suggested Sessional Work	SW3.1 Assignments	Write about the probability distribution Calculate probability by suitable examples
(SW): anyone	SW3.2 Mini Project	how is probability important in biological systems?
	SW3.3 other activity	Find out some youtube videos based on probability theorems.

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate Hours					
levels, which students are anticipated to accomplish through various modes of instruction including						
Classroom Instruction (CI). Laboratory Instruction (LI). Sessional Work (SW), and Self Learning (SL).	Item	Cl	LI	SW	SL	Total
As the course progresses, students should showcase their mastery of Session Outcomes (SOs),	Approx. Hrs	09	01	01	02	13
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-05BT604.4Interpret results of	SO4.1 Outline the	LI4.1 Understand the working	CI4.1 Correlation and Regression-	SL4.1 Understand
commonly used statistical analyses	Correlation	of regression equation by given	Introduction,	the Positive or
in written summaries		data.		Negative
				Correlation.
	SO4.2 Explain Regression.		CI4.2Explain Regression.	SL4.2 Learn regression
				equation
	SO4.3 Explain types of		CI4.3 Types of Correlation	
	correlation			
	SO4.4 Analyse the Positive		CI4.4 Positive or Negative	
	Correlation		Correlation,	
	SO4.5 Analyse the Negative		CI4.5 Analyse the Negative	
	Correlation		Correlation	
	SO4.6Explain Correlation		CI4.6 Correlation coefficient	
	coefficient,			
	SO4.7 Illustrate Linear		CI4.7 Linear regression	
	regression			
	SO4.8 Illustrate the		CI4.8 Regression equation.	
	Regression equation.			
	SO4.9 Explain Application		CI4.9 Application of Regression and	
	of Regression and		Correlation.	
	Correlation			

Suggested Sessional	SW4.1 Assignments	Illustrating Principles of Correlation and Regression		
Work (SW): anyone	SW4.2 Mini Project	How regression equation is important in the area of biological research?		
	SW4.3 Other Activities (Specify)	Find out some youtube videos based on Correlation and Regression.		

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Approximate Hours					
Instruction (CI). Laboratory Instruction (LI). Sessional Work (SW), and Self Learning (SL). As the course	Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall	Approx. Hrs	09	00	01	02	12
achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-05BT604.5 Interpret results of commonly used statistical analyses in written summaries	SO5.1 Introduce the Procedure of Testing Hypothesis		CI 5.1 Introduce the Procedure of Testing Hypothesis	SL5.1 Understand the Null and Alternative Hypothesis.
	SO5.2 Explain Null Hypothesis.		CI 5.2 Null Hypothesis.	SL5.2 Differentiation between T-Test and Chi-Square test.
	SO5.3 Explain Alternative Hypothesis.		CI 5.3 Alternative Hypothesis.	
	SO5.4 UnderstandT-Test for small samples.		CI 5.4 T-Test for small samples.	
	SO5.5 Explain Properties of t-Test.		CI 5.5 Properties and Application of t-Test.	
	SO5.6 Explain the Application of the t-Test		CI 5.6 Application of t-Test	
	SO5.7 Understandthe Chi-Square test		CI 5.7 Chi-Square test	
	SO5.8 ExplainProperties of chi distribution.		CI 5.8 Properties of chi distribution.	
	SO5.9 Explain the Application of chi distribution		CI 5.9 Application of chi distribution	

Suggested Sessional	SW5.1 Assignments	Differentiate Null and Alternative Hypothesis.				
Work (SW): anyone	SW5.2 Mini Project	How T-Test and Chi-Square test are playing important role in biostatistics?				
	SW5.3 Other Activities (Specify)	Find out some you tube videos based on Test of significance.				

Course duration (in hours) to attain Course Outcomes:

Course Title: Biostatistics		Course Code: 05BT604			
Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-05BT604.1Describe the roles biostatistics serves in the discipline of public health.	9	4	2	1	16
CO2-05BT604.2Apply basic statistical concepts commonly used in public health and Health Sciences	9	6	2	1	18
CO3-05BT604.3: Demonstrate basic analytical techniques to generate results	9	4	2	1	16
CO4-05BT604.4Interpret results of commonly used statistical analyses in written summaries	9	1	2	1	13
CO5-05BT604.5: Demonstrate statistical reasoning skills accurately and contextually	9	0	2	1	12
Total Hours	45	15	10	05	75

End-semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Biostatistics

Course Code:05BT604

Course Outcomes	Μ	Total Marks		
	R	U	Α	
CO1-05BT604.1Describe the roles biostatistics serves in the discipline of public health.	03	02	04	09
CO2-05BT604.2Apply basic statistical concepts commonly used in public health and Health Sciences	04	05	02	11
CO3-05BT604.3: Demonstrate basic analytical techniques to generate results	02	06	02	11
CO4-05BT604.4Interpret results of commonly used statistical analyses in written summaries	03	05	02	10
CO5-05BT604.5: Demonstrate statistical reasoning skills accurately and contextually	03	04	03	10
Total Marks	15	22	13	50

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	BIOSTATISTICS, P.N.Arora, P.K.Malhan, Himalaya Publishing House, edition2 & 2005
2	Fundamentals of biostatistics, Khan and Khanam, Ukaaz Publication 2 & 2004
3	Elements Of Biostatistics, Prasad Rastogi Publication, edition, 3& 2009

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Roleplay
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based Teaching Learning
- 9. Brainstorming

Program Name: B. Sc. Biotechnology **Semester:** VI Semester **Course Title:** BIOSTATISTICS Course Code: 05BT604

CO/PO Mapping															
Course Outcome		Program Outcomes (POs)										Prog Outo	Program Specific Outcomes (PSOs)		
COs	PO1	PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12 PS01								PSO2	PSO3				
CO1-05BT604.1Describe the roles biostatistics serves in the discipline of public health.	-	-	-	1	2	2	2	-	1	2	2	3	3	2	1
CO2-05BT604.2Apply basic statistical concepts commonly used in public health and Health Sciences	-	-	-	-	-	-	3	-	2	2	3	3	2	1	2
CO3-05BT604.3: Demonstrate basic analytical techniques to generate results	-	1	1	1	-	-	2	-	3	1	1	2	1	2	1
CO4-05BT604.4Interpret results of commonly used statistical analyses in written summaries	-	1	1	-	2	2	2	3	-	1	-	-	2	2	3
CO5-05BT604.5: Demonstrate statistical reasoning skills accurately and contextually	1	1	1	-	-	2	3	3	1	2	2	2	2	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

POs & PSOs	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning (SL)
No.			Instruction (LI)		
PO 1.2.3.4.5.6	CO1-05BT604.1Describe the roles	SO1.1 SO1.2	LI 1	1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,	
7.8.9.10.11.12	biostatistics serves in the discipline of	SOI.3 SOI.4	LI 2	1.9	
,,,,,,,,,,,,,,,,	public health.	SO1.5 SO1.6			1SL-1,2,
PSO 1.2. 3		SO1.7 SO1.8			
1.00 1,2,0		SO1.9			
PO 1 2 3 4 5 6	CO2-05BT604.2Apply basic statistical	SO2.1 SO2.2	LI 1	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,	
7 8 9 10 11 12	concepts commonly used in public	SO2.3 SO2.4	LI 2	2.9	
7,0,9,10,11,12	health and Health Sciences	SO2.5 SO2.6	LI 3		2SL-1,2,
PSO 1 2 3		SO2.7 SO2.8			
150 1,2, 5		SO2.9			
PO 1 2 3 4 5 6	CO3-05BT604.3: Demonstrate basic	SO3.1 SO3.2	LI 1	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	
7 8 9 10 11 12	analytical techniques to generate	SO3.3	LI 2		
7,0,9,10,11,12	results	SO3.4SO3.5			3SL-1,2
PSO 1 2 3		SO3.6 SO3.7			
150 1,2, 5		SO3.8 SO3.9			
PO 1 2 3 4 5 6	CO4-05BT604.4Interpret results of	SO4.1 SO4.2	LI 1	4.1,4.2,4.3,4.4, 4.5,	
7 8 9 10 11 12	commonly used statistical analyses in	SO4.3 SO4.4		4.6,4.6,4.7,4.8, 4.9	
7,0,7,10,11,12	written summaries	SO4.5 SO4.6			4SL-1,2
PSO 1 2 3		SO4.7 SO4.8			
150 1,2, 5		SO4.9			
	CO5-05BT604.5: Demonstrate	SO5.1 SO5.2		5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,	
PO 1,2,3,4,5,6	statistical reasoning skills accurately	SO5.3		5.9	
7,8,9,10,11,12	and contextually	SO5.4SO5.5			5SI -1 2
		SO5.6 SO5.7			3.51-1,2
PSO 1,2, 3		SO5.8 SO5.9			

Program Name	B.Sc. (HONOURS) BIOTECHNOLOGY						
Semester	VII						
Course Code:	01BT701						
Course title:	COMPUTATIONAL BIOLOGY AND BIOINFORMATICS	Curriculum Developer: Mr. Piyush Kant Rai, Assistant professor					
Pre-requisite:	Biology fundamentals (molecular biology, genetics), programming (Python), statistics, mathematics, bioinformatics tools, genomics, NGS technologies, Linux/Unix, version control, and effective communication.						
Rationale:	The proposed syllabus integrates essential elements for bioinformatics proficiency. It combines foundational biology with practical programming skills, statistical and mathematical methods, and database management. This comprehensive approach ensures students acquire the necessary tools to analyze biological data fostering a robust understanding of bioinformatics principles and applications						
Course Outcomes (COs):	 01BT701.1: The unit will explain bioinformatics history, homology 01BT701.2: Analyze protein information from PDB, SWISS-utilization in research. 01BT701.3: Operates diverse data generation techniques, unde biological analyses. 01BT701.4: Master sequence and phylogeny analysis, detect ORF interpret results. 01BT701.5: Navigate databases, execute similarity searches (E and gene identification. 	y, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene). PROT, TREMBL databases, mastering their structures for effective rstand bioinformatics challenges, and apply problem-solving skills in Fs, understand sequence assembly, mutation matrices, BLAST usage, and BLAST, FASTA), and annotate genomes, integrating pattern finding					

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=4:0:2)	
MAJOR	01BT701	COMPUTATIONAL BIOLOGY AND BIOINFORMATICS	4	4	1	2	11	4+2=6	

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);

SL: Self Learning;

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

			Scheme of Assessment (Marks)								
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)		
MAJOR	01BT701	COMPUTATIONAL BIOLOGY AND BIOINFORMATICS	15	20	10	5	50	50	100		

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MAJOR	01BT701	COMPUTATIONAL BIOLOGY AND BIOINFORMATICS	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	03	22

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-01BT701.1: The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene).	SO1.1: The notion of Homology. Sequence Information Sources.	Ll1.1: Learn how to use a computer for bioinformatics tasks.	Cl1.1: Introduction to the notion of Homology. Sequence Information Sources.	SL1.1: Visit and explore EMBL website.
	SO1.2: EMBL database.	LI1.2: Learn how to use a ONLINE DATABASE	CI1.2: Explore the EMBL database structure and applications.	SL1.2: Explore NCBI website for related resources.
	SO1.3: DDBJ, Swiss-Prot databases.		Cl1.3: Introduction to DDBJ and Swiss- Prot databases.	
	SO1.4: GENBANK database.		CI1.4: Introduction to the GENBANK database and its structure.	
	SO1.5: Entrez and Unigene databases.		Cl1.5: Overview of Entrez and Unigene databases.	
	SO1.6: Understanding the structure of each database and how to use it on the web.		Cl1.6: Practical understanding of using sequence information sources on the web.	
	SO1.7: Explore sequence data types in bioinformatics.	Ll1.3: Use web-based tools to retrieve sequence data from databases.	Cl1.7: Classification of sequence data types in databases.	SL1.3: Research different types of biological sequences (DNA, RNA, Protein).
	SO1.8: Basic concepts of nucleotide and protein sequences.		Cl1.8: Introduction to nucleotide and protein sequences.	
	SO1.9: Key bioinformatics tools for sequence retrieval.		Cl1.9: Key bioinformatics tools and how they help retrieve sequence data.	
	SO1.10: Sequence submission methods.		Cl1.10: How to submit biological sequences to public databases.	
	SO1.11: Use of public databases for research.		Cl1.11: How researchers use public databases for biological data analysis.	
	SO1.12: Ethical considerations in sequence submission.		Cl1.12: Ethical guidelines and best practices in data submission.	

Suggested Sessional Work SW1.1 Assignments		Summarizes the GenBank, EMBL and DDBJ			
(SW):anyone	ne SW1.2Mini Project Demonstrate how to retrieve data from EMBL.				
SW1.3 Other Activities (Specify) c		correlate the data redundancy among INSDC databases.			

			Item Cl	LI SW SL Total		
			Approx.Hrs 12	6 1 3 22		
Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)		
CO2-01BT701.2: Analyze protein information from PDB, SWISS-PROT, TREMBL	SO2.1: Introduction to protein data sources.	LI2.1: Learn how to access protein databases using web tools.	Cl2.1: Overview of protein databases: PDB, SWISSPROT, and TREMBL.	SL2.1: Visit PDB and explore available protein structures.		
databases, mastering their structures for effective	SO2.2: SWISSPROT and TREMBL database structure.	LI2.2: Perform BLAST	CI2.2: Explore the structure and function of SWISSPROT and TREMBL.	SL2.2: Analyze a protein entry in SWISSPROT.		
utilization in research.	SO2.3: Understanding the Protein Data Bank (PDB).		CI2.3: Introduction to PDB: How it stores 3D protein structures.			
	SO2.4: Retrieving protein sequences.		Cl2.4: Methods for retrieving protein sequences from databases.			
	SO2.5: Interpretation of protein structure data.	LI2.3: Practice retrieving and interpreting protein sequences from PDB.	Cl2.5: How to interpret data from protein structure sources.			
	SO2.6: Using protein databases for research.		CI2.6: Application of protein databases in biological research.			
	SO2.7: SWISSPROT annotations and their significance.		CI2.7: Understanding the annotation features of SWISSPROT.			
	SO2.8: Cross-references between protein databases.		CI2.8: How to use cross-references between PDB, SWISSPROT, and TREMBL.			
	SO2.9: Importance of protein classification systems.		Cl2.9: How protein classification systems organize protein data.	SL2.3: Research the role of protein classification in bioinformatics.		
	SO2.10: Protein sequence alignment tools.		Cl2.10: Introduction to protein sequence alignment and available tools.			
	SO2.11: Understanding protein domains and motifs.		CI2.11: How protein domains and motifs are annotated in databases.			
	SO2.12: Protein structure prediction methods.		CI2.12: Introduction to protein structure prediction techniques.			

Suggested Sessional	SW2.1 Assignments	Justify the role of SwissProt in biotechnology.		
Work (SW):anyone	SW2.2Mini Project Interpret the TrEMBL result concerning the DNA.			
	SW2.3 Other Activities (Specify)	Incorporate some youtube videos based on features of TrEMBL construction.		

			Item Cl	LI SW SL Total		
			Approx.Hrs 12	6 1 3 22		
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning(SL)		
CO3-01BT701.3: Operates diverse data generation techniques, understand bioinformatics challenges, and apply	SO3.1: Introduction to data generating techniques in bioinformatics.	LI3.1: Learn to identify data generated from different biological experiments.	, SL3.1: Study the key steps in the PCR process.			
problem-solving skills in biological analyses.	SO3.2: Understanding restriction digestion and its applications.		CI3.2: How restriction digestion is used in bioinformatics.	SL3.2: Research on how restriction digestion aids in sequence analysis.		
	SO3.3: Chromatograms and their role in sequencing data.		CI3.3: Introduction to chromatograms: how they visualize sequence data.			
	SO3.4: Use of blotting techniques in bioinformatics.	LI3.2: Practical use of blotting techniques in bioinformatics labs.	CI3.4: Explanation of blotting techniques (Southern, Northern, Western).			
	SO3.5: Polymerase Chain Reaction (PCR) in data generation.		CI3.5: Overview of PCR and its importance in bioinformatics.			
	SO3.6: Microarrays and their applications in data analysis.		CI3.6: Introduction to microarray technology for large-scale data analysis.			
	SO3.7: Understanding Mass Spectrometry.		CI3.7: The role of mass spectrometry in protein identification and analysis.			
	SO3.8: Bioinformatics problems posed by these techniques.		CI3.8: Issues in handling and analyzing data from various biological experiments.			
	SO3.9: Tools used to process data from restriction digestion and PCR.	LI3.3: Practice analyzing data from restriction digestion and PCR experiments.	CI3.9: Introduction to software tools for analyzing PCR and restriction digestion data.			
	SO3.10: Analysis of data from chromatograms and microarrays.		CI3.10: Overview of software tools for analyzing chromatogram and microarray data.	SL3.3: Research on how software tools how it use .		
	SO3.11: Challenges in processing large-scale data from mass spectrometry.		CI3.11: Understanding the bioinformatics challenges in mass spectrometry data analysis.			
	SO3.12: Integration of data from multiple techniques for analysis.		Cl3.12: How to integrate data from restriction digestion, blots, PCR, and microarrays for a comprehensive analysis.			

