Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of Four Year Multidisciplinary Degree (Honors) Programme with Multiple Entry and Exit option

Undergraduate Programme of Science and Technology

B.Sc. (Honors) in Biotechnology

Board of Studies

in

Biotechnology

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

[UG II Year]

w.e.f. June, 2024

(In Accordance with NEP-2020)

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of B.Sc. **(Honors) in Biotechnology** Programme to be effective from the **Academic Year 2024-25.**

Date: 16/04/2024

Place: Latur

(Dr.Sachin Kulkarni)
Chairperson
Board of Studies in Biotechnology
Rajarshi Shahu Mahavidyalaya, Latur
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Under the Faculty of Science and Technology

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3	**Dr. Rahul. P. Bhagat** Asst. Professor, Department of Biotechnology, Govt. Institute of Science, Aurangabad (Autonomous)	Member	Academic Council Nominee
4	**Dr. Rajesh M. Jorgewad** Asst. Professor, Department of Biotechnology and Bioengineering, KIT college, Kolhapur (Autonomous)	Member	Academic Council Nominee
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17	**Dr. Kakasaheb S. Raut**	Member	Member from same Faculty

From the Desk of the Chairperson…

Biotechnology as a subject is a highly interdisciplinary that combines biological sciences with engineering technologies to manipulate living organisms and biological systems to produce products that advances healthcare, medicine, agriculture, food, pharmaceuticals and environment. At its simplest, biotechnology is technology based on biology - which harnesses cellular and bimolecular processes to develop technologies and products that help to improve our lives and health of our planet.

Taking into consideration of the importance of Biotechnology, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous), have taken an initiative to introduce a new emerging field as an undergraduate Programme in biotechnology under the faculty of science. B. Sc. Biotechnology is a Three-year graduate degree program which is started in the academic year 2004-05 followed by the postgraduate program started in academic year 2006-07.

National Education Policy (NEP) 2020 recognizes the relevance of biotechnology in the education system due to its interdisciplinary nature, potential for research and innovation, and its alignment with the development of 21st-century skills. By integrating biotechnology into the curriculum, the policy aims to prepare students for the challenges and opportunities of a rapidly advancing biotechnology driven world.

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation a self-reliant and global leader. In the same spirit, we at Department of Biotechnology, have developed a curriculum framework to encompass the goals of NEP 2020. In the overall curriculum we have incorporated choice of courses of study, creating academic pathways having constructive combinations with multiple entry and exit points as well as focus on experiential learning for students by introducing multidisciplinary, skill enhancement, vocational courses along generic elective(s) and course based on Indian knowledge system and actual Hand's on training in the recent and trending areas of Biotechnology.

With reference to global changes occurring in higher education in various national and foreign universities, the newly designed syllabi of B.Sc. Biotechnology as per NEP 2020 guidelines are effectively implemented from June, 2023. The committee members of Board of Studies in Biotechnology also took the local need and employability of graduate students into consideration while framing the given curriculum, keeping in view of the guidelines given in the University Grants Commission, New Delhi.

By aligning curriculum development, pedagogy, interdisciplinary connections, research opportunities, industry collaborations, teacher training, and available infrastructure with the institute, the department of biotechnology plans to integrate students with a comprehensive understanding of biotechnology, foster critical thinking and research skills, and prepare them for future careers in the field.

(Dr. Sachin Kulkarni)
Chairperson
Board of Studies in Biotechnology

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Faculty of Science and Technology

Structure for Four Year Multidisciplinary Undergraduate Degree Programme in Biotechnology Multiple Entry and Exit (In accordance with NEP-2020)

Year & Level	Sem	Major		Minor	GE/OE	VSC/ SEC (VSEC)	AEC/ VEC	OJT,FP,CEP, RP	Credit per Sem.	Cum./Cr. per exit
		DSC	DSE							
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**10**
II 5.0	III	DSC V: 04 Cr. DSC VI: 04 Cr.	NA	Minor I:04 Cr.	GE-III: 02 Cr.	SEC-III: 02 Cr.	AEC-III:02 Cr.	CC-I: 02 Cr. (SSC) Field Project: 02 Cr.	22	88 Cr. UG Diploma
	IV	DSC VII: 04 Cr. DSC VIII: 04 Cr.	NA	Minor II:04 Cr.	GE-IV: 02 Cr.	SEC-IV: 02 Cr.	AEC-IV: 02	CC-II: 02 Cr. (SSC) Field Project: 02 Cr..	22	
	Cum. Cr.	16	-	08	04	04	04	08	44	
Exit Option: Award of UG Diploma in Major with 88Credits and Additional 04 Credits Core NSQF Course/Internship or continue with Major and Minor										

Abbreviations:

1. DSC : Discipline Specific Core (Major)
2. DSE : Discipline Specific Elective (Major)
3. DSM : Discipline Specific Minor
4. GE/OE : Generic/Open Elective
5. VSEC : Vocational Skill and Skill Enhancement Course
6. VSC : Vocational Skill Courses
7. SEC : Skill Enhancement Course
8. AEC : Ability Enhancement Course
9. MIL : Modern Indian Languages
10. IKS : Indian Knowledge System
11. FSRCE : Fostering Social Responsibility & Community Engagement
12. VEC : Value Education Courses
13. OJT : On Job Training
14. FP : Field Projects
15. CEP : Community Engagement and Service
16. CC : Co-Curricular Courses
17. RP : Research Project/Dissertation
18. SES : Shahu Extension Services

Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science & Technology

Programme Outcomes (POs) for B.Sc. Programme	
PO 1	
PO 2	
PO 3	
PO 4	
PO 5	
PO 6	
PO 7	

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Programme Specific Outcomes (PSOs) for B.Sc. Biotechnology (Honors)	
PSO No.	Upon completion of this programme, the students will be able to -
PSO 1	Prepare the students with the skills, ethics, aptitude and human values of practicing the science in day-to-day life
PSO 2	Promote the interdisciplinary research in biotechnology for tackling the future problems threatening the society
PSO 3	Equip the students with the abilities required to attain self-sufficiency and life sustainability by imparting entrepreneurial skills
PSO 4	Design process equipment, plants, biosensors and recombinant molecules for biotechnological and allied processes
PSO 5	Identify measures for energy, environment, health, safety and society following ethical principles and apply the knowledge of basic science and engineering to solve complex biotechnological problems
PSO 6	Isolate, purify and characterize biological samples using sophisticated analytical experimental techniques
PSO 7	Apply modern software tools including prediction and modeling methods on biological databases to identify issues in biomedical problems
PSO 8	Assess personal, product and environmental safety, intellectual property and social responsibilities related to modern biotechnological research and development

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Department of Biotechnology

B.Sc. (Honors) in Biotechnology

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
II 5.0	III	201BIO3101 (DSC-V)	Immunology and Virology	03	45
		201BIO3103	Lab Course-V	01	30
		201BIO3102 (DSC-VI)	Metabolism	03	45
		201BIO3104	Lab Course-VI	01	30
		201BIO3301 (Minor I)	Applied Microbiology	03	45
		201BIO3302	Lab Course-Minor I	01	30
		(GE-III)	From Basket	02	30
		(SEC-III)	From Basket	02	30
		AEC-III	From Basket	02	30
		CC-I		02	60
		AIPC/OJT-I	Field Project	02	60
	Total Credits			**22**	
	IV	201BIO4101 (DSC-VII)	Molecular Biology	03	45
		201BIO4103	Lab Course-VII	01	30
		201BIO4102 (DSC-VIII)	Biocatalysis & Enzyme Engineering	03	45
		201BIO4104	Lab Course-VIII	01	30
		201BIO4301 (Minor II)	Clinical Microbiology	03	45
		201BIO4302	Lab Course-Minor II	01	30
		(GE-IV)	From Basket	02	30
		(SEC-IV)	From Basket	02	30
		(AEC-III)	From Basket	02	30
		CC-II		02	60
		AIPC/OJT-I	Mini project/ Field Project	02	60
	Total Credits			**22**	
Total Credits (Semester III & IV)				**44**	

SEMESTER III

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Department of Biotechnology

Course Type: DSC-V

Course Title: Immunology and Virology

Course Code: 201BIO3101

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To understand Innate and Adaptive immune response.
LO 2. To understand the variation in structure of antibody and their biological significance.
LO 3. To understand biological role of the cells of Immune system.
LO 4. To understand mechanism of T and B cell signalling.
LO 5. To know Affinity and avidity Immunological reactions
LO 6. To study the working mechanism of primary, secondary & tertiary lymphoid organs.
LO 7. To get the knowledge about the discovery & structure of viruses.
LO 8. To learn about the lytic and lysogenic cycle of bacteriophage.