Suggested Sessional	SW3.1 Assignments	Read about the conventional and non-conventional PCR.			
Work (SW): anyone	SW3.2 Mini Project	Draw the flow chart model of mass spectrometry.			
	SW3.3 Other Activities (Specify)	How to integrate data from restriction digestion, blots, PCR, and microarrays			

				Item	Cl	LI	SW	SL	Total		
				Approx.Hrs	12	6	1	3	22		
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)			Self-Learning(SL)					
CO4-01BT701.4: Master sequence and phylogeny analysis,	SO4.1: Introduction to sequence and phylogeny analysis.	LI4.1: Learn how to identify sequences using web-based tools.	CI4.1: Overview of seque analysis methods.	ence and phylogeny	SL4.1: phylo	Stu geneti	idy th ic trees	ie ba:	sics of		
detect ORFs, understand sequence assembly, mutation matrices BLAST usage and	SO4.2: Detecting Open Reading Frames (ORFs).		CI4.2: Understanding importance in gene pred	ORFs and their iction.	SL4.2: detec	Expl ting O	ore or RFs in s	line to equen	ools for ces.		
interpret results.	SO4.3: Outline of sequence assembly.	LI4.2: How to interpret and analyze BLAST search results	CI4.3: Introduction to s processes and tools.	sequence assembly	SL4.3: assem	bly pi	Explore rocesse	se s and t	equence ools		
	SO4.4: Understanding mutation and substitution matrices.		CI4.4: Explanation of mu matrices used in sequence	itation/substitution ce alignment.							
	SO4.5: Introduction to BLAST.	LI4.3: Practice using BLAST for sequence similarity searches.	CI4.5: Introduction to th and its applications.	ne BLAST algorithm	1						
	SO4.6: Interpreting BLAST results.		CI4.6: How to interpret search results.	and analyze BLAST	•						
	SO4.7: Pairwise sequence alignment.		CI4.7: Introduction to alignment techniques.	pairwise sequence	2						
	SO4.8: Multiple sequence alignment.		CI4.8: How to perform alignments (MSA).	multiple sequence	2						
	SO4.9: Phylogenetic analysis methods.		CI4.9: Introduction to phylogenetic analysis.	methods used for							
	SO4.10: Constructing phylogenetic trees.		CI4.10: Understanding t phylogenetic trees from	he construction of sequence data.	:						
	SO4.11: Comparison of phylogenetic analysis tools.		CI4.11: Compare diffe analysis tools (e.g., MEG.	rent phylogenetic A, PHYLIP).	:						
	SO4.12: Challenges in sequence and phylogeny analysis.		CI4.12: Discussion on th in sequence and phyloge	e challenges faced netic analyses.							

Suggested Sessional	SW4.1 Assignments	Propose ideas on comparative gene studies				
Work (SW): anyone	SW4.2 Mini Project	Compare different phylogenetic analysis tools (e.g., MEGA, PHYLIP).				
	SW4.3 Other Activities (Specify)	Explore the Amrita lab for phylogenetic studies.				
Item	Cl	LI	SW	SL	Total	
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Approx.Hrs	12	6	1	3	22	

Course Outcome (CO)	Session	Laboratory	Classroom Instruction(CI)	Self-Learning(SL)
	Outcomes(SOs)	Instruction(LI)		
CO5-01BT701.5: Navigate databases, execute	SO5.1: Introduction to database	LI5.1: Learn to search	CI5.1: Overview of searching	SL5.1: Explore how to search for
similarity searches (BLAST, FASTA), and	searching.	databases using tools like	biological databases using SRS	nucleotide and protein sequences
annotate genomes, integrating pattern finding and		BLAST and FASTA.	and Entrez.	on NCBI.
gene identification.	SO5.2: Sequence similarity		CI5.2: Understanding sequence	SL5.2: Research how FASTA is
	searches using BLAST.		similarity search methods: BLAST.	used for sequence comparison.
	SO5.3: Introduction to FASTA for		CI5.3: How to use FASTA for	
	sequence searches.		sequence similarity searches.	
	SO5.4: Data submission to		CI5.4: Introduction to data	
	biological databases.		submission processes for	
			biological databases.	
	SO5.5: Key concepts of genome	LI5.2: Practice genome	CI5.5: Overview of genome	
	annotation.	annotation using online	annotation processes and tools.	
		tools.		
	SO5.6: Pattern and repeat finding	LI5.2: Practice Sequence	CI5.6: Techniques for identifying	
	in genome sequences.	matching	patterns and repeats in genome	
			sequences.	
	SO5.7: Tools for gene		CI5.7: Introduction to gene	
	identification in genomes.		identification tools (e.g.,	
			AUGUSTUS, Glimmer).	
	SO5.8: Gene prediction and its		CI5.8: Explanation of gene	
	significance.		prediction methods and their	
			applications.	
	SO5.9: Comparison of genome		CI5.9: Discuss the pros and cons	SL5.3: Investigate the latest
	annotation tools.		of genome annotation tools.	advancements in genome
				annotation techniques.
	SO5.10: Importance of functional		CI5.10: Introduction to functional	
	annotation in genomics.		annotation and its role in	
			genomics.	
	SO5.11: Ethical considerations in		CI5.11: Ethical guidelines for	
	genome data sharing.		sharing and using genome data.	
	SO5.12: Future trends in genome		CI5.12: Discussion on emerging	
	annotation.		trends and technologies in	
			genome annotation.	

Suggested Sessional	SW5.1 Assignments	make a flow chart of the genome comparison.				
Work (SW): anyone	SW5.2 Mini Project	Discuss the pros and cons of genome annotation tools.				
	SW5.3 Other Activities (Specify)	Try to learn and apply repeat findings and patterns for protein.				

Course duration (in hours) to attain Course Outcomes:

Course Title:Computational biology and bioinformatics

Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction(L1)	(SL)	(SW)	(L1+C1+SL+SW)
CO1-01BT701.1: The unit will explain bioinformatics	12	6	3	1	22
history, homology, and utilize sequence databases (EMBL,					
GENBANK, Entrez, Unigene).					
CO2-01BT701.2: Analyze protein information from PDB,	12	6	3	1	22
SWISS-PROT, and TREMBL databases, mastering their					
structures for effective utilization in research.					
CO3-01BT701.3: Operates diverse data generation	12	6	3	1	22
techniques, understand bioinformatics challenges, and					
apply problem-solving skills in biological analyses.					
CO4-01BT701.4: Master sequence and phylogeny	12	6	3	1	22
analysis, detect ORFs, understand sequence assembly,					
mutation matrices, BLAST usage, and interpret results.					
CO5-01BT701.5: Navigate databases, execute similarity	12	6	3	1	22
searches (BLAST, FASTA), and annotate genomes,					
integrating pattern finding and gene identification.					
Total Hours	60	30	15	5	110

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: computational biology and bioinformatics

Course Code:01BT701

Course Outcomes		Total Marka			
	Α	An	Ε	С	Total Marks
CO1-01BT701.1: The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene).	02	03	04	1	10
CO2-01BT701.2: Analyze protein information from PDB, SWISS-PROT, and TREMBL databases, mastering their structures for effective utilization in research.	04	02	02	2	10
CO3-01BT701.3: Operates diverse data generation techniques, understand bioinformatics challenges, and apply problem-solving skills in biological analyses.	03	03	02	2	10
CO4-01BT701.4: Master sequence and phylogeny analysis, detect ORFs, understand sequence assembly, mutation matrices, BLAST usage, and interpret results.	03	04	02	1	10
CO5-01BT701.5: Navigate databases, execute similarity searches (BLAST, FASTA), and annotate genomes, integrating pattern finding and gene identification.	04	03	02	1	10
Total Marks	17	14	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details	
1	BioinformaticsThomas Dandekar, Meik Kunz Springer-Verlag GmbH Germany, part of Springer N	ature 2023
2	Introduction to bioinformaticsArthur LeskOxford University Press 2023	
3	Essential bioinformatics Jin Xiong Cambridge University Press 2007	

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Research lab (BSL-1)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Biotechnology **Semester:**Vth Sem **Course Title:** COMPUTATIONAL BIOLOGY AND BIOINFORMATICS **Course Code:** 01BT701

CO/PO/PSO Mapping															
Course Outcome (Cos)					1	Program	Outcom	es (POs))				Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11						PO12	PSO1	PSO2	PSO3	
CO1-01BT701.1: The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene).	-	-	-	1	2	2	1	-	1	2	2	3	3	3	1
CO2-01BT701.2: Analyze protein information from PDB, SWISS-PROT, and TREMBL databases, mastering their structures for effective utilization in research.	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
CO3-01BT701.3: Operates diverse data generation techniques, understand bioinformatics challenges, and apply problem-solving skills in biological analyses.	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
CO4-01BT701.4: Master sequence and phylogeny analysis, detect ORFs, understand sequence assembly, mutation matrices, BLAST usage, and interpret results.	-	1	1	-	2	2	2	3	-	1	-	-	1	2	3
CO5-01BT701.5: Navigate databases, execute similarity searches (BLAST, FASTA), and annotate genomes, integrating pattern finding and gene identification.	1	1	1	-	-	2	3	3	1	2	2	2	1	-	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
	CO1-01BT701.1: The unit will explain	SO1.1, SO1.2,		1.1, 1.2, 1.3, 1.4, 1.5,	
PO 4,5,6	bioinformatics history, homology, and	SO1.3, SO1.4,	11 1	1.6, 1.7, 1.8, 1.9,	
7,9,10,11,12	utilize sequence databases (EMBL,	SO1.5, SO1.6,		1.10, 1.11, 1.12	161 1 2 2
	GENBANK, Entrez, Unigene).	SO1.7, SO1.8,			13L-1,2,5
PSO 1,2, 3		SO1.9, SO1.10,	IL 3		
		SO1.11, SO1.12			
	CO2-01BT701.2: Analyze protein	SO2.1, SO2.2,		2.1, 2.2, 2.3, 2.4, 2.5,	
DO 7 0 10 11 12	information from PDB, SWISS-PROT, and	SO2.3, SO2.4,		2.6, 2.7, 2.8, 2.9,	
PO 7,9,10,11,12	TREMBL databases, mastering their	SO2.5, SO2.6,	111	2.10, 2.11, 2.12	
DCO 4 3 3	structures for effective utilization in	SO2.7, SO2.8,	IL 2		2SL-1,2,3
PSO 1,2, 3	research.	SO2.9, SO2.10,	IL 3		
		SO2.11, SO2.12			
	CO3-01BT701.3: Operates diverse data	SO3.1, SO3.2,		3.1, 3.2, 3.3, 3.4, 3.5,	
PO 2,3,4,	generation techniques, understand	SO3.3, SO3.4,		3.6, 3.7, 3.8, 3.9,	
7,9,10,11,12	bioinformatics challenges, and apply	SO3.5, SO3.6,	11.1	3.10, 3.11, 3.12	261 4 2 2
	problem-solving skills in biological	SO3.7, SO3.8,			33L-1,2,3
PSO 1,2, 3	analyses.	SO3.9, SO3.10,	IL 3		
		SO3.11, SO3.12			
	CO4-01BT701.4: Master sequence and	SO4.1, SO4.2,		4.1, 4.2, 4.3, 4.4, 4.5,	
PO 2,3,5,6	phylogeny analysis, detect ORFs,	SO4.3, SO4.4,		4.6, 4.7, 4.8, 4.9,	
7,8,10,11,12	understand sequence assembly, mutation	SO4.5, SO4.6,		4.10, 4.11, 4.12	461 1 2 2
	matrices, BLAST usage, and interpret	SO4.7, SO4.8,			43L-1,2,3
PSO 1,2, 3	results.	SO4.9, SO4.10,	IL S		
		SO4.11, SO4.12			
	CO5-01BT701.5: Navigate databases,	SO5.1, SO5.2,		5.1, 5.2, 5.3, 5.4, 5.5,	
DO 1 2 2 6	execute similarity searches (BLAST,	SO5.3, SO5.4,		5.6, 5.7, 5.8, 5.9,	
7 9 0 10 11 12	FASTA), and annotate genomes, integrating	SO5.5, SO5.6,	IL 1	5.10, 5.11, 5.12	
/,0,3,10,11,12	pattern finding and gene identification.	SO5.7, SO5.8,	IL 2		5SL-1,2,3
		SO5.9, SO5.10,	IL 3		
F3U 1, 5		SO5.11, SO5.12			

Program Name	B.Sc. (Hons) in Biotechnology								
Semester	VII								
Course Code:	02RM701								
Course title:	Research Methodology	Curriculum Developer: Dr. Deepak Mishra, Professor							
Pre-requisite:	Student should have basic and advanced knowledge of Biotechnology and practical as well as research skills.								
Rationale:	The paper on Research Methodology in a B.S scientific tools in analyzing Biotechnological r literature, development of research skills and process helps us for doing any research in a splagiarism knowledge.	c. (Hons.) in Biotechnology program explores the critical role of specialized research and research. It delves into the use of precise instruments for monitoring and analyzing data and scientific aptitudes. This study enables students to understand how systematic research systematic manner along with data publication. It also explores the publication ethics and							
Course Outcomes (COs):	CO1-02RM701.1: Students are being knowled CO2-02RM701.2: Development of critical thir CO3-02RM701.3: Proficiency in communicatin CO4-02RM701.4: Recognize various issues rela CO5-02RM701.5: Proficiency in report writing	geable with essentials of research methodology through various tools available. Iking skills for evaluating scientific literature and identifying research problems. Ig research findings through various written forms. ated to research ethics, data processing and integrity, research commercialization. , plagiarism rectification, making deliberations and presentation.							

Scheme of Studies:

Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)
Minor (RM)	02RM701	Research Methodology	3	2	1	5	11	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

Scheme of Assessment: Theory

					Sch	neme of Assessme	ent (Marks)		
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Minor (RM)	02RM701	Research Methodology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)						
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
Minor (RM)	02RM701-L	Research Methodology	35	5	5	5	50	50	100	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Approximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom		-				
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the	Item	Cl	LI	SW	SL	Total
course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the	Approx.Hrs	09	04	01	05	19
overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-02RM701.1: Students are being knowledge-able with essentials of research methodology through various tools available	SO1.1 Define and Describe concept of scientific writing and research, its types	LI 1.1 Study Online Data Bases	Unit-1 Cl1.1 Scientific Writing & Research- meaning, types,	SL1.1 Search various reference books and study material to start the learning of research and scientific writing
	SO1.2 Describe about objectives and approaches of research	LI 1.2 Study about sampling	Cl1.2 objectives, and approaches	SL1.2 Differentiation of research problems based on objective
	SO1.3 Explain about methods and sources of literature		Cl1.3 Literature collection: Different sources,	SL1.3 Searching and literature on different online resources.
	SO1.4 Describe about biological online database		Cl1.4 Biological online databases,	
	SO1.5 Study of sampling techniques		Cl1.5 Determining sample design,	SL1.4 Use of sampling methods for collection of scientific data related to different research problems
	SO1.6 Study of data collection methods		Cl1.6 collecting data	
	SO1.7 Describe concept of hypothesis testing		Cl1.7 analysis and hypothesis testing	SL1.5 Setting up the Hypothesis and their application in research
	SO1.8 Study about generalization		Cl1.8 Generalization	
	SO1.9 Study about interpretation of research findings		Cl1.9 interpretation.	

Suggested Sessional Work	SW1.1 Assignments	Describe in detail research and its types
(SW):anyone	SW1.2Mini Project	Collection of data and literature related to any biotechnological research problem
	SW1.3 Other Activities (Specify)	Searching of online database available on internet and their application in research

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-02RM701.2: Development of critical thinking skills for evaluating scientific literature and identifying research problems	SO2.1 Explore the concept and techniques of writing reviews	LI2.1 Writing review articles	Unit-II Cl2.1 Writing review articles,	SL2.1 Search various contents for writing a review article
	SO2.2 Describe the contents of research article		CI2.2 Writing Journal articles, bibliography	SL2.2 designing of a research article
	SO2.3 Reflecting about the concept and contents of books and monograph		CI2.3 books, and monographs-	SL2.3 Learn about contents of an ideal book
	SO2.4 Explain about contents of an ideal thesis	LI2.12 study structure of thesis	CI2.4Structure of thesis;	SL2.3 Searching and literature on different online resources.
	SO2.5 Assessing the role of manuscript and proof correction in research		CI2.5 Manuscript and proof correction,	
	SO2.6 Explaining the steps of research process		Cl2.6Research Process: selection of problems:	SL2.5 Use of research process to solve different research problems
	SO2.7 Explaining the stages of execution of research		CI2.7 stages in the execution of research	
	SO2.8 explain about research designs.		CI2.8 Research Designs.	
	SO2.8 explain about different types of research designs.		Cl2.9 Types of Research Design	

Suggested Sessional	SW2.1 Assignments	Describe in detail about different stages of execution of research by using research process.
Work (SW):anyone	SW2.2Mini Project	Designing of a research thesis.
	SW2.3 Other Activities (Specify)	Take a research problem a select a specific research design for solving it.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	05	19

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Class room Instruction	Self-Learning(SL)
		Instruction(L1)	(CI)	
CO3-02RM701.3: Proficiency	SO3.1 Explain the role of	LI3.1 Study about	Unit-III	SL3.1 Read about various types of
in communicating research findings through various written forms.	different types of data in research.	collection data	Cl3.1 Data Collection: Secondary Data, Primary Data	data and their applications in research
	SO3.2 Assessing different methods used in data collection	LI3.2 Study about scaling methods	CI3.2 Methods of collection	SL3.2 Collection of research data using different tools
	SO3.3 Explaining concept and types of scales		CI3.3 Scaling Techniques Concepts and types,	SL3.3 Illustration about different scaling techniques
	SO3.4 Assessing different scaling methods used in research		CI3.4 Rating scales and Ranking scales, Scale Construction techniques	
	SO3.5 Describe about multi- dimensional scaling		CI3.5 Multi-Dimensional Scaling.	
	SO3.6 Assessing the role of research journals in research		CI3.6 Journals:	SL3.4 Collection of different research journals
	SO3.7 Assessing the role of research journals and their standards		CI3.7 Standard of research Journals	SL3.5 Assess role of impact factor and citation index in research
	SO3.8 Describe about concept of impact factor		CI3.8 Impact factor,	
	SO3.9 Describe about concept of citation index		CI3.9 citation index	

Suggested Sessional	SW3.1 Assignments	Describe in detail different categories of data and its collection methods.
Work (SW): anyone	SW3.2 Mini Project	Describe the role of scaling methods in research and their application for data validation
	SW3.3 Other	Prepare a list of research journal and checking their standard parameters.
	Activities (Specify)	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	02	01	05	17

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory	Classroom Instruction(CI)	Self-Learning(SL)
CO4.02RM701 4: Recognize various issues related to	SO4 1	I I I I I Study	Unit IV	SI 4 1
research ethics data processing and integrity research	Exploring the concept of data processing	research ethics	CI4.1 Data processing	Learn about data processing
commercialization	Exploring the concept of data processing	researen etnies	Dum processing	approaches and its implementation.
	SO4.2 Explaining the analytical/ statistical methods involved in research		CI4.2 Qualitative and Quantitative analytical / statistical methods involved in research.	SL4.2 Learn about analytical and scientific methods of research.
	SO4.3 Assessing the sources of ethical		CI4.3 Research Ethics- The source of ethical	SL4.3 Discuss ethical concern of
	issues in science and biotechnology		issues in science and biotechnology	research in science and biotechnology
	SO4.4 Explaining the concept of		CI4.4 research and reporting objectivity and	SL4.4 Learn about various types
	objectivity and integrity		integrity,	of reports
	SO4.5 Explaining the plagiarism and		CI4.5 the problem of plagiarism and related	SL4.4 Case studies related to
	related issues		issues	plagiarism
	SO4.6 Evaluate impact of international norms and standards.		CI4.6 international norms and standards	
	SO4.7 Describe the impact of scientific temper and virtues		CI4.7 Scientific temper and virtues expectations from scientific community	
	SO4.8 Assessing the ethical issues and		CI4.8 Ethical issues and Environmental	SL4.5 Case studies related to ethical
	environmental impact		impact aspects	impact of research
	SO4.9 Describe about the		CI4.9 Commercializing research- Copy right,	<u> </u>
	commercializing research.		IPRs	

Suggested Sessional	SW4.1 Assignments	Explain about Qualitative and Quantitative analytical / statistical methods involved in research.
Work (SW): anyone	SW4.2 Mini Project	Describe the various ethical issues related to biotechnological research.
	SW4.3 Other Activities (Specify)	Prepare one article on commercialization of research

			Item C1 Approx.Hrs 09	LI SW SL Total			
Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self- Learning(SL)			
CO5-02RM701.5: Proficiency in report writing, plagiarism rectification, making deliberations and presentation	SO5.1 Define the concept and types and components of scientific reports	SL5.1 learn about basic concept & requirement of research report					
	SO5.2 Able to execute steps layout and structure of research.		CI5.2 Steps, Layout and structure; Illustrations and tables	SL5.2 Review different layouts of report			
	SO5.3 Apply the role of Bibliography, referencing and footnotes		CI5.3 Bibliography, referencing and footnotes	SL5.3learn how prepare a report			
	SO5.4 Evaluate the concept of plagiarism in research	LI5.1 Use of visual aids- Importance of effective communication	CI5.4 Reproduction of published material Plagiarism,	SL5.4 Learn about plagiarism checking			
	SO5.5 Evaluate the citation and bibliography		CI5.5 Citation and acknowledgement				
	SO5.6 Describe about reproducibility and accountability		CI5.6 Reproducibility and accountability				
	SO5.7 Describe about Seminars; Symposia; Workshops, Conferences		CI5.7 General idea about: Seminars; Symposia; Workshops, Conferences				
	SO5.8 Elaborate the role of deliberations in research		CI5.8 Making deliberations (Oral presentation)	SL5.5 Learn about role of deliberation.			
	SO5.9 Describe about methods of presentation preparation		CI5.9 Planning - Preparation and Making presentation				

Suggested Sessional	SW5.1 Assignments	Explain general characteristics and components of research report
Work (SW): anyone	SW5.2 Mini Project	Describe the role of deliberation in research
	SW5.3 Other Activities (Specify)	Prepare a detail document on Use of visual aids- Importance of effective communication

Course duration (in hours) to attain Course Outcomes:

Course Title: Research Methodology		Course Code: 02RM701					
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)		
CO1-02RM701.1: Students are being knowledgeable with essentials of research methodology through various tools available.	9	4	5	1	19		
CO2-02RM701.2: Development of critical thinking skills for evaluating scientific literature and identifying research problems.	9	4	5	1	19		
CO3-02RM701.3: Proficiency in communicating research findings through various written forms.	9	4	5	1	19		
CO4-02RM701.4: Recognize various issues related to research ethics, data processing and integrity, research commercialization.	9	2	5	1	17		
CO5-02RM701.5: Proficiency in report writing, plagiarism rectification, making deliberations and presentation.	9	1	5	1	16		
Total Hours	45	15	25	05	90		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Research Methodology

Course Code:02RM701

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-02RM701.1: Students are being knowledgeable with essentials of research methodology	2	1	1	1	5
through various tools available.					
CO2-02RM701.2: Development of critical thinking skills for evaluating scientific literature and	2	4	2	2	10
identifying research problems.					
CO3-02RM701.3: Proficiency in communicating research findings through various written	2	3	3	2	10
forms.					
CO4-02RM701.4: Recognize various issues related to research ethics, data processing and	3	5	5	2	15
integrity, research commercialization.					
CO5-02RM701.5: Proficiency in report writing, plagiarism rectification, making deliberations	5	4	1	0	10
and presentation.					
Total Marks	14	17	12	07	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2	Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi
3	Writing the doctoral dissertation. Barrons Educational series, 2nd edition, Davis, G.B. and C.A. Parker, 1997. pp 160.
4	Authoring a PhD, thesis: how to plan, draft, write and finish a doctoral dissertation, Duncary, P. 2003.
5	Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to virology lab (BSL-3)
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Ho ns.) Biotechnology Semester: VII Semester Course Title: Research Methodology Course Code: 02RM701

Course Outcome (Cos)		Program Outcomes (POs)								Program Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02RM701.1: Students are being knowledgeable with essentials of research methodology through various tools available.	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO2-02RM701.2: Development of critical thinking skills for evaluating scientific literature and identifying research problems.	2	2	3	2	3	2	2	3	2	2	3	2	2	3	3
CO3-02RM701.3: Proficiency in communicating research findings through various written forms.	2	2	3	2	3	2	2	3	2	2	3	2	2	3	3
CO4-02RM701.4: Recognize various issues related to research ethics, data processing and integrity, research commercialization.	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO5-02RM701.5: Proficiency in report writing, plagiarism rectification, making deliberations and presentation.	3	3	3	3	2	3	3	3	3	3	3	3	3	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	CO1-02RM701.1: Students are being knowledgeable with essentials of research methodology through various tools available.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	LI 1 LI 2	1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8, 1.9	1SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	CO2-02RM701.2: Development of critical thinking skills for evaluating scientific literature and identifying research problems.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	LI 1 LI 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9	2SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	CO3-02RM701.3: Proficiency in communicating research findings through various written forms.	SO3.1 SO3.2 SO3.3 SO3.4SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	LI 1 LI 2	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	CO4-02RM701.4: Recognize various issues related to research ethics, data processing and integrity, research commercialization.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	LI 1	4.1,4.2,4.3,4.4, 4.5, 4.6,4.6,4.7,4.8, 4.9	4SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	CO5-02RM701.5: Proficiency in report writing, plagiarism rectification, making deliberations and presentation.	SO5.1 SO5.2 SO5.3 SO5.4SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI 1	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8, 5.9	5SL-1,2,3,4,5

Bachelorof Science (Hons.) in Biotechnology (B.Sc. (Hons.) BT)							
VII							
05BT701							
Pharmaceutical Biotechnology Curriculum Developer: Chahana Desai, Teaching Associate							
Students should have basic knowledge of biotechnology and the role of biotechnology in Pharmaceuticals.							
Pharmaceutical biotechnology is a field of biomedical sciences that uses novel technologies for production, formulation, and synthesis of biological substances from the living organisms, Which acts as drug molecules for the treatment and prevention of various diseases and syndromes.							
CO1-05BT701.1: Elucidate the basic fundamentals of anti CO2-05BT701.2: Explain the mode of action of different CO3-05BT701.3: Applied knowledge about microbial pro CO4-05BT701.4: Analyze the Government regulatory pol CO5-05BT701.5: Evaluate Good Laboratory Practices(GI	biotics, chemical disinfectants, antiseptics and preservatives. antibiotic and non-antibiotic antimicrobial agents as well as drug targeting anddrug delivery system duction and Spoilage of pharmaceutical Products and new vaccine technology icies, biosensors and application of microbial enzymes in pharmaceuticals. .P) and Good Manufacturing Practices (GMP) and safety in microbiology laboratory.						
	Bachelorof Science (Hons.) in Biotechnology VII 05BT701 Pharmaceutical Biotechnology Students should have basic knowledge of biotect Pharmaceutical biotechnology is a field of bior biological substances from the living organism syndromes. C01-05BT701.1: Elucidate the basic fundamentals of anti C02-05BT701.2: Explain the mode of action of different C03-05BT701.3: Applied knowledge about microbial proc C04-05BT701.5: Evaluate Good Laboratory Practices(GI						

Scheme of Studies:

Board of Study	Study Course Code Course Title		Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)
Major (DSC)	05BT701	Pharmaceutical Biotechnology	3	0	1	2	6	3+0=3

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

				Scheme of Assessment (Marks)									
		Progressive Assessment (PRA)											
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)				
Major (DSC)	05BT701	Pharmaceutical Biotechnology	15	20	10	5	50	50	100				

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major (DSC)	05BT701-L	Pharmaceutical Biotechnology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Appr	oximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	09	04	01	02	16
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-05BT701.1: Elucidate the basic fundamentals of antibiotics, chemical disinfectants, antiseptics and preservatives.	SO1.1 Explain the concept of antibiotics and antimicrobial agents	LI1.1 To Demonstrate the comparison of various antibiotics against a variety of bacteria.	Unit-1Introductiontopharmaceutical biotechnologyCI1.1Antibioticsantimicrobial agents	SL1.1 Find out some examples of common antibiotics
	SO1.2 Determine the basics of antibiotics	LI1.2 To perform the test for effects of disinfectants.	CI1.2 Antibiotics	SL1.2 Characteristics of disinfectants
	SO1.3 Elaborate the concept of synthetic anti microbial agents.		CI1.3 synthetic antimicrobial agents,	
	SO1.4 study Aminoglycosides		CI1.4 Aminoglycosides	
	SO1.5 Explain β -lactams, tetracyclines		CI1.5 β -lactams, tetracyclines	
	SO1.6 Explain about ansamycins, macrolid antibiotics		CI1.6 ansamycins, macrolid antibiotics	
	SO1.7 study antitumor substances,		CI1.7 antitumor substances,	
	SO1.8 Elaborate about Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents.		CI1.8 Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents.	
	SO1.9 Illustrate Chemical disinfectants, antiseptics and preservatives.		CI1.9 Chemical disinfectants, antiseptics and preservatives.	

Suggested Sessional	SW1.1 Assignments	Describe in detail antibiotics and its types.
Work (SW):anyone	SW1.2Mini Project	Elaborate various types of disinfectants.
	SW1.3 Other Activities (Specify)	Make a power point presentation on various antitumor substances.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	ApproximateHours					
which students are anticipated to accomplish through various modes of instruction including Classroom						
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the	Item	Cl	LI	SW	SL	Total
course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in	Approx.Hrs	09	04	01	03	17
the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-05BT701.2:	SO2.1	LI2.1 To perform Isolation of	Unit-2 Mechanism of action	SL2.1 Note down the effects of
Explain the mode of action of	Explainthe mechanism of	drug molecules	of antibiotics:	bacterial resistance to
different antibiotic and non-	action of different antibiotics	_	CI2.1 Mechanism of action of	antibiotics
antibiotic antimicrobial agents as			antibiotics	
well as drug targeting and	SO2.2 Elucidate the principles	LI2.2 To perform the Effect of	CI2.2 (inhibitors of cell wall	SL2.2 Read the latest research
drug delivery system	of drug targeting and drug	drug on animal models	synthesis, nucleic	on antibiotics.
	delivery.	_	acid and protein synthesis),	
	SO2.3 Elaborate the reaction of		CI2.3 Molecular principles of	SL2.3 Write down few points
	antimicrobial agents at the		drug targeting.	on importance of gene therapy
	target site.			
	SO2.4 Drug delivery system in		CI2.4 Drug delivery system in	
	gene therapy		gene therapy	
	SO2.5 Bacterial resistance to		CI2.5 Bacterial resistance to	
	antibiotics,		antibiotics,	
	SO2.6 Mode of action of		CI2.6 Mode of action of	
	bacterial killing by		bacterial killing by	
	quinolinones, Bacterial		quinolinones, Bacterial	
	resistance to		resistance to	
	quionolinones		quionolinones	
	SO2.7 IllustrateMode of action		CI2.7 Mode of action of non-	
	of non- antibiotic antimicrobial		antibiotic antimicrobial agents	
	agents			
	SO2.8 Discuss Penetrating		CI2.8 Penetrating defences,	
	defences, How the		How the antimicrobial agents	
	antimicrobial agents reach the		reach the targets	
	targets			
	SO2.9 Explain cellular		CI2.9 (cellular permeability	
	permeability barrier, cellular		barrier, cellular transport	
	transport system and drug		system and drug	
	diffusion		diffusion).	