Course Outcomes:

After completion of course the student will be able to-

CO 1 Extend comprehensive understanding of the fundamental concepts in immunology, including innate and adaptive immunity, antigen recognition, and immune cell interactions.
CO 2 Understand the functions and biological role of cells and organs of the immune system.
CO 3 Understand the basic virology principles, including viral structure, classification, replication cycles.
CO 4 Understand the epitopes, paratopes, haptens, adjuvant and its types.
CO 5 Acquire the knowledge about life cycle & replication of viruses.
CO 6 Adapt the information about ggeneral structure of antibody molecule
CO 7 Acquaint the knowledge of vaccines and antiviral drugs.
CO 8 Integrate knowledge from immunology and virology to understand the immune responses to viral infections, including viral evasion strategies and immune-mediated pathology.

Unit No.	Title of Unit & Contents	Hrs.
I	**Overview of Immunology**	**11 Hrs.**
	1. Historical perspective 2. Innate and Adaptive Immune response. 3. Hematopoiesis 4. Cells of Immune system and their biological role.	

Unit No.	Title of Unit & Contents	Hrs.
	5. Humoral and cell mediated Immunity (T and B cell signalling) 6. The Primary and Secondary lymphoid organs. 7. Tertiary Lymphoid Tissues	
	Unit Outcomes: UO 1 Extend understanding of the mechanisms of T and B cell signalling. UO 2 Describe the biological role of cells of immune system.	
II	**Basics of Immunology**	**13 Hrs.**
	1. Antigen: Antigens- General properties & types 2. Factors that influence antigenicity 3. Epitopes, Paratopes, Haptens, adjuvant and its types. 4. Antibody: General Structure of antibody molecule 5. Antibodies- variation in structure of antibody and their biological significance. 6. Antibody Antigen interactions: Strength of Antigen-Antibody Interactions 7. Ka and Kd with its importance 8. Affinity and avidity Immunological reactions: Precipitation and Agglutination reactions 9. ELISA	
	Unit Outcomes: UO 1. Understand the variation in structure of antibody and their biological significance. UO 2. Understand the factors influencing antigenicity.	
III	**Introduction to Viruses**	**10 Hrs.**
	1. Viruses and their importance. 2. Discovery of viruses. 3. Structure of virus: viral nucleic acid, nucleocapsid, envelope. 4. Variation in structure of viruses. 5. Viroids and Prions. 6. Nomenclature and Classification of viruses.	
	Unit Outcomes: UO 1. Understand the structure of virus: viral nucleic acid, nucleocapsid, envelope.	

Unit No.	Title of Unit & Contents	Hrs.
	UO 2. Describes the nnomenclature and cclassification of viruses.	
IV	**Life Cycle of Viruses**	**11 Hrs.**
	1. Structure of animal virus (HIV) 2. Structure of plant virus (TMV) 3. Life cycle and replication of DNA virus 4. Life cycle and replication of RNA viruses 5. Life cycle and replication of Retrovirus 6. Bacteriophages (lytic and lysogenic cycle) 7. Vaccines 8. Antiviral drugs.	
	Unit Outcomes: UO 1. Understand the life cycle and replication of different types of viruses. UO 2. Understand the structure of animal and plant virus.	

Learning Resources:

1. Cellular and Molecular Immunology, Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, 9th Edition, Elsevier; 2017.
2. Kuby Immunology, Judy Owen, Jenni Punt, Sharon Stranford, 8th Edition, W.H. Freeman & Company; 2018.
3. Virology: Principles and Applications, John Carter, Venetia Saunders, 1st Edition, Wiley; 2007.
4. Principles of Virology" by S.J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka, 4th Edition, ASM Press; 2015.
5. The Immune System" by Peter Parham, 4th Edition, Garland Science; 2014.
6. Kuby Immunology, Thomas J. Kindt Richard A. Goldsby, Barbara A. Osborne, 4th Ed., W. H. Freeman & Company, 2000.
7. Vaccines, Stanley A. Plotkin, Walter A. Orenstein, Paul A. Offit, 7th Edition, Elsevier; 2017.
8. Kuby Immunology, Thomas J. Kindt Richard A. Goldsby, Barbara A. Osborne, 6th Ed., W.H. Freeman & Company, 2000.
9. Roitt's Essential Immunology, Deives, Martin, Burton, Roitt., 11th ed. Wiley Blackwell publications, 2017.
10. Virology Principles and Applications, John B. Carter and Venetia A. Saunders, John Wiley & Sons Ltd., 2013.

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Course Type: Lab Course
Course Title: Lab Course – V (Based on DSC- V)
Course Code: 201BIO3103
Credits: 01 **Max. Marks: 50** **Hours: 30**

Leaning Objectives:

LO 1 To study tools and technical skills in the field of Immunology and Virology.
LO 2 To provide hands on approach for different immunodiagnostic techniques.
LO 3 To provide hands on approach on different basic techniques of virus isolation.
LO 4 To study antigen antibody interactions.
LO 5 To train students with cell proliferation assay
LO 6 To provide skills in observation of stem cell through permanent slide.

Course Outcomes:

After completion of course the student will be able to-

CO 1 Perform agglutination tests accurately and interpret results to identify antigen-antibody reactions
CO 2 Interpret precipitation patterns to determine antigen-antibody interactions and relative antigen concentrations
CO 3 Perform various methods of virus isolation.
CO 4 Perform radial immunodiffusion assays to quantify antigen or antibody levels in samples.
CO 5 Gain practical experience in observing lymphoid organs under the microscope.
CO 6 Learn techniques for isolating bacteriophages (viruses that infect bacteria) from environmental samples such as sewage.
CO 7 Acquaint the knowledge about principle and components of the enzyme-linked immunosorbent assay.

Practical No.	Unit
1	Agglutination reaction
2	Ouchterlony Double Diffusion reaction
3	Radial Immunodiffusion reaction.
4	Preparation of Peripheral blood smear
5	Identification of Blood cells
6	Differential leucocyte count
7	Microscopic observation of lymphoid organs
8	To perform Widal test

9	To perform VDRL test
10	Demonstration of ELISA.
11	Isolation of Bacteriophages from sewage

N.B.: Any Ten Practicals from above.

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Course Type: DSC-VI

Course Title: Metabolism

Course Code: 201BIO3102

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 To understand the fundamental concepts of metabolism

LO 2 To describe the processes involved in aerobic and anaerobic respiration, including glycolysis, Krebs cycle, and electron transport chain.

LO 3 To explain the regulation mechanisms governing key metabolic pathways.

LO 4 To identify the different types of photosynthetic pigments and their roles in light absorption.

LO 5 To outline the stages of photosynthesis, including light reactions and dark reactions.

LO 6 To analyze carbohydrate metabolism pathways.

LO 7 To describe lipid metabolism processes including fatty acid synthesis, storage, and oxidation.

LO 8 To explore amino acid and nucleotide metabolism, covering biodegradation, biosynthesis, and associated disorders.