Suggested Sessional	SW2.1 Assignments	Describe the antibiotics which act as a cell wall synthesis inhibitor.
Work (SW):anyone	SW2.2Mini Project	Make a chart on antibiotics and its mechanism of action.
	SW2.3 Other Activities (Specify)	Make Power point presentation on drug delivery in gene therapy.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Аррі	roximateHours					
which students are anticipated to accomplish through various modes of instruction including Classroom	Classroom						
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL). As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx.Hrs	09	04	01	03	17
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-05BT701.3:	SO3.1 Elucidate the knowledge	LI3.1 To perform	Unit-3Microbial production	SL3.1 Find out the process of
Applied knowledge about microbial	about microbial contamination	Physicochemical analysis of	and Spoilage of harmaceutical	sterilization techniques.
production and Spoilage of	and spoilage of pharmaceutical	specific antibiotic.	Products:	_
pharmaceutical Products and new	products.	-	CI3.1 Microbial contamination and	
vaccine technology.			spoilage of pharmaceutical products	
	SO3.2 Explain about the	LI3.2 To perform sterilization for	CI3.2(sterile injectibles, non-	SL3.2 Read the process of
	sterilization requirement for	various compounds used	injectibles, ophthalmic	pharmaceutical manufacturing.
	various types of contaminants.	pharmaceuticals.	preparations and implants) and	
			their sterilization.	
	SO3.3 Analyse the different		CI3.3 Manufacturing procedures	SL3.3 Read about latest vaccine
	pharmaceuticals produced by		and in process control of	clinical trials
	microbial fermentation.		pharmaceuticals	
	SO3.4 explain pharmaceuticals		CI3.4 Other pharmaceuticals	
	produced by microbial		produced by microbial	
	fermentations		fermentations	
	CI3.5 explain about		CI3.5 streptokinase,	
	streptokinase & streptodornase		streptodornase	
	SO3.6 Elaborate the different		CI3.6 New vaccine technology,	
	types of vaccines		DNA vaccines,	
	SO3.7 Elaborate the synthetic		CI3.7 synthetic peptide	
	vaccines		vaccines,	
	SO3.8 Elaborate the multivalent		CI3.8 multivalent subunit	
	vaccine		vaccines	
	SO3.9 Elaborate vaccine		CI3.9 Vaccine clinical trials	
	clinical trial			

Suggested Sessional	SW3.1 Assignments	Flow chart on production of pharmaceuticals by microbial fermentation.
Work (SW): anyone	SW3.2 Mini Project	Describe the importance of new vaccine technology to the world.
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on manufacturing process of pharmaceuticals.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Approximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI). Laboratory Instruction (LI). Sessional Work (SW), and Salf Learning (SL). As the course	Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the	Approx. Hrs	09	03	01	02	15
overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-05BT701.4: Analyz the	SO4.1 Elucidate about the	LI4.1	Unit-4Regulatory practices,	SL4.1 List down the various
Government regulatory policies,	Government regulatory	To perform the estimation of	biosensors and applications in	regulatory policies for
biosensors and application of	practices and policies,	bioactive components of plants	Pharmaceuticals	pharmaceuticals in India.
microbial enzymes in			CI4.1 Financing R&	
pharmaceuticals.			D capital and market outlook.	
1			IP, BP, USP.	
	SO4.2	LI4.2	CI4.2 Government regulatory	SL4.2 Read the role and
	Derive the rational drug design.	To perform enzyme extraction	practices and policies,	importance of FDA
		methods		-
	SO4.3 FDA perspective.		CI4.3 FDA perspective.	
	SO4.4 Illustrate Reimbursement		CI4.4 Reimbursement of drugs	
	of drugs and biologicals,		and biologicals, legislative	
	legislative perspective		perspective	
	SO4.5 Rational drug design.		CI4.5 Rational drug design.	
	SO4.6 Study Immobilization		CI4.6 Immobilization	
	procedures for pharmaceutical		procedures for pharmaceutical	
	applications (liposomes).		applications (liposomes).	
	SO4.7 Study Macromolecular,		CI4.7 Macromolecular, cellular	
	cellular and synthetic drug		and synthetic drug carriers	
	carriers			
	SO4.8 Illustrate Biosensors in		CI4.8 Biosensors in	
	pharmaceuticals		pharmaceuticals	
	SO4.9 Explain Application of		CI4.9 Application of microbial	
	microbial enzymes in		enzymes in pharmaceuticals.	
	pharmaceuticals.			

Suggested Sessional	SW4.1 Assignments	Determine the various applications and importance of biosensors in pharmaceuticals.
Work (SW): anyone	SW4.2 Mini Project	Explain among the cellular and synthetic drug carriers.
	SW4.3 Other Activities (Specify)	Make a Power point presentation on Government regulatory policies.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	App	oroximateHour	S				
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx.Hrs	09	00	01	02	11
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-05BT701.5: EvaluateGood Laboratory Practices(GLP) and Good Manufacturing Practices (GMP) and safety in microbiology laboratory.	SO5.1 Elucidate the application and importance of GLP and GMP.		Unit-5Quality Assurance and Validation CI5.1 Good Manufacturing Practices (GMP)	SL5.1 Basic knowledge about requirement of microbiology laboratory.
	SO5.2 Good Laboratory Practices (GLP)		CI5.2 Good Laboratory Practices (GLP)	SL5.2 List down instruments used in m microbiology/
	SO5.3 Regulatory aspects of quality control.		CI5.3 Regulatory aspects of quality control.	
	SO5.4 Quality assurance SO5.5 quality management in pharmaceuticals		CI5.4 Quality assurance CI5.5 quality management in pharmaceuticals	
	SO5.6 ISO,WHO and US certification		CI5.6 ISO,WHO and US certification	
	SO5.7 Sterilization control. SO5.8 sterility testing		CI5.7 Sterilization control. CI5.8 sterility testing	
	SO5.9 Safety in microbiology laboratory.		CI5.9 Safety in microbiology laboratory.	

Suggested Sessional	SW5.1 Assignments	Explain the safety aspects in microbiology laboratory
Work (SW): anyone	SW5.2 Mini Project	Describe the Good laboratory Practices in detail.
		Differentiate between quality control and quality assurance.
	SW5.3 Other Activities (Specify)	Prepare power point presentation on ISO, WHO and US certification for pharmaceuticals.

Course duration (in hours) to attain Course Outcomes:

Course Title: Pharmaceutical Biotechnology **Course Code:05BT701 Course Outcomes(COs) Class lecture** Self-Learning Sessional work **Total Hours** Laboratory Instruction(LI) (SL) (**SW**) (Li+CI+SL+SW) (**CI**) **CO1-05BT701.1:** Elucidate the basic fundamentals of 9 2 16 4 1 antibiotics, chemical disinfectants, antiseptics and preservatives. CO2-05BT701.2: Explain the mode of action of different 9 4 3 17 1 antibiotic and non-antibiotic antimicrobial agents as well as drug targeting and drug delivery system CO3-05BT701.3: Applied knowledge about microbial 9 3 17 4 1 production and Spoilage of pharmaceutical Products and new vaccine technology CO4-05BT701.4: Analyze the Government regulatory 9 3 2 1 15 policies, biosensors and application of microbial enzymes in pharmaceuticals CO5-05BT701.5: Evaluate Laboratory 9 2 Good 0 11 1 Practices(GLP) and Good Manufacturing Practices (GMP) and safety in microbiology laboratory. 45 **Total Hours** 15 12 77 05

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Design and Operation of Bioreactor

Course Code:05BT701

Course Outcomes		Marks I	Distribution	n	
	Α	An	Е	С	Total Marks
CO1-05BT701.1: Elucidate the basic fundamentals of antibiotics, chemical disinfectants,	2	1	1	1	5
antiseptics and preservatives.					
CO2-05BT701.2: Explain the mode of action of different antibiotic and non-antibiotic	2	4	5	1	12
antimicrobial agents as well as drug targeting and drug delivery system					
CO3-05BT701.3: Applied knowledge about microbial production and Spoilage of	3	5	5	1	14
pharmaceutical Products and new vaccine technology					
CO4-05BT701.4: Analyz the Government regulatory policies, biosensors and application of	2	3	5	1	11
microbial enzymes in pharmaceuticals					
CO5-05BT701.5: EvaluateGood Laboratory Practices(GLP) and Good Manufacturing Practices	2	4	1	1	10
(GMP) and safety in microbiology laboratory.					
Total Marks	11	17	17	05	50

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Pharmaceutical Microbiology – Edt. By W.B.Hugo& A.D.Russell Sixth edition. Blackwell scientific
	Publications.
2	Analytical Microbiology – Edt by Frederick Kavanagh Volume I & amp; amp; II. Academic Press New York.
3	Quinolinone antimicrobial agents - Edt. by David C. Hooper, John S.Wolfson .ASM Washington DC.
4	Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New
	York.
5	Biotechnology – Edt. by H.J.Rehm& amp; G.Reed, Vol 4. VCH Publications, Federal Republic of
	Germany.
6	Pharmaceutical Biotechnology by S.P.Vyas& amp; V.K.Dixit. CBS Publishers & amp; amp; Distributors, New
	Delhi.
7	Good Manufacturing Practices for Pharmaceuticals Second Edition, by Sydney H.Willig, Murray
	M.Tuckerman, William S.Hitchings IV. Mercel Dekker NC New York.
8	Advances in Applied Biotechnology Series Vol 10, Biopharmaceuticals in transition. Industrial
	Biotechnology Association by Paine Webber. Gulf Publishing Company Houston.
9	Drug Carriers in biology & amp; amp; Medicine Edt. by Gregory Gregoriadis. Academic Press New York.

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Group Discussion
- 4. Role play
- 5. Demonstration
- 6. ICT Based teaching Learning
- 7. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) biotechnology Semester: VII Semester Course Title: Pharmaceutical Biotechnology. Course Code: 05BT701

CO/PO/PSO Mapping								
Course Outcome (COs)		Progran	n Outcom	Program	Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3
CO1-05BT701.1: Elucidate the basic fundamentals of	1	2	-	1	2	2	2	1
CO2-05BT701.2: Explain the mode of action of different antibiotic	-	1	1	-	-	1	1	2
and non-antibiotic antimicrobial agents as well as drug targeting and								
CO3-05BT701.3: Applied knowledge about microbial production	1	1	2	1	-	3	1	1
and Spoilage of pharmaceutical Products and new vaccine								
CO4-05BT701.4: Analyz the Government regulatory policies,	1	1	1	_	2	1	1	3
biosensors and application of microbial enzymes in pharmaceuticals								
CO5-05BT701.5: EvaluateGood Laboratory Practices(GLP) and	2	1	1	-	-	1	3	2
laboratory.								

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	Cos	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
	CO1-05BT701.1: -Elucidate the basic	SO1.1 SO1.2	LI 1	1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,	1SL-1,2
PO 1,2,4,5	fundamentals of antibiotics, chemical	SO1.3 SO1.4	LI 2	1.9	
	disinfectants, antiseptics and	SO1.5 SO1.6			
PSO 1,2, 3	preservatives.	SO1.7 SO1.8			
		SO1.9			
	CO2-05BT701.2: -05BT701.2: Explain	SO2.1 SO2.2	LI 1	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,	2SL-1,2,3
PO2,3,	the mode of action of different antibiotic	SO2.3 SO2.4	LI 2	2.9	
	and non-antibiotic antimicrobial agents	SO2.5 SO2.6			
PSO 1,2, 3	as well as drug targeting and	SO2.7 SO2.8			
	drug delivery system	SO2.9			
	CO3-05BT701.3: - Applied knowledge	SO3.1 SO3.2	LI 1	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2,3
PO 1,2,3,4	about microbial production and	SO3.3	LI 2		
	Spoilage of pharmaceutical Products	SO3.4SO3.5			
PSO 1,2, 3	and new vaccine technology	SO3.6 SO3.7			
		SO3.8 SO3.9			
	CO4-05BT701.4: -Analyz the	SO4.1 SO4.2	LI 1	4.1,4.2,4.3,4.4, 4.5,	4SL-1,2
PO 1,2,3,5	Government regulatory policies,	SO4.3 SO4.4	LI 2	4.6,4.6,4.7,4.8, 4.9	
	biosensors and application of microbial	SO4.5 SO4.6			
PSO 1,2, 3	enzymes in pharmaceuticals	SO4.7 SO4.8			
		SO4.9			
	CO5-05BT701.5: -EvaluateGood	SO5.1 SO5.2		5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,	5SL-1,2
PO 1.2.3.	Laboratory Practices(GLP) and Good	SO5.3		5.9	
	Manufacturing Practices (GMP) and	SO5.4SO5.5			
PSO 1.2. 3	safety in microbiology laboratory.	SO5.6 SO5.7			
		SO5.8 SO5.9			

Program name	Bachelor of Science. (Hons) Biotechnology					
Semester	VII					
Course Code:	05BT702					
Course title:	Stem Cell & Tissue Engineering	Curriculum Developer: Dr. Monika Soni, Assistant Professor				
Pre-requisite:	Students should have basic knowledge of stem	cell & tissue engineering				
Rationale:	The subject aims to provide an overview of st tissue engineering, and the potential implication	tem cells & tissue engineering, and describe the current progress with stem cell research in ns on medical treatment.				
Course Outcomes (COs):	CO1-05BT702.1: To comprehend the fundame CO2-05BT702.2: To comprehend the isolatic various medical conditions. CO3-05BT702.3: To demonstrate a comprehen CO4-05BT702.4: To demonstrate a comprehen CO5-05BT702.5: Todemonstrate a comprehen	entals of stem cells, including their properties, and the technology behind stem cell therapy. on of embryonic stem cells, techniques, differentiation, and potential uses of stem cells in nsive understanding of tissue engineering, and the application of cell transplantation. nsive understanding of biomaterials and their applications in tissue engineering. sive understanding of the principles and practices of gene therapy and its applications.				

Scheme of Studies:

Board of Study	Course Code	Course Title	CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits(C) (L:T:P=3:0:1)	
Major (DSC)	05BT702	Stem Cell & Tissue Engineering	3	2	1	2	8	3+1=4	

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

 Note:
 SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

					Sch	neme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major (DSC)	05BT702	Stem Cell & Tissue Engineering	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					S	cheme of Assessr	nent (Marks)		
					Progressive A	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Major	05BT702-L	Stem Cell & Tissue	35	5	5	5	50	50	100
(DSC)		Engineering							

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	A	pproximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom	ΙΓ	Item	CI	LI	SW	SL	Total
Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course			-			-	10
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the		Approx.Hours	9	4	1	5	19
overall achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO1-05BT702.1: To comprehend the fundamentals of stem cells, including their properties, and the technology	SO1.1 Describe and define the stem cells.		Unit-1 CI1.1 Brief in detail introduction of stem cells.	SL1.1 Search various reference books and other study material to start the learning about stem cells.
behind stem cell therapy.	SO1.2 Explain in detail the properties of stem cells.	LI1.1 To observe and understand the properties of stem cells.	CI1.2 Describe the properties of stem cells.	SL1.2 Gain a basic understanding of stem cells and their significance in biology and medicine.
	SO1.3 Explain in detail the types of stem cells.		CI1.3 Describe the types of stem cells.	SL1.3 Explore the different types of stem cells and their characteristics.
	SO1.4 Explain in detail the sources of stem cells.		CI1.4 Describe the sources of stem cells.	SL1.4 Investigate the various sources of stem cells and their significance in research and therapy.
	SO1.5 Explain in detail the umbilical cord stem cells.	LI1.2 To isolate and culture umbilical cord stem cells for further study.	CI1.5 Study the umbilical cord stem cells.	
	SO1.6 Describe thetechnology of stem cells.		CI1.6 Describe the technology of stem cells therapy.	SL1.5 Explore the technology and techniques used in stem cells therapy.
	SO1.7 Describe the applications of stem cells therapy.		CI1.7 Discuss the applications of stem cells therapy.	
	SO1.8 Discuss the ethical and regulatory considerations.		CI1.8 Discuss the ethical and regulatory considerations.	
	SO1.9 Discuss the future perspective and opportunities.		CI1.9 Discuss the future perspective and opportunities.	

Suggested Sessional	SW1.1 Assignment	Describe in detail the sources of stem cells.
Work (SW): anyone	SW1.2 Mini Project	Describe and define the stem cells and technology of stem cells therapy.
	SW1.3 Other Activities (Specify)	Explain in detail the ethical and regulatory considerations related to stem cells.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	5	19

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO2-05BT702.2: To comprehend the isolation of embryonic stem cells, techniques, differentiation.	SO2.1 Describe and define the embryonic stem cells.	LI2.1 To understand the process of isolating ESCs and stimulating their differentiation <i>in vitro</i> .	Unit-2 CI2.1 Brief in detail introduction to embryonic stem cells.	SL2.1 Search various reference books and other study material to start the learning about Stem cells.
and potential uses of stem cells in various medical conditions.	SO2.2 Explain in detail the isolation of embryonic stem cells.		CI2.2 Study the isolation of embryonic stem cells.	SL2.2 Gain an understanding of the processes involved in isolating and stimulating
	SO2.3 Explain in detail the stimulation of embryonic stem cells differentiation.		CI2.3 Study the stimulation of embryonic stem cells differentiation.	embryonic stem cells (ESCs) for differentiation.
	SO2.4 Explain in detail the differentiation of adult stem cells.		CI2.4 Study the differentiation of adult stem cells.	
	SO2.5 Describe and define the transdifferentiation and plasticity of adult stem cells	LI2.2 To explore the differentiation potential and plasticity of adult stem cells.	CI2.5 Describe and define the transdifferentiation and plasticity of adult stem cells.	SL2.3 Explore the differentiation potential and plasticity of adult stem cells.
	SO2.6 Discuss the similarities and dissimilarities between embryonic and adult stem cells.		CI2.6 Discuss the similarities and dissimilarities between embryonic and adult stem cells.	SL2.4 Compare and contrast the properties of embryonic and adult stem cells.
	SO2.7 Explian in detail the potential uses of stem cells in parkinson's disease and limb amputation.		CI2.7 Study the potential uses of stem cells in parkinson's disease and limb amputation.	SL2.5 Explore the potential applications of stem cell therapy in treating different medical conditions.
	SO2.8 Explian in detail the potential uses of stem cells in heart disease and spinal cord injuries.		CI2.8 Study the potential uses of stem cells in heart disease and spinal cord injuries.	
	SO2.9 Explian the potential uses of stem cells in diabetes, burns, and alzheimer's disease.		CI2.9 Study the potential uses of stem cells in diabetes, burns, and alzheimer's disease.	

Suggested Sessional	SW1.1 Assignment	Describe in detail the isolation and stimulations of embryonic stem cells.
Work (SW): anyone	SW1.2 Mini Project	Explain in detail the differentiation, transdifferentiation, and plasticity of adult stem cells.
	SW1.3 Other Activities (Specify)	Explain in detail the potential uses of stem cells in parkinson's and alzheimer's disease.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	4	18

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)	
CO3-05BT702.3:Todemonstrateacomprehensiveunderstandingunderstandingoftissue	SO3.1 Describe and define the tissue engineering.		Unit-3 CI3.1 Brief in detail to introduction of tissue engineering.	SL3.1 Search various reference books and other study material to start the learning about tissue engineering.	
application of cell transplantation.	SO3.2 Describe the fundamentals of tissue engineering.	LI3.1 To introduces students to the concept and strategies of tissue engineering.	CI3.2 Describe the fundamentals of tissue engineering.	SL3.2 Gain a foundational understanding of tissue engineering concepts and its	
	SO3.3 Describe the general strategies for tissue replacement.		CI3.3 Describe the general strategies for tissue replacement.	significance in modern medicine.	
	SO3.4 Describe the cellular therapies in tissue engineering.		CI3.4 Describe the cellular therapies in tissue engineering.	SL3.3 Explore the current status of tissue engineering research and applications.	
	SO3.5 Describe the open system of cell transplantation.	LI3.2 To demonstrate the process of tissue engineering using an open system of cell transplantation.	CI3.5 Describe the open system of cell transplantation.	SL3.4 Examine the potential future directions and emerging research areas in tissue engineering.	
	SO3.6 Explain in detail the scaffold design and fabrication.		CI3.6 Study the scaffold design and fabrication.		
	SO3.7 Explain in detail thebiomolecular strategies in tissue engineering.		CI3.7 Study the bimolecular strategies in tissue engineering.		
	SO3.8 Discuss the present status of tissue engineering.		CI3.8 Discuss the present status of tissue engineering.		
	SO3.9 Discuss the future aspects and research directions.		CI3.9 Discuss the future aspects and research directions.		

Suggested Sessional	SW3.1 Assignment	Describe in detail to bimolecular strategies in tissue engineering.
Work (SW): anyone	SW3.2 Mini Project	Explain in detail to open and close system of cell transplantation.
	SW3.3 Other Activities (Specify)	Prepare one review article on cellular therapies in tissue engineering.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	2	1	4	16

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4-05BT702.4:Todemonstrateacomprehensiveof	SO4.1 Describe and define the biomaterials in tissue engineering.		Unit-4 CI4.1 Brief in detail introduction to biomaterials in tissue engineering.	SL4.1 Search various reference books and other study material to start the learning about biomaterials
biomaterials and their applications in tissue engineering.	SO4.2 Explain in detailthe degradable polymeric scaffolds.	LI4.1 To fabricate degradable polymeric scaffolds and acellular bio-matrices, and seed them with cells for tissue engineering applications.	CI4.2 Study the degradable polymeric scaffolds.	and bioreactors in tissue engineering.
	SO4.3 Explain in detail theacellular bio-matrices.		CI4.3 Study the a-cellular bio- matrices.	
	SO4.4 Explain in detailthe biological-derived polymers in tissue engineering.		CI4.4 Studythe biological-derived polymers in tissue engineering.	
	SO4.5 Explain in detailthe cell seeding of scaffolds.		CI4.5 Study the cell seeding of scaffolds.	SL4.2 Learn about various methods for seeding cells onto scaffolds in tissue engineering.
	SO4.6 Describe and define the allogenic cells.		CI4.6 Describe the cell sources in tissue engineering: allogenic cells.	SL4.3 Understand the different cell sources used in tissue engineering and their applications.
	SO4.7 Describe and define the autologous cells.		CI4.7 Describe the cell sources in tissue engineering: autologous cells.	
	SO4.8 Describe and define the stem cells.		CI4.8 Describe the cell sources in tissue engineering: stem cells.	
	SO4.9 Explain in detail thebioreactors in tissue engineering: naughton's and pulsatile bioreactors.		CI4.9 Study the bioreactors in tissue engineering: naughton's and pulsatile bioreactors.	SL4.4 Familiarize yourself with bioreactor systems used for culturing engineered tissues in tissue engineering.

Suggested Sessional	SW4.1 Assignments	Describe and define the biomaterials in tissue engineering.
Work (SW): anyone	SW4.2 Mini Project	Describe in the detail bioreactors in tissue engineering: naughton's and pulsatile bioreactors.
	SW4.3 Other Activities (Specify)	Study one research article on biomaterials used in tissue engineering.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	1	1	3	14

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5-05BT702.5: To demonstrate a comprehensive understanding of the	SO5.1 Describe and define the gene therapy.	LI5.1 To design and construct gene delivery vectors for potential use in gene therapy applications.	Unit-5 CI5.1 Brief in detail introduction to gene therapy.	SL5.1 Search various reference books and other study material to start the learning about gene therapy.
principles and practices of gene therapy and its applications.	SO5.2 Explain in detail therequirements of gene therapy.		CI5.2 Studythe requirements of gene therapy.	
	SO5.3 Explain in detail the genetic defects and disease.		CI5.3Describe the genetic defects and disease.	
	SO5.4 Explain in detail the target cells for gene therapy.	LI5.1 To perform in vitro transfection experiments and analyze gene expression in target cells.	CI5.4 Study the target cells for gene therapy.	
	SO5.5 Describe the process of gene therapy.		CI5.5 Describe the process of gene therapy.	
	SO5.6 Explain in detail thefactors responsible for effective gene therapy.		CI5.6 Study the factors responsible for effective gene therapy.	
	SO5.7 Discuss the recent developments in gene therapy research.		CI5.7 Discuss the recent developments in gene therapy research.	SL5.2 Explore recent advancements and breakthroughs in the field of gene therapy.
	SO5.8 Discuss the ethical considerations of gene therapy.		CI5.8 Discuss the ethical considerations of gene therapy.	SL5.3 Investigate the ethical implications and considerations associated with gene therapy research and application.
	SO5.9 Describe the clinical applications and future directions.		CI5.9 Describe the clinical applications and future directions.	

Suggested Sessional	SW5.1 Assignments	Explain in detail genetic defects and disease.
Work (SW): anyone	SW5.2 Mini Project	Describe in detail the gene therapy.
	SW5.3 Other Activities (Specify)	One case study of gene therapy.

Course duration (in hours) to attain Course Outcomes:

Course Title: Stem cell & tissue engineering

Course Code: 05BT702

Course Outcomes (COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours
	(CI)	Instruction (LI)	(SL)	(SW)	(Li+CI+SL+SW)
CO1-05BT702.1: To comprehend the fundamentals of	9	4	5	1	17
stem cells, including their properties, and the technology					
behind stem cell therapy.					
CO2-05BT702.2: To comprehend the isolation of	9	4	5	1	17
embryonic stem cells, techniques, differentiation, and					
potential uses of stem cells in various medical conditions.					
CO3-05BT702.3: To demonstrate a comprehensive	9	4	4	1	18
understanding of tissue engineering, and the application of					
cell transplantation.					
CO4.05BT702.4 : To demonstrate a comprehensive	9	2	4	1	16
understanding of biomaterials and their applications in					
tissue engineering.					
CO5-05BT702.5: To demonstrate a comprehensive	9	1	3	1	14
understanding of the principles and practices of gene					
therapy and its applications.					
Total Hours	45	15	21	05	86

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Stem cell & tissue engineering

Course Code: 05BT702

Legend:R, Remember; U, Understand; A, Apply; A, Analyze

Course Outcomes		larks Di	Total Marks		
	R	U	Α	Α	
CO1-05BT702.1: To comprehend the fundamentals of stem cells, including their properties, and the technology behind stem cell therapy.	2	2	3	2	9
CO2-05BT702.2: To comprehend the isolation of embryonic stem cells, techniques, differentiation, and potential uses of stem cells in various medical conditions.	2	3	3	3	11
CO3-05BT702.3: To demonstrate a comprehensive understanding of tissue engineering, and the application of cell transplantation.		3	3	2	10
CO4-05BT702.4: To demonstrate a comprehensive understanding of biomaterials and their applications in tissue engineering.		3	3	2	10
CO5-05BT702.5: To demonstrate a comprehensive understanding of the principles and practices of gene therapy and its applications.		2	3	3	10
Total Marks	10	13	15	12	50
Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	Robert Lanza, Robert Langer, Joseph P. Vacanti, and Antonios G. Mikos., Principles of Tissue Engineering. Academic
	Press.
2.	Jonathan Slack., Stem Cells: A Very Short Introduction. New York Oxford University Press, 2016.
3.	Robert Lanza, Anthony Atala, and Helen M. Blau., Essentials of Stem Cell Biology. Academic Press, 2014
4.	Eapen Cherian, G Nandhini, Anil Kurian., Stem Cells. Jaypee Brothers Medical Publishers (P) Ltd. 2011.

(b) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to stem cell biology lab
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biotechnology **Semester:** VIIthSemester **Course Title:** Stem cell & tissue engineering **Course Code:** 05BT702

	CO/PO/PSO Mapping														
Course Outcome (Cos)		Program Outcomes (POs)									Program Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-05BT702.1: To comprehend the fundamentals of stem cells, including their properties, and the technology behind stem cell therapy.	3	1	-	2	2	2	-	2	2	1	2	1	3	3	2
CO2-05BT702.2: To comprehend the isolation of embryonic stem cells, techniques, differentiation, and potential uses of stem cells in various medical conditions.	1	2	-	2	2	2	2	2	1	1	2	1	2	2	2
CO3-05BT702.3: To demonstrate a comprehensive understanding of tissue engineering, and the application of cell transplantation.	2	2	1	2	2	1	1	2	1	1	2	1	3	2	2
CO4-05BT702.4: To demonstrate a comprehensive understanding of biomaterials and their applications in tissue engineering.	2	2	-	2	2	2	2	2	1	1	3	2	3	2	2
CO5-05BT702.5: To demonstrate a comprehensive understanding of the principles and practices of gene therapy and its applications.	3	2	1	2	3	3	2	1	1	2	2	1	3	2	3

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	_
PO1,2,3,4,5,6,7,8,9,	CO1-05BT702.1: To comprehend the	SO1.1 SO1.2	LI 1	1.1,1.2,1.3,1.4,1.5	1SL-1,2,3,4,5
10,11,12	fundamentals of stem cells, including their	SO1.3 SO1.4	LI 2	1.6,1.7,1.8,1.9	
	properties, and the technology behind stem	SO1.5 SO1.6			
PSO 1,2,3	cell therapy.	SO1.7 SO1.8			
		SO1.9			
PO1,2,3,4,5,6,7,8,9,	CO2-05BT702.2: To comprehend the	SO2.1 SO2.2	LI 1	2.1, 2.2, 2.3, 2.4,	2SL-1,2,3,4,5
10,11,12	isolation of embryonic stem cells, techniques,	SO2.3 SO2.4	LI 2	2.5,2.6,2.7,2.8,2.9	
	differentiation, and potential uses of stem	SO2.5 SO2.6			
PSO 1,2,3	cells in various medical conditions.	SO2.7 SO2.8			
		SO2.9			
PO1,2,3,4,5,6,7,8,9,	CO3-05BT702.3: To demonstrate a	SO3.1 SO3.2	LI 1	3.1,3.2,3.3,3.4,3.5,	3SL-1,2,3,4
10,11,12	comprehensive understanding of tissue	SO3.3 SO3.4	LI 2	3.6,3.7,3.8,3.9	
	engineering, and the application of cell	SO3.5 SO3.6			
PSO 1,2,3	transplantation.	SO3.7 SO3.8			
		SO3.9			
PO1,2,3,4,5,6,7,8,9,	CO4-05BT702.4: To demonstrate a	SO4.1 SO4.2	LI 1	4.1,4.2,4.3,4.4,4.5,	4SL-1,2,3,4
10,11,12	comprehensive understanding of biomaterials	SO4.3 SO4.4		4.6,4.7,4.8,4.9	
	and their applications in tissue engineering.	SO4.5 SO4.6			
PSO 1,2,3		SO4.7 SO4.8			
		SO4.9			
PO1,2,3,4,5,6,7,8,9,	CO5-05BT702.5: To demonstrate a	SO5.1 SO5.2	LI 1	5.1,5.2,5.3,5.4,5.5,	5SL-1,2,3
10,11,12	comprehensive understanding of the	SO5.3 SO5.4		5.6,5.7,5.8,5.9	
	principles and practices of gene therapy and	SO5.5 SO5.6			
PSO 1,2,3	its applications.	SO5.7 SO5.8			
		SO5.9			

Program Name	Bachelor of Science (B.Sc.)- Biotechnology								
Semester	VIII								
Course Code:	01BT801								
Course title:	Genomics and Proteomics Curriculum Developer: Sonal Gupta, Assistant Professor								
Pre-requisite:	Students should have basic knowledge of biochemistry, molecular biology and bioinformatics								
Rationale:	Genomics is an entry point for looking at genetic instructions provided by the DNA dynamic protein products and their interact proteins are identified at a certain time in an develop a protein-network map where inter	the other 'omics' sciences. Genomics provides an overview of the complete set of A, while transcriptomics looks into gene expression patterns. Proteomics studies ions. An application of proteomics is known as protein "expression profiling" where h organism as a result of the expression to a stimulus. Proteomics can also be used to action among proteins can be determined for a particular living system.							
Course Outcomes (COs):	CO1-01BT801.1: Understand about the funct CO2-01BT801.2: Outline the next-generatio CO3-01BT801.3: Introduction of proteomics CO3-01BT801.3: Introduction of proteomics a CO5-01BT801.5: Mass spectrometery and it	lamentals of genomics and related techniques. n sequencing techniques and bioinformatic tools used in genomic studies. s and various analytical approach to identify protein structures nd various analytical approach to identify protein structures s application in proteomics.							

Scheme of Studies:

		Course Title						
Board of Study	Course Code		Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	Total Credits (C) (L:T:P=3:0:1)
MAJOR	01BT801	Genomics and Proteomics	3	2	1	3	9	3+1=4

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	eme of Assessme	ent (Marks)			
				Progressive Assessment (PRA)						
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
MAJOR	01BT801	Genomics and Proteomics	15	20	10	5	50	50	100	

Scheme of Assessment: Practical

			Scheme of Assessment (Marks)								
					Progressive As	ssessment (PRA)					
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)		
MAJOR	01BT801-L	Genomics and Proteomics	35	5	5	5	50	50	100		

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate Hours					
levels, which students are anticipated to accomplish through various modes of instruction including						
Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL).	Item	Cl	LI	SW	SL	Total
As the course progresses, students should showcase their mastery of Session Outcomes (SOs).	Approx. Hrs	12	06	01	05	24
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-01BT801.1: Understand	SO1.1 An introduction of	LI1.1 List the basic	Unit-1Introduction of genomics	SL1.1 Find out some examples
genomics and related techniques.	genomics	software used for genomic study	CII.I Introduction to Genomics,	softwares used for genome assembly
	SO1.2 Describe DNA sequencing	LI1.2 Comparative study of DNA sequencing methods	CI1.2 DNA sequencing	SL1.2 Explain the manual methods of DNA sequencing
	SO1.3 Elaborate the methods of	LI1.2 Demonstration of	CI1.3 methods	SL1.3 Write down methodology
	DNA sequencing	DNA sequencing methods		of shotgun sequencing method of genome sequencing
	SO1.4 Define the manual and		CI1.4 manual and Automated	SL1.4 Write an overview on
	automated sequencing		Sequencing	genomics and its types
	SO1.5 Describe Maxam & Gilbert method		CI1.5 Maxam & Gilbert method	SL1.5 Collect information on NGS methods
	SO1.6 Elaborate Sanger method		CI1.6 Sangers method	
	SO1.7 Explain Pyrosequencing		CI1.7 Pyrosequencing,	
	SO1.8 Genome Sequencing:		CI1.8 Genome Sequencing: Shotgun	
	Shotgun methods,		methods,	
	SO1.9 Hierarchical (clone contig)		CI1.9 Hierarchical (clone contig)	
	methods,		methods,	
	SO1.10 Study automated: and.		CI1.10 automated: and. Computer	
	Computer tools for		tools for	
	SO1.11–Illustrate about		CI1.11–sequencing projects	
	sequencing projects			
	SO1.12 Learn about Genome		CI1.12 Genome sequence assembly	
	sequence assembly software.		software.	