Course Outcomes:

After completion of the course, the student will be able to-

CO 1 Demonstrate a comprehensive understanding of metabolic processes, distinguishing between catabolism and anabolism.

CO 2 Apply knowledge of aerobic and anaerobic respiration pathways to explain energy production mechanisms in cells.

CO 3 Evaluate the regulatory mechanisms controlling metabolic pathways to maintain cellular homeostasis.

CO 4 Analyze the different stages of photosynthesis and their contributions to carbon fixation and energy production.

CO 5 Interpret carbohydrate metabolism pathways and their significance in energy storage and release.

CO 6 Assess lipid metabolism processes, including fatty acid synthesis and oxidation, in the context of cellular energy management.

CO 7 Evaluate the role of amino acid metabolism in protein synthesis, cellular function, and the occurrence of metabolic disorders.

CO 8 Apply knowledge of nucleotide metabolism to explain drug mechanisms and develop therapeutic interventions.

Unit No.	Title of Unit & Contents	Hrs.
I	**Metabolism and Respiration**	**11**
	1. Overview of metabolism: catabolism and anabolism 2. Glycolysis and regulation 3. Krebs cycle and regulation 4. Electron Transport Chain and inhibitors 5. Chemiosmotic theory and ATP synthase 6. Anaerobic Respiration: Alcohol and Lactic acid Fermentation 7. Cori cycle	
	Unit Outcomes: UO 1 Differentiate between catabolic and anabolic pathways, illustrating their roles in energy production and molecule synthesis. UO 2 Discuss the significance of maintaining metabolic balance for cellular homeostasis and adaptation to changing environmental conditions.	
II	**Photosynthesis**	**11**
	1. Photosynthetic pigments and absorption spectra 2. Photosynthetic units and pigment systems 3. Cyclic and non-cyclic photophosphorylation 4. Carbon fixation Cycle 5. C2 Cycle, C4 cycle and CAM pathway 6. Starch and sucrose synthesis	
	Unit Outcome: UO 1 Outline the stages of photosynthesis, including light reactions and dark reactions, and their contributions to energy conversion and carbon assimilation. UO 2 Evaluate the integration of photosynthetic pathways in different plant species and their adaptations to varying environmental conditions.	
III	**Carbohydrate and Lipid Metabolism**	**12**
	1. Pathways: Glyoxylate, Pentose Phosphate, Entner-Doudoroff 2. Carbohydrate metabolism: Gluconeogenesis, Glycogen Metabolism 3. Lipid metabolism: Synthesis and storage of TAG, Biosynthesis and oxidation of fatty acids. 4. Ketone bodies	
	Unit Outcomes: **UO 1** Investigate carbohydrate metabolism pathways and highlighting their roles in carbon utilization and energy production.	

Unit No.	Title of Unit & Contents	Hrs.
	UO 2 Examine lipid metabolism processes and elucidate their roles in energy storage, membrane structure, and signaling.	
IV	**Amino Acid and Nucleotide Metabolism**	**11**
	1. Amino acid Metabolism: • Biodegradation of amino acids • Urea Cycle • Biosynthesis of amino acids • Disorders of amino acid metabolism 2. Nucleotide metabolism: • Nucleotide Biosynthesis (De-Novo and Salvage pathways) • Nucleotide Degradation	
	Unit Outcomes: **UO 1** Investigate the biodegradation and biosynthesis of amino acids and their roles in protein turnover and nitrogen balance. **UO 2** Examine nucleotide synthesis pathways and analyze nucleotide degradation pathways.	

Learning Resources:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, Albert L. Lehninger, 5th Edition, W. H. Freeman and Company, New York, 2008.
2. Biochemistry, Donald Voet, Judith G. Voet, 4th Edition, John Wiley & Sons, 2011.
3. Life Sciences, Pranav Kumar & Usha Mina, Pathfinder publication, 8th Edition,2023.
4. Fundamentals of Biochemistry, J. L. Jain, Sunjay Jain, Nithin Jain, S. Chand & Co Ltd, 2008.
5. A Textbook of Biochemistry, E.S. West, W.R. Todd, H.S. Mason, J.T. van Bruggen, Oxford and IBH Publishing Co., New Delhi, 1974.
6. Harper's Biochemistry, Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, 25th Revised edition, Appleton & Lange, 1999.
7. Principles of Biochemistry, Geoffrey L. Zubay, William W. Parson, Dennis E. Vance, McGraw-Hill Higher Education,1995.
8. Biochemistry, Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Lubert Stryer, 8th Edition, W. H. Freeman & Co., 2015.
9. Plant Biochemistry, P. M. Dey, J. B. Harborne, Elsevier, 1997.
10. Metabolic Pathways, David Greenberg, Elsevier Science,2012.

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Course Type: Lab Course
Course Title: Lab Course –VI (Based on DSC-VI)
Course Code: 201BIO3104
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives

LO 1 To Understand the principles and procedures involved in fatty acid titration.
LO 2 To identify the significance of ketone bodies and learn the methods for their estimation.
LO 3 To gain proficiency in determining urinary titrable acidity and its relevance in clinical assessment.
LO 4 To learn the technique for estimating urinary creatinine and its application in renal function evaluation.
LO 5 To familiarize with the assay protocol for measurement and its clinical implications.
LO 6 To master the Zak and Henley's method for total serum cholesterol and Van de Bergh reaction for serum Bilirubin estimation.

Course outcomes

After completion of the course, the student will be able to-

CO 1 Perform fatty acid titration accurately, demonstrating competence in laboratory techniques for lipid analysis.
CO 2 Develop the skills to estimate ketone bodies in biological samples, interpreting results for diagnostic purposes in conditions like diabetic ketoacidosis.
CO 3 Proficient in estimating urinary creatinine levels, enabling assessment of renal function and adjustment of drug dosages.
CO 4 Capable of measuring acid phosphatase enzyme activity, applying the knowledge in diagnosing conditions related to bone and prostate health.
CO 5 Understand the assay for β-amylase enzyme activity, correlating the results with pancreatic function and carbohydrate metabolism.
CO 6 Gain expertise in the estimation of serum bilirubin and serum cholesterol, aiding in the diagnosis and monitoring of health issues.

Practical No.	Unit
1	To Perform Fatty Acid Titration
2	Estimation of Ketone Bodies
3	Determination of Urinary Titrable acidity
4	Estimation of Urinary Creatinine
5	Estimation of Enzyme activity of Acid Phosphatase
6	Estimation of Enzyme activity of β-amylase

7	Estimation of Total Serum Cholesterol by Zak and Henley's method
8	Determination of Serum Bilirubin by Van de Bergh reaction
9	Determination of Urease Activity
10	Determination of Lipase Activity
11	Determination of Lysine decarboxylase and Ornithine decarboxylase activity
12	Solution of Problems in Biochemistry and Metabolism

N.B.: Any Ten practical from above.

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Course Type: Minor I

Course Title: Applied Microbiology

Course Code: 201BIO3301

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 To create awareness about microorganism which is exploited in industrial process, product development it's beneficial as well as harmful aspect and study of applied areas.

LO 2 To provide the information on new approaches in microorganism's exploitation.

LO 3 To know the technical knowhow about the soil, water and air microorganism along with the microbe which is disease causing and beneficial and their activities for recycling and sustainability

LO 4 To inculcate the new approaches to direct the issues related to research in applied microbiology.

LO 5 To acquaint the knowledge of role of microorganism in food processes

LO 6 To comprehend the significance of index organism

LO 7 To explain biogeochemical cycles.

LO 8 To explain water borne, air borne and food borne diseases.

Course Outcomes:

After completion of course, the student will be able to-

CO 1 Understand the significance of microorganism in biogeochemical cycling of nutrients,

CO 2 Apply the knowledge of soil microbiology and significant biochemical processes of microbes to improve the agricultural practices.

CO 3 Define the science of microbiology, its development and importance for human welfare.