Suggested Sessional	SW1.1 Assignments	Describe the role of bioinformatics and computational biology in genomics				
Work (SW):anyone	SW1.2Mini Project	Differentiate between shot gun and hierarchical method of genome sequencing				
	SW1.3 Other Activities (Specify)	Draw a flowchart compiling all steps of Sanger and Maxam Gilbert methods of DNA sequencing				

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate Hours					
levels, which students are anticipated to accomplish through various modes of instruction including						
Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning	Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs),	Approx. Hrs	12	06	01	05	24
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-01BT801.2: Outline the	SO2.1 Explainweb-based	LI2.1 Make a list of various	Unit-2	SL2.1 Find out all the
next-generation sequencing	server	browsers used for genome	Managing and	browser used to search
techniques and bioinformatic		analysis	Distributing Genome	genomic database
tools used in genomic studies.			Data	
			CI2.1Managing Genome Data:	
	SO2.2 Describe concept of	LI2.2 Make a chart of first,	CI2.2 Distributing Genome	SL2.2 Read the latest
	distributing genome data	second and next generation	Data	research in genome
		sequencing platforms		sequencing
	SO2.3 Describe various web		CI2.3 Web based servers	SL2.3 Write down a note on
	based servers			genome database
	SO2.4 Define the softwares	LI2.2 Demonstration of	CI2.4 software's for	SL2.4 Find out the different
	used for genome analysis	genome sequencing	genome analysis	kinds of platforms used for
		softwares	8	genome sequencing projects
	SO2.5 Explain the ENS		CI2.5 ENS	
	SO2.6 Explain EMBL		CI2.6EMBL	
	SO2.7Describe VISTA		CI2.7 VISTA	
	SO2.8 Learn about UCSC		CI2.8 UCSC	
	SO2.9 Study Genome		CI2.9 Genome Browser	
	Browser			
	SO2.10 To know about		CI2.10 NCBI genome.	
	NCBI genome.			
	SO2.11 Study about Model		CI2.11 Selected Model	
	Organisms'		Organisms'	
	SO2.12 Illustrate about		CI2.12 Genomes and	
	Genomes and Databases.		Databases.	

Suggested Sessional	SW2.1 Assignments	Describe browsers and servers used for genomic studies
Work (SW):anyone	SW2.2Mini Project	Make a comparative chart on genomic databases
	SW2.3 Other Activities (Specify)	Make apower point presentation on "Next Generation Sequencing".

This course syllabus illustrates the expected learning achievements, both at the course and session	Approximate Hours					
levels, which students are anticipated to accomplish through various modes of instruction including						
Classroom Instruction (CD, Laboratory Instruction (LD, Sessional Work (SW), and Self Learning	Item	Cl	LI	SW	SL	Total
(SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs).	Approx. Hrs	12	06	01	03	22
culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-01BT801.3: Introduction	SO3.1 Introduction to	LI3.1 To perform the gel	Unit-3	SL3.1 Study the various
of proteomics and various	concept of protein structure	electrophoresis for protein	CI3.1 Introduction to	chemical bonds stabilize
analytical approach to identify		separations	protein structure,.	protein structure
protein structures				
	SO3.2 Elaborate Chemical	LI3.2 To perform SDS	CI3.2Chemical properties of	SL3.2 Read the process of
	properties of proteins	PAGE	proteins	protein separation by gel electrophoresis
	SO3.3 Learn about Physical	LI3.2 To perform Native	CI3.3 Physical interactions	SL3.3 Find out the process
	interactions that determine	PAGE	that determine the property	of centrifugation and its
	the property of proteins.		of proteins.	application in proteomics
	SO3.4 Determination of size		CI3.4 Short-range	
	of protein		interactions, electrostatic	
			forces,	
	SO3.5 Explain the role of		CI3.5, van der waal	
	bonds in protein structure		interactions, hydrogen	
			bonds	
	SO3.6 Study Hydrophobic		CI3.6 Hydrophobic	
	interaction in proteins		interactions	
	SO3.7 study about		CI3.7 Determination of	
	Determination of sizes		sizes	
	SO3.8 study Sedimentation		CI3.8 Sedimentation	
	analysis		analysis	
	SO3.9 Learn gel filteration		CI3.9 gel filteration	
	SO3.10 Elaborate SDS-		CI3.10 SDS-PAGE); Native	
	PAGE); Native PAGE,		PAGE,	
	SO3.11 Study about		CI3.11 Determination of	
	covalent structures		covalent structures	
	SO3.12 Assess Edman		CI3.12 Edman degradation.	
	degradation.			

Suggested Sessional	SW3.1 Assignments	Describe the properties of proteins
Work (SW): anyone	SW3.2 Mini Project	Describe the role of SDS PAGE in proteomic studies
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on "Proteomics"

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	04	23

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4 01BT801.4 Understand 2D PAGE and its significance in proteomic studies.	SO4.1 Introduction and scope of proteomics;	LI4.1 To perform the protein separation by gel electrophoresis	Unit-4 Introduction and scope of proteomics CI4.1An overview on proteomics	SL4.1 Find out the applications of electrophoretic techniques in proteomics
	SO4.2 study its types	LI4.2To perform 2D PAGE	CI4.2 its types	SL4.2 List down various electrophoretic methods
	SO4.3 Elaborate its Scope		CI4.3Scope	SL4.3 Study electrophoresis
	SO4.4 Learn its Application	LI4.3 To perform the protein electrophoresis	CI4.4Application	SL4.4 Describe role of 2D PAGE proteomic studies.
	SO4.5 Study of Separation of proteins by 2D PAGE		CI4.5 Separation of proteins by using 2 D PAGE	
	SO4.6 Learn Concept of 2D PAGE		CI4.6 Concept of 2D PAGE	
	SO4.7 Study Sample Preparation		CI4.7 Sample Preparation	
	SO4.8 Study Process		CI4.8 Process	
	SO4.9 Assess Solubilization		CI4.9 Solubilization	
	SO4.10 study reduction		CI4.10 reduction	
	SO4. Illustrate 2D PAGE:		CI4.112D PAGE:	
	SO4.12 StudyResolution		CI4.12 Resolution	

Suggested Sessional	SW4.1 Assignments	Describe the working principle of electrophoretic techniques and their applications in protein studies
Work (SW): anyone	SW4.2 Mini Project	Read research articles on recent advancements in proteomics
	SW4.3 Other	Make a presentation on 2D PAGE
	Activities (Specify)	

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which	nich ApproximateHours					
students are anticipated to accomplish through various modes of instruction including Classroom Instruction						
(CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course progresses	Item	Cl	LI	SW	SL	Total
students should showcase their mastery of Session Outcomes (SOS), culminating in the overall achievement of	Approx.Hrs	12	06	01	04	23
Course Outcomes (COs) upon the course's conclusion.						

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Explain	LI5.1Make a list mass	Unit-5	SL5.1 Find out the industrial
reproducibility of 2D PAGE	spectrometric techniques	CI5.1 Reproducibility of 2 D	applications of functional
	used for proteomic	PAGE	proteomics
SO5.2 Explain Mass		CI5.2 Mass spectrometery:	SL5.2 What is
spectrometery: Concept		Concept	reproducibility in 2 D PAGE
SO5.3 Assess Mass		CI5.3 Mass spectrometery:	SL5.3 An overview on Mass
spectrometery: principle,		principle,	spectrometery
SO5.4 Study Mass	LI5.2 Demonstration of	CI5.4 Mass spectrometery:	SL5.4 Explain protein
spectrometery:	mass spectrometric	instrumentation	sequencing
instrumentation	techniques		
SO5.5 Learn Mass	LI5.2 Perform mass	CI5.5 Mass spectrometery:	
spectrometery: application	spectrometric techniques	application in proteome study	
in proteomics			
SO5.6 Study various		CI5.6 various techniques used	
techniques used for protein		for protein identification	
identification			
SO5.7 Assess De novo		CI5.7 De novo sequencing-	
sequencing- Concept		Concept	
SO5.8 Elaborate De novo		CI5.8 De novo sequencing-	
sequencing- Principle		Principle	
SO5.9 Assess De novo		CI5.9 De novo sequencing -	
sequencing - Method		Method	
SO5.10 Learn De novo		CI5.10 De novo sequencing –	
sequencing – Factors		Factors affecting	
affecting			
SO5.11 Study De novo		CI5.11 De novo sequencing -	
sequencing - Applications		Applications	
SO5.12 Study De novo		CI5.12 De novo sequencing	
sequencing using mass		using mass spectrometric data	
spectrometric data			
	Session Outcomes (SOs) SO5.1. Explain reproducibility of 2D PAGE SO5.2 Explain Mass spectrometery: Concept SO5.3 Assess Mass spectrometery: principle, SO5.4 Study Mass spectrometery: instrumentation SO5.5 Learn Mass spectrometery: application in proteomics SO5.6 Study various techniques used for protein identification SO5.7 Assess De novo sequencing- Concept SO5.8 Elaborate De novo sequencing- Principle SO5.9 Assess De novo sequencing - Principle SO5.9 Assess De novo sequencing - Method SO5.10 Learn De novo sequencing - Factors affecting SO5.11 Study De novo sequencing - Applications SO5.12 Study De novo sequencing using mass spectrometric data	Session Outcomes (SOs)Laboratory Instruction (LI)SO5.1. Explain reproducibility of 2D PAGELI5.1Make a list mass spectrometric techniques used for proteomicSO5.2 Explain Mass spectrometery: ConceptIIII Section SOS.3 Assess Mass spectrometery: principle,SO5.3 Assess Mass spectrometery: principle,LI5.2 Demonstration of mass spectrometric techniquesSO5.4 Study MassLI5.2 Demonstration of mass spectrometery: instrumentationSO5.5 Learn Mass spectrometery: application in proteomicsLI5.2 Perform mass spectrometric techniquesSO5.6 Study various techniques used for protein identificationLI5.2 Perform mass spectrometric techniquesSO5.6 Study various techniques used for protein identificationSO5.7 Assess De novo sequencing- PrincipleSO5.9 Assess De novo sequencing - MethodSO5.10 Learn De novo sequencing - Factors affectingSO5.11 Study De novo sequencing - ApplicationsSO5.12 Study De novo sequencing using mass spectrometric data	Session Outcomes (SOs)Laboratory Instruction (L1)Class room Instruction (CI)SO5.1 Explain reproducibility of 2D PAGELI5.1Make a list mass spectrometric techniques used for proteomicCI5.1Reproducibility of 2 D PAGESO5.2 Explain Mass spectrometery: ConceptCI5.2 Mass spectrometery: conceptCI5.2 Mass spectrometery: principle,SO5.4 Study Mass spectrometery: principle,LI5.2 Demonstration of mass spectrometric techniquesCI5.5 Mass spectrometery: instrumentationSO5.4 Study Mass

Suggested Sessional	SW5.1 Assignments	Explain reproducibility of 2 D PAGE
Work (SW): anyone	SW5.2 Mini Project	Describe various applications of proteomic studies
	SW5.3 Other Activities (Specify)	Prepare one article on the "Mass spectrometery"

Course duration (in hours) to attain Course Outcomes:

C Titles C. omics and Drotoomi

Course Title: Genomics and Pr		Course Code:01BT801				
Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours	
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)	
CO1-01BT801.1: Understand about the fundamentals	12	6	01	05	24	
of genomics and related techniques.						
CO2-01BT801.2: Outline the next-generation	12	6	01	05	24	
sequencing techniques and bioinformatic tools used in						
genomic studies.						
CO3-01BT801.3: Introduction of proteomics and	12	6	01	03	22	
various analytical approach to identify protein						
structures						
CCO3-01BT801.3: Introduction of proteomics and	12	6	01	04	23	
various analytical approach to identify protein						
structures						
CO5-01BT801.5: Mass spectrometery and its	12	6	01	04	23	
application in proteomics.						
Total Hours	60	30	05	21	116	

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Genomics and Proteomics

Course Code:01BT801

Course Outcomes	Marks Distribution				
	Α	An	E	С	Total Marks
CO1-01BT801.1: Understand about the fundamentals of genomics and related techniques.	2	1	1	1	5
CO2-01BT801.2: Outline the next-generation sequencing techniques and bioinformatic tools used in genomic studies.	2	4	5	1	12
CO3-01BT801.3: Introduction of proteomics and various analytical approach to identify protein structures	3	5	5	1	14
CCO3-01BT801.3: Introduction of proteomics and various analytical approach to identify protein structures	2	3	5	1	11
CO5-01BT801.5: Mass spectrometery and its application in proteomics.	5	4	1	0	10
Total Marks	14	17	17	04	52

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

- (a) Books:
- **(b)**

S.No.	Title/Author/Publisher details
1	Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2	Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3	Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and
	C.L. Patten, 2010.
4	Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5	Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6	Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
7	Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
8	Russell, P. J. (2509). I Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
9	Glick, B.R., Pasternak, J.J. (2503). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press,
	Washington.
10	Pevsner, J. (2509). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) Biotechnology Semester: V Semester Course Title: Genomics and proteomics Course Code: 01BT801

CO/PO Mapping															
Course Outcome		Program Outcomes (POs)									Program Specific Outcomes (PSOs)				
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-01BT801.1: Understand about the fundamentals of genomics and related techniques.	-	1	-	1	2	2	3	-	3	3	3	3	1	2	1
CO2-01BT801.2: Outline the next-generation sequencing techniques and bioinformatic tools used in genomic studies.	-	-	-	-	-	-	2	-	3	2	3	3	3	-	2
CO3-01BT801.3: Introduction of proteomics and various analytical approach to identify protein structures	-	-	1	1	-	-	3	-	3	1	-	-	1	2	-
CCO3-01BT801.3: Introduction of proteomics and various analytical approach to identify protein structures	1	-	1	-	2	-	2	3	-	1	-	1	2	1	3
CO5-01BT801.5: Mass spectrometery and its application in proteomics.	1	1	1	-	-	2	3	3	1	2	3	3	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curricul	um:				
POs & PSOs No.	COs	SOs No.	Laboratory	Classroom	Self-Learning (SL)
			Instruction (LI)	Instruction (CI)	
	CO1-01BT801.1: Understand about the	SO1.1 SO1.2	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4,	1SL-1,2,3,4,5
PO 1,2,3,4,5,6	fundamentals of genomics and related	SO1.3 SO1.4		1.5, 1.6, 1.7, 1.8,	
7,8,9,10,11,12	techniques.	SO1.5 SO1.6		1.9, 1.10, 1.11,	
		SO1.7 SO1.8		1.12	
PSO 1,2, 3		SO1.9 SO1.10			
		SO1.11 SO1.12			
	CO2-01BT801.2: Outline the next-	SO2.1 SO2.2	2.1, 2.2, 2.3,	2.1, 2.2, 2.3, 2.4,	2SL-1,2,3,4, 5
PO 1,2,3,4,5,6	generation sequencing techniques and	SO2.3 SO2.4		2.5, 2.6, 2.7, 2.8,	
7,8,9,10,11,12	bioinformatic tools used in genomic	SO2.5 SO2.6		2.9, 2.10, 2.11,	
	studies.	SO2.7 SO2.8		2.12	
PSO 1,2, 3		SO2.9 SO2.10			
		SO2.11 SO2.12			
	CO3-01BT801.3: Introduction of	SO3.1 SO3.2	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4,	3SL-1,2,3,4
PO 1,2,3,4,5,6	proteomics and various analytical	SO3.3 SO3.4		3.5, 3.6, 3.7, 3.8,	
7,8,9,10,11,12	approach to identify protein structures	SO3.5 SO3.6		3.9, 3.10, 3.11,	
		SO3.7 SO3.8		3.12	
PSO 1,2, 3		SO3.9 SO3.10			
		SO3.11 SO3.12			
	CCO3-01BT801.3: Introduction of	SO4.1 SO4.2	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4,	4SL-1,2,3,4
PO 1,2,3,4,5,6	proteomics and various analytical	SO4.3 SO4.4		4.5, 4.6, 4.7, 4.8,	
7,8,9,10,11,12	approach to identify protein structures	SO4.5 SO4.6		4.9, 4.10, 4.11,	
		SO4.7 SO4.8		4.12	
PSO 1,2, 3		SO4.9 SO4.10			
		SO4.11 SO4.12			
	CO5-01BT801.5: Mass spectrometery and	SO5.1 SO5.2	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4,	5SL-1,2,3,4,5
PO 1,2,3,4,5,6	its application in proteomics.	SO5.3 SO5.4		5.5, 5.6, 5.7, 5.8,	
7,8,9,10,11,12		SO5.5 SO5.6		5.9, 5.10, 5.11,	
		SO5.7 SO5.8		5.12	
PSO 1,2, 3		S05.9 SO5.10			
		SO5.11 SO5.12			

Program Name	Bachelorof Science (Hons.) in Biotechnology (B.Sc. (Hons.) BT)							
Semester	VIII	VIII						
Course Code:	02BC801							
Course title:	Mammalian Physiology Curriculum Developer: Chahana Desai, Teaching Associate							
Pre-requisite:	Students should have basic knowledge of biology, general chemistry and human anatomy.							
Rationale:	Mammalian Physiology is the study of physical of human physiology, homeostasis, molecular at	al and biological functions of mammals. Students will learn about the fundamental concepts and cellular physiology and the functions of tissues, organs and organ systems.						
CourseOutcomes (COs):	CO1-02BC801.1: Elucidate the basic fundame CO2-02BC801.2: Explain the mechanism of c CO3-02BC801.3: Elaborate the detailed know CO4-02BC801.4: Analyze the Nervous system CO5-02BC801.5: Evaluate different types of e	ntals of digestive system and respiratory system. irculatory system and cardiac system in humans. ledge about muscle physiology and muscle movement as well as excretory system. and endocrine systems in human body. endocrine glands and mode of action of various hormones.						