CO 4 Acquaint the knowledge in the different areas of microbiology

CO 5 Understand the bacteriological examinations of water

CO 6 Comprehend water borne, air borne and food borne diseases

CO 7 Acquire the knowledge about environmental and agricultural microbiology

CO 8 Learn the mechanism of action of antibiotics.

Unit No.	Title of Unit & Contents	Hrs.
I	**Soil, Water and Air microbiology**	**07**
	1. Soil, Water and Air microbiology. 2. Biogeochemical cycles: Mineralization in Carbon, Nitrogen, And Sulfur, Phosphorous etc. 3. Bacteriological examinations of water; (Presumptive, confirmative, complete test) MPN, SPC, IMVIC. 4. Significance of index organism. 5. Significance of microorganism in Air.	

Unit No.	Title of Unit & Contents	Hrs.
	6. Methods of enumeration and controls.	
	Unit Outcomes: UO 1 Understand the basic concepts in soil, water and air microbiology. UO 2 Understand the biogeochemical cycles.	
II	**Food Microbiology and Preservation**	**15**
	1. Scope of Food microbiology. 2. Role of microorganism in food processes. 3. Spoilage of food, potential responsible microbes. 4. Bacteriological examination of foods. 5. Preservation of food: Different methods of preservation: High temperatures, chemical, irradiation and physical techniques and pasteurization. 6. Single cell protein: Process, production and its significance.	
	Unit Outcomes: UO 1. Discuss the significance of single cell protein. UO 2. Gain the knowledge aboutdifferent methods of preservation of food.	
III	**Introduction to Medical Microbiology**	**13**
	1. Normal flora of the body. 2. Immune system and Immunity. 3. Microbial and viral infections and diseases. 4. Use of antibiotics its mechanism of action, broad spectrum, narrow spectrum and its respective mechanism. 5. Chemotherapy: Water borne, air borne, food borne diseases and their causative agents from different reservoirs.	
	Unit Outcomes: UO 1. Comprehend water borne, air borne and food borne diseases UO 2. Explain the use of antibiotics its mechanism of action	
IV	**Environmental and Agriculture Microbiology**	**10**
	1. Environmental microbiology: Scope and concern 2. Agricultural microbiology: Scope and concern 3. Industrial effluents and Waste water Assessment 4. Sewage treatment plants: Aerobic & anaerobic treatment processes. 5. Integration of genetic engineering & application of genetically engineered 6. Microbes in Agriculture 7. Environmental and waste water treatments.	
	Unit Outcomes: UO 1 Develop the ability to understand both aerobic & anaerobic treatment UO 2 Understand about microbes in agriculture	

Learning Resources:

1. Soil Microbiology, Martin Alexander, 2nd ed., John Wiley and Sons Ltd. ,1977.
2. Principles of Microbiology, Ronald M. Atlas and William C. Brown, 1995.
3. Food Microbiology, Martin R. Adams, Moris O Moss., Peter MacClure, 4th ed., Royal society of Chemistry, 1995.
4. Microbiology, Pelczar Tata McGraw-Hill, 1998.
5. Brock Biology of Microorganisms, Michael T. Madigan., John M Martinko., Kelly S. Bendar, 15th ed., David A. Stahl Pearson Publications, 2021.
6. General Microbiology, Roger Y. Stanier London-MacMillan publication, 1976.
7. Anantharaman and Panikkar's Textbook of Microbiology, 10th ed. Dr.Reba Kanungo, 2017.
8. General Microbiology, Vol. I and Vol. II by Pawar and Daginawala Himalaya Publishing House, 2019.
9. Brock Biology of Microorganisms, Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley - Pearson; 16th Edition, 2019.
10. Applied Microbiology, R.C. Dubey, D.K. Maheshwari, 1st Edition, CBS Publishers & Distributors, 2017.

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Biotechnology

Course Type: Lab Course
Course Title: Lab Course –Minor I (Based on Minor I)
Course Code: 201BIO3302
Credits: 01 **Max. Marks: 50** **Hours: 30**

Leaning Objectives

LO 1 To develop practical skills in isolating and enumerating microbes from various sources such as soil, water, and food samples.
LO 2 To acquire techniques for isolating and characterizing cellulose-degrading microorganisms.
LO 3 To master the process of isolating Rhizobium from root nodules and Azotobacter from rhizospheric soil.
LO 4 To learn methods for isolating phosphate-solubilizing bacteria.
LO 5 To gain proficiency in the bacteriological examination of water using MPN and IMVIC tests.
LO 6 To understand the procedures for isolating mycotoxins from infected food and vegetables.
LO 7 To experience fieldwork through a visit to a wastewater treatment plant to observe practical applications of microbiological techniques.

Course outcomes

After completion of course, the student will be able to-

CO 1 Isolate and enumerate microbes from soil, water, and food samples, demonstrating proficiency in microbial techniques.
CO 2 Gain expertise in isolating specific types of microbes, including cellulose degraders, rhizobium, azotobacter, and phosphate-solubilizing bacteria.
CO 3 Adept at performing mpn and imvic tests for the bacteriological examination of water, ensuring accurate detection and enumeration of indicator organisms.
CO 4 Develop the capability to isolate mycotoxins from contaminated food and vegetables, enhancing their understanding of food safety and toxicology.
CO 5 Gain practical insights into the application of microbiological techniques in environmental management.
CO 6 Acquire a holistic understanding of microbial diversity, roles, and applications in agriculture, environment, and food safety, contributing to sustainability efforts.

Practical No.	Unit
1	Isolation and enumeration of microbes from soil, water and food samples.
2	Isolation of cellulose degraders
3	Isolation of Rhizobium from root nodules
4	Isolation and characterization of Azotobacter from Rhizospheric soil.
5	Isolation of Phosphate solubilizing bacteria
6	Isolation of microbes from air and their enumeration
7	MPN (bacteriological examination of water)
8	IMVIC (bacteriological examination of water)
9	Isolation of mycotoxin from infected food and vegetables.
10	Visit to waste water plant (field visit)

N.B.: Any Ten Practicals from above.

SEMESTER IV

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Department of Biotechnology

Course Type: DSC-VII
Course Title: Molecular Biology
Course Code: 201BIO4101
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To understand basic of molecular biology and its applications.
LO 2. To study DNA polymerases and other enzymes that catalyze DNA synthesis.
LO 3. To understand role of telomerase in DNA replication.
LO 4. To understand introduction to eukaryotic translation.
LO 5. To understand the role of cAMP and CAP.
LO 6. To study the concept of RNAi and gene Silencing.
LO 7. To acquire the knowledge about repair mechanism.
LO 8. To acquire the knowledge about mutation and their classification.

Course Outcomes:

After completion of course the student will be able to-

CO 1 Acquire knowledge of central Dogma of Life.
CO 2 Gain the knowledge about DNA replication and Telomere maintenance.
CO 3 Acquaint the knowledge of Post Transcriptional Modifications in Eukaryotes.
CO 4 Adapt the knowledge about Catabolic and Anabolic Operon.
CO 5 Gain the knowledge about eukaryotic gene expression.
CO 6 Acquire knowledge of diseases due to defects in nucleotide excision repair.
CO 7 Acquaint the knowledge of double-strand break repair by removal of DNA damage.
CO 8 Adapt the knowledge about translation process in eukaryotic and prokaryotic system.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to Molecular Biology and DNA Replication**	**10**
	1. Definition and Scope of molecular Biology, Overview of DNA, RNA and central Dogma of Life. 2. Historical Development of Molecular Biology: Milestones in the Discovery of DNA structure, 3. DNA replication and Telomere maintenance: DNA polymerases and other enzymes that catalyze DNA synthesis, 4. DNA replication- In prokaryotes and brief introduction to eukaryotes. 5. Telomer maintenance: the role of telomerase in DNA replication, aging, and cancer.	

	Unit Outcomes: UO 1 Discuss History and scop of molecular biology. UO 2 Explain difference between prokaryotic and eukaryotic replication.	
II	**From gene to protein**	**12**
	1. Introduction, Prokaryotic Transcription, 2. Brief introduction to Eukaryotic Transcription 3. Post Transcriptional Modifications in Eukaryotes. 4. The genetic code, Secondary structure of RNA. 5. Prokaryotic Translation - Brief introduction to Eukaryotic Translation 6. Post Translational Modifications in Eukaryotes.	
	Unit Outcome: UO 1 Describe enzymes involved in prokaryotic and eukaryotic transcription with their mode of action. UO 2 Acquire knowledge of Translational Modifications in Eukaryotes.	
III	**Gene Expression and Regulation**	**13**
	1. Operon and Prokaryotic Gene Expression, definition, Catabolic and Anabolic Operon, 2. Example of Operon (LAC, Trp operon) 3. Role of cAMP and CAP, 4. Brief introduction to eukaryotic gene expression (RNAi and gene Silencing).	
	Unit Outcomes: UO 1 Acquaint the knowledge of Prokaryotic Gene Expression. UO 2 Understand operon concept.	
IV	**Mutation, DNA repair, recombination**	**10**
	1. Introduction, Types of mutations and their phenotypic consequences, 2. Repair of single Base, excision repair -Mismatch repair, Nucleotide excision repair 3. Disease - Hereditary nonpolyposis colorectal cancer 4. Double-strand break repair by removal of DNA damage - Homologous recombination -Nonhomologous end-joining 5. Disease –Xeroderma pigmentosum and related disorders: defects in nucleotide excision repair 6. Disease - Hereditary breast cancer syndromes: mutations in BRCA1 and BRCA2, 7. SOS repair	
	Unit Outcomes: UO 1 Elucidate significance of Types of mutations and their phenotypic consequences. UO 2 Describe mechanism of DNA repair system.	

Learning Resources:

1. Molecular Cell Biology, Lodish et al, Scientific American Book, 2004.
2. A Molecular Approach the Cell, Cooper & Hausmann –4th Edition, 2004.
3. Cell and Molecular Biology, Gerald Karp - 4th Edition, 2007.
4. Molecular biology of the gene, Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (7th ed.). Pearson, 2017.
5. Molecular biology, Weaver, R. F. McGraw-Hill Education, 5th edition, 2012.
6. Concepts of genetics, Klug, W. S., & Cummings, M. R., 6th edition, Pearson, 2020.
7. Genetics, Strickberger, M. W. Prentice Hall College Division, 2000.
8. Principles of Genetics, Gardner, Simmons, and Snustad, Wiley; 8th edition. 2006.
9. Molecular Biology 0f The Gene, James D. Watson, Pearson Education, Seventh edition, 2017.
10. Principles of Molecular Biology 2nd Edn by Veer Bala Rastogi, MEDTEC, 2015.

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(Autonomous)

Department of Biotechnology

Course Type: Lab Course
Course Title: Lab Course –VII (Based on DSC-VII)
Course Code: 201BIO4103
Credits: 01 **Max. Marks: 50** **Hours: 30**

Leaning Objectives:

LO 1 To develop proficiency in isolating DNA from bacterial cells, plant cells (using the CTAB method), and animal tissues.
LO 2 To gain hands-on experience in resolving DNA samples using agarose gel electrophoresis.
LO 3 To learn techniques for quantifying DNA using the Diphenylamine (DPA) method and determining nucleic acid purity and concentration through spectroscopy.
LO 4 To acquire skills in isolating total RNA from yeast cells and plant tissues and quantitatively estimating RNA using the orcinol reagent.
LO 5 To understand the process of creating a survival curve for bacterial cultures exposed to germicidal ultraviolet radiation as a mutagen.
LO 6 To master bacterial transformation and the replica plating procedure to isolate antibiotic-resistant mutants.

Course outcomes:

After completion of course the student will be able to-

CO 1 Adept at isolating DNA from various sources (bacterial, plant, and animal tissues) and RNA from yeast cells and plant tissues, showcasing their versatility in molecular biology techniques.
CO 2 Resolve DNA samples using agarose gel electrophoresis and quantify DNA accurately using the Diphenylamine (DPA) method.
CO 3 Demonstrate competence in using spectroscopy to determine nucleic acid purity and concentration.
CO 4 Develop the ability to quantitatively estimate and enhance their skills in nucleic acid analysis.
CO 5 Understand and apply the process of creating a survival curve for bacterial cultures exposed to ultraviolet radiation, demonstrating their knowledge of mutagenesis and bacterial response to UV exposure.
CO 6 Master bacterial transformation techniques and the replica plating procedure, enabling them to isolate and analyze antibiotic-resistant mutants, crucial for genetic and microbiological research.

CO 7 Gain a broad set of skills in molecular biology, including DNA/RNA isolation, quantification, and analysis, preparing them for advanced research and practical applications in biotechnology and microbiology.

Practical No.	Unit
1	Isolation of DNA from Bacterial cells.
2	Isolation of DNA from plant cells by CTAB method
3	Isolation of DNA from Animal Tissue.
4	To resolve the given DNA sample by using agarose gel electrophoresis
5	Quantification of DNA by using Diphenylamine (DPA) method.
6	Spectroscopic determination of nucleic acid purity and concentration.
7	Isolation of total RNA from yeast cells and plant tissues.
8	To estimate RNA quantitatively using orcinol reagent.
9	To prepare a survival curve for the given bacterial culture using germicidal ultraviolet Radiation as a mutagen.
10	Bacterial Transformation
11	To perform replica plating procedure for isolating antibiotic resistant mutants.

N. B.: Any Ten Practicals from above.

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Department of Biotechnology

Course Type: DSC-VIII
Course Title: Biocatalysis and Enzyme Engineering
Course Code: 201BIO4102
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 To gain a comprehensive understanding of the hierarchical structure of enzymes.
LO 2 To learn the principles of enzyme kinetics.
LO 3 To investigate various catalytic mechanisms of enzymes.
LO 4 To understand the mechanisms of enzyme regulations.
LO 5 To develop skills in enzyme extraction, purification, and characterization through laboratory techniques and methods.
LO 6 To explore techniques in enzyme engineering.
LO 7 To study the principles of biocatalysis and the role of enzymes in organic synthesis and industrial processes.
LO 8 To explore the use of enzymes in various applications, including industrial, pharmaceutical, and diagnostic contexts.

Course Outcomes:

After completion of course the student will be able to-

CO 1 Describe the structural features of enzymes and explain how these structures relate to their catalytic functions.
CO 2 Apply the principles of enzyme kinetics to calculate reaction rates and determine kinetic parameters using various models.
CO 3 Demonstrate a clear understanding of enzyme mechanisms and be able to explain how specific enzymes catalyze reactions.
CO 4 Explain the various mechanisms of enzyme regulation and predict the effects of regulatory factors on enzyme activity.
CO 5 Gain practical skills in the purification and characterization of enzymes, utilizing modern laboratory techniques.
CO 6 Design and conduct experiments in enzyme engineering, demonstrating an understanding of mutagenesis and protein engineering techniques.
CO 7 Apply the principles of biocatalysis to real-world industrial and synthetic processes, understanding the advantages of enzyme-catalyzed reactions.
CO 8 Capable of identifying and explaining the diverse applications of enzymes in biotechnology, medicine, and industry, and proposing novel uses of enzymes in these fields.