Scheme of Studies:

					Scheme of	fstudies (Hou	ırs/Week)	Total Credits(C)
Board of Study	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	(L:T:P=3:0:1)
MINOR	02BC801	Mammalian Physiology	3	0	1	2	6	3+0=3

 Legends:
 CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);

 LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);

 SW: Sessional Work (includes assignment, seminar, mini project etc.);

 SL: Self Learning;

 C: Credits.

 Nata:
 SW & SL has to be planned and performed under the centinuous guidance and feedback of teacher to achieve course of

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

					Sch	eme of Assessme	ent (Marks)		
					Progressive Ass	essment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MINOR	02BC801	Mammalian Physiology	15	20	10	5	50	50	100

Scheme of Assessment: Practical

					Se	cheme of Assessr	nent (Marks)		
					Progressive As	ssessment (PRA)			
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
MINOR	02BC801-L	Mammalian Physiology	35	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which	Ар	proximate Hou	rs				
students are anticipated to accomplish through various modes of instruction including Classroom Instruction							
(CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL). As the course progresses		Item	Cl	LI	SW	SL	Total
students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of		Approx. Hrs	09	04	01	02	16
Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-02BC801.1 Elucidate	SO1.1 Explain the	LI1.1 Demonstration of	Unit-1Digestion and	SL1.1 Write down important
the basic fundamentals of	detailed concept of	action of an enzyme	Respiration Digestion:	terminologies related to
digestive system and	digestion and	involved in digestion.	CI1.1 Mechanism of	human physiology
respiratory system.			digestion	
	SO1.2 Explain the	LI1.2 Demonstration of	CI1.2 , absorption of	SL1.2 Write down enzymes
	process of absorption	mechanism of digestion.	carbohydrates, Proteins,	involved in digestion of
			Lipids and nucleic acids	various biomolecules.
	SO1.3 Elaborate the		CI1.3 Composition of bile	
	composition of bile			
	SO1.4 Study about		CI1.4 Saliva, Pancreatic	
	Saliva, Pancreatic juice		juice	
	SO1.5 Illustrate about		CI1.5 gastric and intestinal	
	gastric and intestinal juice		juice	
	SO1.6 Explain		CI1.6 Respiration: Exchange	
	respiration: Exchange of		of gases,	
	gases,			
	SO1.7 Study transport of		CI1.7 Transport of O2 and	
	O2 and CO2		CO2	
	SO1.8 Illustrate oxygen		CI1.8 Oxygen dissociation	
	dissociation curve		curve	
	SO1.9 Discuss about		CI1.9 Chloride shift	
	Chloride shift			

Suggested Sessional	SW1.1 Assignments	Describe of O2 and CO2 in detail.					
Work (SW):anyone		List out various organs involved in respiration.					
	SW1.2Mini Project	Draw human digestive system with respective functions mentioned.					
	SW1.3 Other Activities (Specify)	Make a power point presentation onhow exchange of gases takes place during respiration.					

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which	Ap	proximate Hou	rs				
students are anticipated to accomplish through various modes of instruction including Classroom Instruction							
(CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course progresses		Item	Cl	LI	SW	SL	Total
students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of		Approx. Hrs	09	08	01	02	20
Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-02BC801.2	SO2.1 Explain the	LI2.1 Finding the	Unit-2Circulatory	SL2.1 Note down the
Explain the mechanism of	composition of blood and	coagulation time of blood	system and Cardiac	characteristics of different
circulatory system and	types of blood cells and		system:	types of blood cells.
cardiac system in humans	their importance.		CI2.1 Composition of	
			blood,	
	SO2.2 Elucidate the	LI2.2 To determine blood	CI2.2 Plasma proteins &	SL2.2 List out the normal
	principles and mechanism	groups	their role,	range of different blood
	of blood clotting			cells.
	SO2.3 Elaborate the	LI2.3 Counting of	CI2.3 Types and	
	mechanism and	mammalian RBCs	importance of blood cells,	
	importance of cardiac		_	
	activity			
	SO2.4 Learn Mechanism	LI2.4 Determination of	CI2.4 Mechanism of	
	of Haemopoisis,	TLC and DLC	Haemopoisis,	
	SO2.5 Study Mechanism		CI2.5 Mechanism of	
	of		coagulation of blood.	
	coagulation of blood.		_	
	SO2.6 Explain		CI2.6 Mechanism of	
	Mechanism of working of		working of heart	
	heart			
	SO2.7 Study Cardiac		CI2.7 Cardiac output,	
	output,			
	SO2.8 Elaborate cardiac		CI2.8 cardiac cycle	
	cycle		-	
	SO2.9 Discuss Origin &		CI2.9 Origin &	
	conduction of heart beat.		conduction of heart beat.	

 Suggested Sessional Work (SW):anyone
 SW2.1 Assignments
 Describe the blood clotting process and various component involved in the process.

 SW2.2Mini Project
 Draw a detailed Cardiac cycle.

 SW2.3 Other Activities (Specify)
 Make Power point presentation on origin and conduction of heart beat with required visuals.

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	ls, ApproximateHours						
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx.Hrs	10	02	01	02	15
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI) Class room Instruction (CI)		Self-Learning (SL)
CO3-02BC801.3	SO3.1 Elucidate the	LI3.1 To perform	Unit-3Muscle physiology	SL3.1
Elaborate the detailed	knowledge about structure	Physicochemical analysis	and excretory system:	Read about microtubules
knowledge about muscle	of different types of	of specific antibiotic.	CI3.1 Muscle physiology	and microfilaments.
physiology and muscle	muscle.	-	and osmoregulation	
movement as well as			Structure of cardiac,	
excretory system.			smooth &skeletal muscle,	
	SO3.2 Explain about the		CI3.2 threshold stimulus,	SL3.2
	mechanism of excretory		All or None rule, ,	Read theof characteristics
	system			of different types of
				muscle.
	SO3.3 Analyse the organs		CI3.3 single muscle	
	involved in muscle		twitch, muscle tone	
	function.			
	SO3.4 Illustrate about		CI3.4 isotonic and	
	isotonic and isometric		isometric contraction,.	
	contraction,.			
	SO3.5 Study physical,		CI3.5 Physical, chemical	
	chemical and electrical		and electrical events	
	events			
	SO3.6 Explain mechanism		CI3.6 mechanism of	
	of muscle contraction.		muscle contraction.	
	SO3.7 Discuss excretion:		CI3.7 Excretion: modes of	
	modes of excretion		excretion	
	SO3.8 Learn ornithine		CI3.8 Ornithine cycle	
	cycle			
	SO3.9 Discuss mechanism		CI3.9 Mechanism of urine	
	of urine formation.		formation.	

Suggested Sessional	SW3.1 Assignments	Flow chart on mechanism of formation of Urine.
Work (SW): anyone	SW3.2 Mini Project	Describe the importance of muscle movements.
	SW3.3Other Activity	Prepare one Power point presentation on muscle contraction and relaxation.
		4//

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Approximate Hours					
which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI). I aboratory Instruction (II) Sessional Work (SW) and Self Learning (SL). As the course	Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall	Approx. Hrs	09	01	01	01	12
achievement of Course Outcomes (COs) upon the course's conclusion.						

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-02BC801.4 Analyze the	Unit-4Nervous system	LI4.1 Explain about the	Unit-4Nervous system	SL4.1 List down the
Nervous system and	SO4.1 Elucidate Nervous	conduction of nerve	CI4.1 Nervous system	various parts and its
endocrine systems in human	system	impulse.		function involved in
body.				nervous system.
	SO4.2 Explore Nervous		CI4.2, Nervous	
	Coordination		Coordination	
	SO4.3 Study about		CI4.3 Endocrine	
	Endocrine Coordination		Coordination	
	SO4.4 Discuss about		CI4.4 Nervous and	
	nervous and endocrine		endocrine coordination	
	coordination			
	SO4.5 Study Mechanism		CI4.5 Mechanism of	
	of generation		generation	
	SO4.6 Explain		CI4.6 propagation of	
	propagation of nerve		nerve impulse	
	impulse		-	
	SO4.7 Discuss structure		CI4.7 structure of synapse	
	of synapse			
	SO4.8 Study synaptic		CI4.8 synaptic conduction,	
	conduction,			
	SO4.9 Illustrate about		CI4.9 Neurotransmitters.	
	Neurotransmitters.			

Suggested Sessional	SW4.1 Assignments	Determine the various types of neurotransmitters.
Work (SW): anyone	SW4.2 Mini Project	Draw a detailed structure of synapse.
	SW4.3 Other Activities (Specify)	Make a Power point presentation on propagation of nerve impulse.

This course syllabus illustrates the expected learning achievements, both at the course and session	ApproximateH	Iours					
levels, which students are anticipated to accomplish through various modes of instruction			1				
including Classroom Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self		Item	Cl	LI	SW	SL	Total
Learning (SL). As the course progresses, students should showcase their mastery of Session		Approx.Hrs	09	00	01	01	11
Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the							
course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-02BC801.5	SO5.1 Elucidate the		Unit-5endocrine glands and	SL5.1
Evaluate different types of	application and importance		hormones	Basic knowledge about
endocrine glands and mode of	of endocrine system.		CI5.1Mechanism of action of	importance of hormones.
action of various hormones.			hormones	*
	SO5.2 Describe the		CI5.2 (insulin and steroids).	
	mechanism of action of			
	Insulin and steroid			
	SO5.3Analyze the different		CI5.3 Different endocrine	
	endocrine glands with its		glands– Hypothalamus,	
	role.			
	CI5.4 Explain role of		CI5.4 pituitary,	
	pituitary gland			
	CI5.5 Illustrate about		CI5.5 pineal,	
	pineal,			
	CI5.6 Study the role of		CI5.6 thymus,	
	thymus,			
	CI5.7 Study function of		CI5.7 thyroid,	
	thyroid,			
	CI5.8 Discuss about		CI5.8 parathyroid and adrenals,	
	parathyroid and adrenals,			
	CI5.9 Explain hypo &		CI5.9 hypo & hyper-secretions	
	hyper-secretions of		of hormones	
	hormones			

Suggested Sessional	SW5.1 Assignments	Explain the mechanism of hormones.
Work (SW): anyone	SW5.2 Mini Project	Make a chart of different types of hormones, its source of secretion and source of action.
	SW5.3 Other Activities (Specify)	Prepare power point presentation on endocrine system.

Course duration (in hours)to attain Course Outcomes:

Course Title: Mammalian Physiology Course Code:02BC801					
Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-02BC801.1- Elucidate the basic fundamentals of digestive system and respiratory system.	9	4	2	1	15
CO2-02BC801.2- Explain the mechanism of circulatory system and cardiac system in humans	9	8	2	1	18
CO3-02BC801.3- Elaborate the detailed knowledge about muscle physiology and muscle movement as well as excretory system.	9	2	2	1	13
CO4-02BC801.4- Analyz the Nervous system and endocrine systems in human body.	9	1	1	1	14
CO5-02BC801.5- Evaluate different types of endocrine glands and mode of action of various hormones.	9	0	1	1	12
Total Hours	45	15	08	05	72

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Mammalian Physiology

Course Code:

Course Outcomes					
	Α	An	Ε	С	Total Marks
CO1-02BC801.1- Elucidate the basic fundamentals of digestive system and respiratory system.	2	1	1	1	5
CO2-02BC801.2-Explain the mechanism of circulatory system and cardiac system in humans	2	4	5	1	12
CO3-02BC801.3- Elaborate the detailed knowledge about muscle physiology and muscle movement as well as excretory system.	3	5	5	1	14
CO4-02BC801.4- Analyz the Nervous system and endocrine systems in human body.	2	3	5	1	11
CO5-02BC801.5- Evaluate different types of endocrine glands and mode of action of various hormones.	2	4	1	1	10
Total Marks	11	17	17	05	50

Legend: A, Apply ;An, Analyze; E, Evaluate ;C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Guyton, A.C. & amp; Hall, J.E. (2506). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd.
	/W.B. Saunders Company.
2	Tortora, G.J. & amp; Grabowski, S. (2506). Principles of Anatomy & amp; Physiology. XI Edition. John wiley& amp;
	sons,Inc.

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Group Discussion
- 4. Role play
- 5. Demonstration
- 6. ICT Based teaching Learning
- 7. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) biotechnology Semester: VIII Semester Course Title: Mammalian physiology. Course Code: 02BC801

	CO/PO Mapping														
Course Outcome					J	Program O	outcomes	(POs)					Program Specific Outcomes (PSOs)		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02BC801.1- Elucidate the basic fundamentals of digestive system and respiratory system.	-	1	-	1	2	2	1	-	3	1	3	1	1	2	1
CO2-02BC801.2- Explain the mechanism of circulatory system and cardiac system in humans	-	1	-	-	-	-	3	-	3	2	3	3	3	-	2
CO3-02BC801.3- Elaborate the detailed knowledge about muscle physiology and muscle movement as well as excretory system	-	2	1	1	-	-	3	-	3	1	3	3	1	1	1
CO4-02BC801.4- Analyz the Nervous system and endocrine systems in human body.	1	-	1	-	2	2	2	3	-	1	3	3	2	2	3
CO5-02BC801.5- Evaluate different types of endocrine glands and mode of action of various hormones.	1	-	2	-	-	2	3	3	-	2	3	3	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	Cos	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5, 6,	CO1-02BC801.1-Elucidate the basic	SO1.1 SO1.2	LI 1	1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,	1SL-1,2
7, 8, 9 10, 11,	fundamentals of digestive system and	SO1.3 SO1.4	LI 2	1.9	
12	respiratory system.	SO1.5 SO1.6			
		SO1.7 SO1.8			
PSO 1,2,3		SO1.9			
PO 1,2,3,4,5, 6,	CO2-02BC801.2- Explain the	SO2.1 SO2.2	LI 1	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,	2SL-1,2,
7, 8, 9 10, 11,	mechanism of circulatory system and	SO2.3 SO2.4	LI 2	2.9	
12	cardiac system in humans.	SO2.5 SO2.6	LI 3		
		SO2.7 SO2.8	LI 4		
PSO 1,2,3		SO2.9			
PO 1,2,3,4,5, 6,	CO3-02BC801.3-Elaborate the	SO3.1 SO3.2		3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2
7, 8, 9 10, 11,	detailed knowledge about muscle	SO3.3	LI 1		
12	physiology and muscle movement as	SO3.4SO3.5			
	well as excretory system.	SO3.6 SO3.7			
PSO 1,2,3		SO3.8 SO3.9			
PO 1,2,3,4,5, 6,	CO4-02BC801.4-Analyz the Nervous	SO4.1 SO4.2	LI 1	4.1,4.2,4.3,4.4, 4.5,	4SL-1
7, 8, 9 10, 11,	system and endocrine systems in	SO4.3 SO4.4		4.6,4.6,4.7,4.8, 4.9	
12	human body.	SO4.5 SO4.6			
		SO4.7 SO4.8			
PSO 1,2,3		SO4.9			
PO 1,2,3,4,5, 6,	CO5-02BC801.5-Evaluate different	SO5.1 SO5.2		5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,	5SL-1
7, 8, 9 10, 11,	types of endocrine glands and mode of	SO5.3		5.9	
12	action of various hormones.	SO5.4SO5.5			
		SO5.6 SO5.7			
PSO 1,2,3		SO5.8 SO5.9			