Unit No.	Title of Unit & Contents	Hrs.
I	**Enzyme Structure and Function**	**8**
	1. Introduction to enzymes: Unique Features, Characteristics of enzymes, Classification: IUB system, rationale, overview and specific examples. 2. Structural hierarchy of enzymes: Primary, secondary, tertiary, and quaternary structures 3. Active site architecture and substrate specificity 4. Cofactors, coenzymes, and prosthetic groups 5. Overview of enzyme-substrate interaction models: Lock-and-key, induced fit. 6. Types of Specificity.	
	Unit Outcomes: UO 1 Comprehend Enzyme Structures UO 2 Analyze Active Sites and Specificity	
II	**Enzyme Kinetics and Mechanisms**	**12**
	1. Basic concepts of enzyme kinetics: Michaelis-Menten equation, Graphical procedures in enzymology. 2. Factors affecting enzyme activity. 3. Inhibition of enzyme activity: Competitive, non-competitive, uncompetitive, and mixed inhibition. 4. Bisubstrate Reactions. 5. Allosteric regulation and cooperativity 6. General principles of enzyme catalysis: Acid-base catalysis, covalent catalysis, metal ion catalysis 7. Mechanistic examples: Serine proteases, lysozyme, and ribonuclease	
	Unit Outcomes: UO 1 Apply the kinetic models to determine kinetic parameters and analyze enzyme-catalyzed reactions. UO 2 Explain the mechanisms of enzyme catalysis.	
III	**Enzyme Regulation and Engineering**	**12**
	1. Enzyme regulation by covalent modification (e.g., phosphorylation) 2. Feedback inhibition and feedforward activation 3. Isozymes and zymogens 4. Methods of enzyme purification and characterization 5. Enzyme engineering: Site-directed mutagenesis, protein engineering, directed evolution 6. Applications of enzyme engineering in biotechnology	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO 1 Describe and analyze the various mechanisms of enzyme regulation. UO 2 Design Engineered Enzymes	
IV	**Applications of Enzymes in Biotechnology and Industry**	**13**
	1. Principles of biocatalysis and its applications 2. Enzymes in organic synthesis and industrial processes 3. Enzymes in the food industry, textile, and detergent industry 4. Enzymes in medicine: Diagnostic tools, therapeutic enzymes, enzyme inhibitors as drugs. 5. Enzyme Immobilization: Techniques and Applications in Biotechnology 6. Advanced topics: Multi-enzyme complexes, metabolic pathways, computational enzymology.	
	Unit Outcomes: UO 1 Apply the principles of biocatalysis to develop and optimize enzyme-catalyzed processes in industrial and synthetic applications. UO 2 Identify and evaluate the use of enzymes in various fields.	

Learning Resources:

1. Principles of Biochemistry - David L. Nelson, Michael M. Cox, W.H. Freeman, 2021.
2. Biochemistry - Donald Voet, Judith G. Voet, Charlotte W. Pratt, Wiley, 2019.
3. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins - Nicholas C. Price, Lewis Stevens, Oxford University Press, 1999.
4. Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems - Irwin H. Segel, Wiley-Interscience, 1993.
5. Enzymatic Reaction Mechanisms - Christopher T. Walsh, W.H. Freeman, 1979.
6. Enzyme Engineering and Evolution: General Concepts, Methods, and Applications - Stefan Lutz, Uwe T. Bornscheuer, Wiley-Blackwell, 2009.
7. Biocatalysis in Organic Synthesis - Kurt Faber, Springer, 2011.
8. Applied Biocatalysis: The Chemist's Handbook - John Whittall, Peter W. Sutton, Wiley, 2009.

9. Principles and Techniques of Biochemistry and Molecular Biology - Keith Wilson, John Walker, Cambridge University Press, 2020.
10. Molecular Enzymology: Principles and Applications - Patrick M. Murphy, CRC Press, 2016.
11. Enzyme Technology - Vijai Kumar, Springer, 2020.

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(Autonomous)

Department of Biotechnology

Course Type: Lab Course
Course Title: Lab Course –VIII (Based on DSC-VIII)
Course Code: 201BIO4104
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives

LO 1 To explain the role of enzymes in biochemical.
LO 2 To study how substrate concentration, salt concentration, pH, temperature, and time affect enzyme activity.
LO 3 To learn to determine kinetic parameters such as Vmax and Km using Michaelis-Menten and Lineweaver-Burk plots.
LO 4 To analyze the Effect of Inhibitors, Activators, and Cofactors.
LO 5 To understand the process of immobilizing enzymes and its applications.
LO 6 To gain hands-on experience in isolating and characterizing enzymes from biological sources.
LO 7 To learn the technique of zymography to detect enzyme activity in biological samples.
LO 8 To explore Enzyme Engineering and Site-Directed Mutagenesis.

Course Outcomes

After completion of the course, the student will be able to-.

CO 1 Demonstrate an understanding of enzyme function and factors affecting enzyme activity.
CO 2 Successfully measure and interpret enzyme kinetic parameters such as Vmax and Km.
CO 3 Assess the impact of substrate concentration, pH, temperature, salt, and time on enzyme activity.
CO 4 Perform enzyme immobilization in sodium alginate and evaluate its effectiveness.
CO 5 Isolate, purify, and characterize enzymes from biological samples using various biochemical techniques.
CO 6 Detect and analyze enzyme activity using zymography.
CO 7 Use double reciprocal plots to analyze enzyme kinetics and solve related problems.
CO 8 Understand and apply basic concepts of site-directed mutagenesis to modify enzyme activity or stability.

Practical No.	Unit
1	To Study Effect of amylase activity on Starch
2	To measure the activity of a specific enzyme, such as amylase, lipase, or catalase
3	Effect of substrate concentration on enzyme activity
4	Effect of Salt concentration on enzyme activity
5	Effect of pH concentration on enzyme activity
6	Effect of Temperature on enzyme activity
7	Effect of Time on enzyme activity
8	Effect of Inhibitors/Activators/Cofactors on enzyme activity,
9	To determine the kinetic parameters Vmax and Km of an enzyme
10	Immobilization of enzyme in sodium alginate matrix
11	Purification and Characterization of an Enzyme from a Biological Source
12	Zymography for Enzyme Detection
13	To analyze enzyme kinetics using a double reciprocal plot
14	Purification of enzyme
15	Analysis of Phosphorylation Effects on Enzyme Activity
16	Enzyme Engineering Techniques: Introduction to Site-Directed Mutagenesis
17	Problems based on Enzyme Kinetic

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Course Type: Minor II
Course Title: Clinical Microbiology
Course Code: 201BIO4301
Credits: 03 **Max. Marks: 50** **Lectures: 45 Hrs.**

Learning Objectives

LO 1 To understand the design and methodology of clinical trials.
LO 2 To explain the regulatory framework and ethical considerations in clinical research.
LO 3 To identify key statistical methods and data analysis techniques used in clinical research.
LO 4 To explore the role of biomarkers and personalized medicine in clinical trials.
LO 5 To review strategies for recruitment, retention, and adherence of study participants.
LO 6 To evaluate the process of clinical trial reporting, publication, and dissemination of findings.
LO 7 To assess the impact of clinical trial results on clinical practice and patient outcomes.
LO 8 To analyze the challenges and limitations of conducting clinical trials in diverse populations and settings.

Course Outcomes

After completion of the course, the student will be able to-

CO 1 Understand concepts of medical microbiology.
CO 2 List and describe medically important microorganisms.
CO 3 Gain knowledge of morphology, cultural characteristics, biochemical tests, epidemiology, laboratory diagnosis etc. of bacterial pathogens.
CO 4 Gain knowledge of morphology, cultural characteristics, biochemical tests, epidemiology.
CO 5 Laboratory diagnosis etc. of bacteria, viral and fungal pathogens.
CO 6 Understand the basics and applications of various chemotherapeutic agents.
CO 7 Understand the modes of action of various chemotherapeutic agents.
CO 8 Chromatography to recover and purify fermentation products efficiently.