Program Name	Bachelor of Science (B.Sc.)- Biotechnology						
Semester	VIII	VIII					
Course Code:)2MB801						
Course title:	Bioprocess Engineering Curriculum Developer: Er. Arpit Srivastava, Assistant Professor						
Pre-requisite:	Students should have basic knowledge of microbiology and fermentation						
Rationale:	Bioprocess engineering leans heavily on individuals who are capable of translating the complexity of both biomedical research and engineering into actionable processes that lead to the creation of new products. A bioprocess is any process that uses living cells to create a product, while engineering is the science of designing and building complex machines or processes. To that end, bioprocess engineering is the planning, construction, execution, and revision of the biological and mechanical processes required to create new products within the life sciences. Develop bioengineering skills for the production and purification of biochemical product using biochemical processes.						
Course Outcomes	CO1-02MB801.1: Define various modes and te	echniques of fermentation					
(COs):	CO2-02MB801.2: Differentiate and predict the suitability of the fermentation methods and vessels						
	CO3-02MB801.3: Identify and develop the microbial inoculum for industrial processing						
	CO4-02MB801.4: Interpret the mechanism of fermentation process in industry						
	CO5-02MB801.5: Examine the mechanism of	biological product development using microbes					

Scheme of Studies:

					Total Credits(C)				
Board of Study	Course Code	CourseTitle	Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	(L:T:P=3:0:1)	
MINOR	02MB801	Bioprocess Engineering	3	2	1	3	9	3+1=4	

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others); LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.); SL: Self Learning; C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

				Scheme of Assessment (Marks)						
			I							
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
MINOR	02MB801	Bioprocess Engineering	15	20	10	5	50	50	100	

Scheme of Assessment: Practical

				Scheme of Assessment (Marks)						
					Progressive A	ssessment (PRA)				
Board of Study	Course Code	Course Title	Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)	
MINOR	02MB801	Bioprocess Engineering	35	5	5	5	50	50	100	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	04	18

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-03MB321.1. Define various modes and techniques of fermentation	SO1.1 Explain the concept of Fermentation	LI1.1 To Demonstrate the working of a Bench Top bioreactor	Unit-1IntroductiontoFermentationCI1.1Introductiontobioprocess technologyCI1.1Introductionto	SL1.1 Search various reference books and study material to start the learning of microorganisms
	SO1.2 Elaborate the about bioprocess technology	LI1.2 To perform the isolation of microorganisms from different kinds of samples	CI1.2Range of bioprocess technology	SL1.2 Find out the literature showing use of fermentation technology in ancient India
	SO1.3 Elaborate the historical perspective of fermentation		CI1.3 its chronological development	SL1.3 Derive the equation representing mode of fermentations
	SO1.4 Explain the basic principles of fermentation		CI1.4 Basic principles,	SL1.4 Explore different bioproducts manufacture in laboratory using various modes of fermentation
	SO1.5 Learn about components of fermentation technology		CI1.5 components of fermentation technology	
	SO1.6 Study the modes of Fermentation		CI1.6 Modes of Fermentation	
	SO1.7 Elaborate different categories of fermentation		CI1.7 (Batch, Fed & continuous) with derivation of equations	
	SO1.8 Explain different types of microbial culture		CI1.8 Types of microbial culture	

Suggested Sessional	SW1.1 Assignments	Describe in detail "Applications of Microorganisms in various Sectors"				
Work (SW):anyone	SW1.2Mini Project	Make a project on "Historical Process of Fermentation and Products produced in India"				
	SW1.3 Other Activities (Specify)	List down the tables of different domains of microorganisms which are industrially important				

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Арр	roximate Hours	5				
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx.Hrs	09	06	01	04	20
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-03MB321.2. Differentiate and predict the suitability of the fermentation methods and vessels	SO2.1 Explain the role of industrial scope of fermentation and role of inoculum development	LI2.1 To Demonstrate the working of Equipment's used in Sterilization	Unit-2 Overview different fermentation parameters CI2.1Design of bioprocess vessels	SL2.1 Search various reference books and study material on to preparing inoculum/starter culture/seed culture
	SO2.2 Derive the roles of microbial growth kinetics	LI2.2To perform screening of microorganisms from different kinds of samples	CI2.2 Significance of Impeller, Baffles, Sparger	SL2.2 Find out the how Microbial growth phases occurs in laboratory-based protocols
	SO2.3 Compare different types of culture vessels	LI2.3To prepare the different kinds of nutrient media for microbial culture	CI2.3Types of culture/production vessels	SL2.3 Derive the equation representing various mode of fermentations
	SO2.4 Differentiate among Modes of Fermentation		CI2.4 Airlift; Cyclone Column	SL2.4 Explore different bioproducts manufacture using various modes of fermentation
	SO2.5 Explain all fundamentals of Upstream Processing		CI2.5 Packed Tower	
	SO2.6 Study types of Reactors on the basis of their applications		CI2.6 Types of Reactors on the basis of their applications	
	SO2.7 Explain the Principles of upstream processing		CI2.7 Principles of upstream processing	
	SO2.8 Explainn media preparation		CI2.8 Media preparation	
	SO2.9 Study about noculum development and sterilization		CI2.9 Inoculum development and sterilization	

Suggested Sessional	SW1.1 Assignments	Write down any 5 kinds of Unit Operations used in Sterilization				
Work (SW):anyone	SW1.2Mini Project	Make a project on showing how microbial colonies grow on different kinds of Culture Media				
	SW1.3 Other Activities (Specify)	Derive equations and Numerical problems based on "Modes of Fermentation"				

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	00	01	05	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-03MB321.3 Identify	SO3.1 Explain the Basic		Unit-3	SL3.1 Search various reference
and develop the microbial	design and construction of		CI3.1 Introduction to	books and study material to
inoculum for industrial	fermenter and ancillaries		oxygen requirement in	define various kinds of reactors
processing			bioprocess.	used in industries
	SO3.2 Study mass transfer		CI3.2 ; mass transfer	SL3.2 Find out the literature
	coefficient		coefficient;	showing production of acids
				and slovents in industries
	SO3.3 Ebaborate the factors		CI3.3 factors affecting	SL3.3 Find out how Biogas can
	affecting			be produced
	SO3.4 Study about KLa		CI3.4 KLa	SL3.4 Write about different
				bioproducts manufacture in
				laboratory
	SO3.5 Explore about		CI3.5 Bioprocess	SL3.5 Find out the applications
	Bioprocess measurement		measurement	of Solid-substrate fermentation
				in industries
	SO3.6 To know the control		CI3.6 control system	
	system			
	SO3.7 Study about Process		CI3.7 Process Control	
	Control			
	SO3.8 Assess control with		CI3.8 Control with	
	computer		computer	
	SO3.9 Explain about		CI3.9 computer aided	
	computer aided process		process control	
	control			

Suggested Sessional	SW3.1 Assignments	Describe in detail cultivation of microorganisms					
Work (SW):anyone	SW3.2Mini Project	Prepare a flowchart showing industrial production of biological products using fermentation					
	Make a Power Point Presentation on "Different Types of Microbial Culture Media"						

This course syllabus illustrates the expected learning achievements, both at the course and session levels,	Is, Approximate Hours						
which students are anticipated to accomplish through various modes of instruction including Classroom							
Instruction (CI) Laboratory Instruction (LI) Sessional Work (SW) and Self Learning (SL) As the course		Item	Cl	LI	SW	SL	Total
progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall		Approx. Hrs	09	04	01	04	18
achievement of Course Outcomes (COs) upon the course's conclusion.							

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-03MB321.4.	SO4. 1Explain the concept	LI4.1To perform the Wine	Unit-4	SL4.1 Find out more on
Interpretate the mechanism of	of downstream processing	production using fruit wate	CI4.1 Introduction to	Solvents and their
fermentation process in industry		and yeast	downstream processing	production process
	SO4.2 Study about principle	LI4.2 To prepare the	CI4.2 Principle of Down	SL4.2 List out the difference
	of Down Stream Processing	different kinds of	Stream Processing	between Solid and
		Submerged Substrates for		Submerged State
		microbial culture		Fermentation
	SO4.3 Learn about methods		CI4.3 Methods of	SL4.3 Explore the role of
	of Downstream Processing		Downstream Processing	Diffusion, distribution and
				Dispersion in Mass transfer
	SO4.4 Explain about		CI4.4 Product recovery	SL4.4 Draw a well labelled
	product recovery			diagram of different kinds of
				bioreactors and its parts
	SO4.5 Study the techniques		CI4.5 Techniques of Product	
	of Product recovery		recovery	
	SO4.6 Study about		CI4.6 Purification	
	Purification			
	SO4.7 Learn principle and		CI4.7 Principle and methods	
	methods			
	SO4.8 Study the effluent		CI4.8 Effluent treatment	
	treatment			
	SO4.9 Learn about methods		CI4.9 Methods and	
	and application		application	

Suggested Sessional	SW4.1 Assignments	Explain the role of Solid and Submerged State Fermentation					
Work (SW): anyone	SW4.2 Mini Project	Describe how therapeutics being produced in biotech-based industries					
	SW4.3 Other Activities (Specify)	Make a list of different kinds of microorganisms which can produce fermented products					

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

 Approximate Hours

 Item
 Cl
 LI
 SW
 SL
 Total

 Approx.Hrs
 09
 01
 01
 03
 14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-03MB321.5	SO5.1 Discuss about Basics	LI5.1To perform the	Unit-5Downstream Process	SL5.1 Explore the various
Examine the mechanism of	of Downstream Processing	downstream processing	CI5.1 Basics of Downstream	kinds of biopolymers and
biological product development		using various unit	Processing	their applications
using microbes		operations		
	SO5.2 Explain the Role of		CI5.2 Role of Downstream	SL5.2 Read research on
	Downstream processing in		processing in Fermentation	advancement in production
	Fermentation Technology		Technology	of biofertilizers
	SO5.3 Discuss about Product		CI5.3 Product recovery.	SL5.3 Explore various
	recovery.			protocols for the microbial
				production of other vitamins
	SO5.4 Explore about		CI5.4 Purification	
	Purification			
	SO5.5 Explain about		CI5.5 Effluent treatment	
	Effluent treatment			
	SO5.6 Study microbial		CI5.6 Microbial production	
	production of ethanol		of ethanol	
	SO5.7 Discuss microbial		CI5.7 Microbial production	
	production of amylase		of amylase	
	SO5.8 Discuss microbial		CI5.8 Microbial production	
	production of lactic acid		of lactic acid	
	SO5.9 Explore microbial		CI5.9 Microbial production	
	production of Single Cell		of Single Cell Proteins	
	Proteins			

Suggested Sessional	SW5.1 Assignments	Explain general characteristics of Downstream processing and its significance
Work (SW): anyone	SW5.2 Mini Project	Describe the production process of acids and other biomolecules through fermentation
	SW5.3 Other	Make a power point presentation on "Downstream Processing and Unit Operations associated with it"
	Activities (Specify)	

Course duration (in hours) to attain Course Outcomes:

Course Title: Bioprocess Engin		Course Code:02MB801					
Course Outcomes(COs)	Class lecture	Laboratory	Self-Learning	Sessional work	Total Hours		
	(CI)	Instruction(LI)	(SL)	(SW)	(Li+CI+SL+SW)		
CO1-02MB801.1: Define various modes and techniques of	9	4	4	1	18		
fermentation							
CO2-02MB801.2:Differentiate and predict the suitability	9	6	4	1	20		
of the fermentation methods and vessels							
CO3-02MB801.3:Identify and develop the microbial	9	0	5	1	15		
inoculum for industrial processing							
CO4-02MB801.4: Interpretate the mechanism of	9	4	4	1	18		
fermentation process in industry							
CO5-02MB801.5:Examine the mechanism of biological	9	1	3	1	14		
product development using microbes							
Total Hours	45	15	20	05	85		

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Bioprocess Engineering

Course Code:02MB801

Course Outcomes		Marks Distribution					
	Α	An	Ε	С	Total Marks		
CO1-02MB801.1: Define various modes and techniques of fermentation	2	1	1	0	5		
CO2-02MB801.2: Differentiate and predict the suitability of the fermentation methods and vessels	2	4	3	0	10		
CO3-02MB801.3:Identify and develop the microbial inoculum for industrial processing	3	5	4	1	15		
CO4-02MB801.4: Interpretate the mechanism of fermentation process in industry	2	3	2	1	10		
CO5-02MB801.5:Examine the mechanism of biological product development using microbes		4	2	2	10		
Total Marks	14	17	12	04	50		

Legend:A, Apply;An, Analyze;E, Evaluate;C, Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Textbook of Microbiology by Ananthnarayanan and Paniker's, eighth edition, Universities Press
2	Microbiology; Lansing M Prescott, John P. Harley, Donald A Klein, Sixth edition, Mc Graw Hill Higher education.
3	J.E. Bailey and D.F. Ollis, Biochemical Engineer-ing Fundamentals, McGraw-Hill, New York
4	Industrial Microbiology and Biotechnology, Pradeep Verma, Springer, 2022
5	An Introduction to Industrial Microbiology, Sivakumar, K. Sukesh and Joe, S. Chand Publications, 2010
6	Principle of Fermentation Technology-P.F. Stanbury, A. Whitakerand S.J.Hall –Butterworth, New Delhi

(c) Online Resources:

Suggested instructions/Implementation strategies:

- 1. Improved lecture
- 2. Tutorial
- 3. Case method
- 4. Group Discussion
- 5. Role play
- 6. Visit to Industrial plant of fermentation industries
- 7. Demonstration
- 8. ICT Based teaching Learning
- 9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biotechnology Semester: V Semester Course Title: Bioprocess Engineering Course Code: 02MB801

CO/PO Mapping															
Course Outcome		Program Outcomes (POs)										Program Specific Outcomes (PSOs)			
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-02MB801.1: Define various modes and techniques of fermentation	-	1	-	1	2	2	1	-	3	1	3	1	1	2	1
CO2-02MB801.2: Differentiate and predict the suitability of the fermentation methods and vessels	-	1	-	-	-	-	3	-	3	2	3	3	3	-	2
CO3-02MB801.3: Identify and develop the microbial inoculum for industrial processing	-	2	1	1	-	-	3	-	3	1	3	3	1	1	1
CO4-02MB801.4: Interpretate the mechanism of fermentation process in industry	1	-	1	-	2	2	2	3	-	1	3	3	2	2	3
CO5-02MB801.5: Examine the mechanism of biological product development using microbes	1	-	2	-	-	2	3	3	-	2	3	3	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs	COs	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning (SL)
No.			Instruction (LI)		
PO 1,2,3,4,5, 6,		SO1.1 SO1.2	LI 1	1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,	1SL-1,2,3,4
7, 8, 9 10, 11,	CO1-02MB801.1: Define various modes and techniques of fermentation	SO1.3 SO1.4	LI 2	1.9	
12		SO1.5 SO1.6			
		SO1.7 SO1.8			
PSO 1,2,3		SO1.9			
PO 1,2,3,4,5, 6,		SO2.1 SO2.2	LI 1	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,	2SL-1,2,3,4
7, 8, 9 10, 11,	CO2-02MB801.2:Differentiate and	SO2.3 SO2.4	LI 2	2.9	
12	predict the suitability of the fermentation	SO2.5 SO2.6	LI 3		
	methods and vessels	SO2.7 SO2.8			
PSO 1,2,3		SO2.9			
PO 1,2,3,4,5, 6,		SO3.1 SO3.2		3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2,3,4,5
7, 8, 9 10, 11,	CO3-02MB801.3:Identify and develop	SO3.3			
12	the microbial inoculum for industrial	SO3.4SO3.5			
	processing	SO3.6 SO3.7			
PSO 1,2,3		SO3.8 SO3.9			
PO 1,2,3,4,5, 6,		SO4.1 SO4.2	LI 1	4.1,4.2,4.3,4.4, 4.5,	4SL-1,2,3,4
7, 8, 9 10, 11,	CO4-02MB801.4: Interpretate the	SO4.3 SO4.4	LI 2	4.6,4.6,4.7,4.8, 4.9	
12	mechanism of fermentation process in	SO4.5 SO4.6			
	industry	SO4.7 SO4.8			
PSO 1,2,3		SO4.9			
PO 1,2,3,4,5, 6,	CO5-02MB801.5:Examine the	SO5.1 SO5.2	LI 1	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,	5SL-1,2,3
7, 8, 9 10, 11,	mechanism of biological product	SO5.3		5.9	
12	development using microbes	SO5.4SO5.5			
	-	SO5.6 SO5.7			
PSO 1,2,3		SO5.8 SO5.9			