Unit No.	Title of Unit & Contents	Hrs.
I	**Medically Important Microorganisms and Their Diseases**	**12**
	1. Medically Important Microorganisms. 2. Microbial diseases with respect to general characters, pathogenesis, diagnosis. 3. Chemotherapy and prophylaxis: A Monkeypox virus B. Nipah virus C. *Human papilloma virus* (HPV) D. Corona virus 4. Handling and Disposal of Infectious Material.	
	Unit Outcomes: UO 1. Understand and Identify Medically Important Microorganisms and Their Associated Diseases. UO 2. Apply Knowledge of Chemotherapy and Prophylaxis for Infectious Diseases.	
II	**Introduction to Hematology and Anticoagulants**	**10**
	1. Introduction to hematolog . 2. Naturally occurring anticoagulants. 3. Commonly used anticoagulants EDTA, citrates, oxalates, heparin anticoagulants and their mode of action. 4. Blood and its composition: Plasma and cellular composition of blood. 5. Formation of blood - erythropoiesis, leucopoiesis, thrombopoiesis, morphology of normal blood cells.	
	Unit Outcomes: UO 1. Understand the Principles of Hematology and Anticoagulants. UO 2. Apply Knowledge of Anticoagulants to Laboratory Practices.	
III	**Mycotic Infections in Humans**	**10**

Unit No.	Title of Unit & Contents	Hrs.
	1. Mycotic infections in humans: Superficial, subcutaneous, cutaneous and systemic mycoses. 2. Source of infection, symptomatology & diagnosis of a. Aspergillosis b. Candidiasis c. Microsporum d. Trichophyton e. Epidermatophyton 3. Protozoal infections in humans: Pathogenesis, life cycles, diagnosis & prophylaxis of a. Entamoeba b. Toxoplasma c. Roundworm d. Tapeworm e. Plasmodium	
	Unit Outcomes: UO 1. Understand and Identify Mycotic Infections. UO 2. Apply Diagnostic and Treatment Approaches to Mycotic Infections.	
IV	**Clinical and Laboratory Diagnosis of Microbial Diseases**	**13**
	1. Hospital infections and methods of disease diagnosis. 2. Types, sources, factors affecting and control measures of nosocomial and iatrogenic infections. 3. Collection, transport and preliminary processing of clinical pathogens. 4. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases.	
	Unit Outcomes: CO 1. Understand and Manage Hospital Infections. CO 2. Apply Methods for Disease Diagnosis and Infection Control.	

Learning Resources:

1. Medical Microbiology: A Guide for the Laboratory, A. K. Gupta, CBS Publishers & Distributors, 2019.

2. Essentials of Medical Microbiology, D. S. Gupte, Jaypee Brothers Medical Publishers, 2022.
3. Fundamentals of Clinical Microbiology, R. K. Jain, Jaypee Brothers Medical Publishers, 2020.
4. Clinical Microbiology: Principles and Applications, S. R. Yadav, Elsevier Health Sciences, 2021.
5. Manual of Clinical Microbiology, Anuradha N. Rao, Wolters Kluwer, 2018.
6. Clinical Microbiology: Current and Future Perspectives, R. P. Gupta, Academic Press, 2022.
7. Textbook of Medical Microbiology, S. S. Bhatia, Jaypee Brothers Medical Publishers, 2020.
8. Clinical and Diagnostic Microbiology, N. K. Sharma, CBS Publishers & Distributors, 2021.
9. Principles of Clinical Microbiology, M. S. Yadav, Elsevier Health Sciences, 2020
10. Clinical Microbiology: Diagnostic Techniques and Applications, S. K. Sharma, Springer, 2023.

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Department of Biotechnology

Course Type: Lab Course
Course Title: Lab Course Minor II (Based on Minor II)
Course Code: 201BIO4302
Credits: 01 **Max. Marks: 50** **Hours: 30 Hrs.**

Learning Objectives:

LO 1 To isolate and identify different pathogenic bacteria and fungi from clinical samples using appropriate culture techniques and identification methods.
LO 2 To isolate and identify multi-drug resistant (MDR) bacterial pathogens from clinical samples according to CLSI guidelines, and perform antimicrobial susceptibility testing.
LO 3 To separate blood components using centrifugation techniques, and analyse each component for its clinical relevance and diagnostic value.
LO 4 To understand and apply standard operating procedures (SOPs) for the collection, transport, and preservation of various clinical samples, ensuring their quality and integrity.
LO 5 To safely dispose of contaminated materials following biohazard protocols, maintaining laboratory safety and preventing contamination.
LO 6 To isolate and identify specific human bacterial pathogens using targeted culture and identification techniques.
LO 7 To measure and document the dimensions of parasitic specimens using micrometry, aiding in their identification and morphological study.
LO 8 To apply polymerase chain reaction (PCR) techniques to amplify bacterial DNA from clinical samples, followed by gel electrophoresis to confirm bacterial species.

Course Outcomes:

After completion of the course, the student will be able to-

CO 1. isolate and identify pathogenic bacteria and fungi from clinical samples, enhancing diagnostic accuracy and treatment planning.
CO 2. isolate and identify multi-drug resistant (MDR) bacterial pathogens according to CLSI guidelines, contributing to effective antimicrobial stewardship and treatment strategies.
CO 3. perform centrifugation to separate and analyze blood components, aiding in diagnostic and therapeutic applications.

CO 4. apply standard operating procedures (SOPs) for the collection, transport, and preservation of clinical samples, ensuring sample integrity and accurate diagnostic results.

CO 5. implement safe and effective disposal procedures for contaminated materials, maintaining laboratory safety and compliance with biohazard protocols.

CO 6. isolate and identify specific human bacterial enhancing targeted diagnostics and treatment.

CO 7. measure and document the dimensions of parasitic specimens using micrometry, aiding in their accurate identification and classification.

CO 8. utilize polymerase chain reaction (PCR) for the molecular identification of bacteria, improving diagnostic precision and understanding of bacterial genetics.

Practical No.	Unit
1.	Isolate and identify different pathogenic bacteria and fungi
2.	Isolation and identification of MDR bacterial pathogen isolated from clinical samples as per CLSI guidelines.
3.	Detection of microbes using Fluorescent labelled antibodies.
4.	Study of SOPs for collection, transport and preservation techniques of human clinical samples (stool, urine, blood, sputum, biopsy, soil, and parasites.
5.	Disposal of contaminated materials
6.	Isolation and Identification of the following human bacterial pathogens (any two): Listeria species, Burkholderia species, Chlamydia species
7.	Measurements of dimensions of any two parasitic specimens using micrometry
8.	Molecular Identification of Bacteria Using Polymerase Chain Reaction (PCR)
9.	Isolation of Lymphocytes.
10.	Evaluation of Sterilization and Disinfection Techniques in the Laboratory
11.	Separation and Analysis of Blood Components Using Centrifugation
12.	Visit to a Pathology Laboratory that processes clinical specimens to understand specimen handling and diagnostic procedures

N.B.: Any Ten Practicals from above.

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UG Second Year

Basket II: Generic/Open Elective (GE/OE)

(GEs offered to the Science & Technology students in Sem.-III)

Sr. No.	BoS Proposing GE/OE	Code	Course Title	Credits	Hrs.
1	Physics	101PHY1401	Energy Sources	04	60
2	English	101ENG1403	Developing Interpersonal Skills	04	60
3	Chemistry	101CHE1401	Medicines for Daily Life	04	60
4	Commerce	101MAE1401	Fundamentals of Statistics	04	60
5	Commerce	101BAI1401	Personal Financial Management	04	60
6	Political Science	101POL1401	Human Rights	04	60
7	Music	101MUS1401	Indian Vocal Classical & Light Music	04	60
8	NCC Studies	101NCC1401	Introduction to NCC	04	60
9	Sports	101SPO1401	Counseling and Psychotherapy	04	60
10	Mathematics	101MAT1401	Fundamentals of Mathematics	04	60

Note: Student can choose any one GE from the basket.

Basket II: Skill Enhancement Courses (SEC)

(SEC offered to the Science & Technology students in Sem.-III)

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Department of Biotechnology

Course Type: SEC III/IV
Course Title: Good Laboratory Practices
Course Code: 201BIO3601
Credits: 02 (01+01) **Max. Marks: 50** **Lectures: 45 Hrs. (15Th +30Pr)**

Learning Objectives:

LO 1 To educate students on the safe handling and regulatory compliance of laboratory facilities.
LO 2 To instruct on accurate recording, maintenance, and analysis of laboratory data.
LO 3 To train in minimizing errors associated with handling laboratory equipment and accessories.
LO 4 To teach the standard operating procedures (sops) for laboratory equipment.
LO 5 To ensure comprehensive and precise documentation of all study aspects.
LO 6 To provide guidelines and controls for proper instrument maintenance.
LO 7 To instruct in detailed testing and measurement techniques.
LO 8 To facilitate thorough and precise data analysis.

Course Outcomes:

After completion of course the student will be able to-

CO 1 understand the basic calibration and handling of instrumentation in laboratory.
CO 2 safely practice, basic laboratory procedures and protocols in on job laboratory situations.
CO 3 maintain laboratory records, complaints with current industry standards.
CO 4 maintain audit record.
CO 5 maintain high quality standards in laboratories and industries.
CO 6 prepare appropriate and technically valid SOPs.
CO 7 prevent the equipment errors in measurements.
CO 8 adapt for preventing unsafe and hazardous acts which could affect individuals.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to GLP**	**03**
	1. Introduction to GLP, History, Scope, Principles and Fundamental points of GLP. 2. WHO guidelines on GLP and GMP. 3. Infrastructure and Levels of Laboratory. 4. Importance of QA and QC in GLP.	
	Unit Outcomes: UO 1 Acquire knowledge of basic laboratory practices. UO 2 Discuss the importance of quality control and assurance in GLP.	
II	**Safety In Laboratory**	**04**
	1. General Rules/Protocols for Lab Safety measures. 2. Precaution and Safety in handling of chemicals and Laboratory tools. 3. Personnel hygiene and sanitation. 4. Basic SOPs for instrument handling and Maintenance.	
	Unit Outcome: UO 1 Gain the methodologies for personnel hygiene and sanitation. UO 2 Explain thebasic SOPs for instruments.	
III	**Laboratory Sampling**	**04**
	1. Reagents, kits and materials used for clinical research laboratories. 2. Pre-examination process , Storage and transportation of sample. Sample acceptance /rejection.	
	Unit Outcomes: UO 1 Acquaint the knowledge of different materials used in clinical research laboratories. UO 2 Describe the sampling procedures.	
IV`	**Laboratory Managements**	**04**
	1. Internal and External Audits. 2. Keeping data records, its analysis by using statistical and mathematical tools. 3. Result analysis and its interpretation.	
	Unit Outcomes: UO 1 Adapt the analysis of results and interpretation of audits. UO 2 Discuss the internal and external audits.	
V	**Practicals (Included in above 04 units)**	**30**

Unit No.	Title of Unit & Contents	Hrs.
	1. General safety measures. 2. Good laboratory practices. 3. Preparation of Standard Solution and Buffers 4. Calibration of Instruments**:** PH meter, colorimeter, spectrophotometer, water bath, Distillation assembly, Burette, Pipette etc. 5. Levels of Biosafety Laboratories. 6. Standard Operating procedures. 7. Ethical considerations. 8. Demo and Maintenance of Internal and External Audit 9. Use of Microsoft word, Excel. (for Data entry, calculation and graphical representation) 10. Use of internet and emails .	

Learning Resources:

1. National Ethical Guidelines for Biomedical and Health Research involving Human Participants. Indian Council of Medical Research 2017.
2. New Drugs and Clinical Trials Rule, Published by Ministry of Health and Family Welfare (Department of Health and Family welfare), Notification New Delhi, the 19th March, 2019.
3. International Organization for Standardization (ISO) 15189:2012 "Medical laboratories –Requirements for quality and competence".
4. National Accreditation Board for Testing and Calibration Laboratories (NABL), 112- "Specific Criteria for Accreditation of Medical Laboratories", Amended 26-Apr-2019.
5. Indian Public Health Standards (IPHS) Guidelines for Primary Health Centres Revised 2012.
6. Indian Public Health Standards (IPHS) Guidelines for Community Health Centres Revised 2012.
7. Indian Public Health Standards (IPHS) Guidelines for District Hospital Revised 2012.
8. National Essential Diagnostics List (NEDL), Indian Council of Medical Research (ICMR), 2019.
9. Laboratory Quality Management System: handbook, WHO, 2011.
10. Indian Standard (IS)- Reagent Grade Water- Specification (Third revision), 1070: 1992

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Department of Biotechnology

Course Type: SEC III/IV
Course Title: Dairy Technology
Course Code: 201BIO4601
Credits: 02 (01+01) **Max. Marks: 50** **Lectures: 45 Hrs. (15Th +30Pr)**

Learning Objectives:

LO 1. To understand objectives of dairy technology.

LO 2. To learn the classification of proteins and enzymes in milk industry.

LO 3. To understand the significance of lactose in dairy industry.

LO 4. To learn the methods of preparation of flavored milk and paneer.

LO 5. To understand the composition of milk.

LO 6. To learn the storage methods of milk.

LO 7. To understand working of cream separator and plate heat exchanger.

LO 8. To understand the concept of alpha and beta forms of lactose.

Course Outcomes:

After completion of course the student will be able to-

CO 1. acquire knowledge of milk processing.

CO 2. gain the methodologies for the different milk products.

CO 3. acquaint the knowledge of processing and importance of enzymes present in milk.

CO 4. adapt the manufacturing method of butter and ice-cream.

CO 5. gain the knowledge about systems of collection of milk.

CO 6. acquire knowledge of platform testing in milk industry.

CO 7. acquaint the knowledge of working of various equipment's in dairy industry.

CO 8. adapt the manufacturing method of Shrikhand and khoa.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to Milk**	**03**
	5. Definition, Production and processing status of milk. 6. Physical properties of milk: Color, taste, pH and buffering capacity, refractive index, viscosity, surface tension. 7. Types of Milk Products.	
	Unit Outcomes: UO 1 Acquire knowledge of milk processing. UO 2 Discuss the physical properties of milk.	
II	**Chemistry of milk Lactose**	**04**
	5. Lactose (alpha and beta forms). And Significances of lactose in dairy industry. 6. Milk fat: Composition and structure, and physical properties. 7. Protein and Enzymes: General structure, amphoteric nature, difference between casein and serum protein, Enzymes- catalase, alkaline phosphatase, lipases and proteases.	
	Unit Outcome: UO 1 Gain the methodologies for the chemical composition of the milk. UO 2 Explain the types of protein present in milk.	
III	**Market milk industry**	**04**
	3. Clean and hygienic milk production. 4. Systems of collection of milk. 5. Platform testing in milk industry. 6. Packaging and Storage, Cleaning and Sanitation.	
	Unit Outcomes: UO 1 Acquaint the knowledge of processing and importance of cleaning and hygiene in milk industry. UO 2 Describe the process of platform testing in milk industry.	
IV`	**Milk Products**	**04**
	4. Various stages of processing: Cooling/ chilling, Filtration, Clarification, Standardization, Homogenization, Pasteurization, Sterilization, cream separator and plate heat exchanger. 5. Manufacture of milk products: Flavoured milk, Butter, ice-cream, Shrikhand, Khoa and Paneer.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO 1 Adapt the manufacturing method of Flavoured milk, Butter, ice-cream, Shrikhand . UO 2 Describe the Classification and types of equipment's used in food industry.	
V	**Practicals (Included in above 04 units)**	**30**
	1. To perform platform tests in milk. 2. To estimate moisture content and total solids in milk. 3. To estimate skim milk protein by titration method. 4. To estimate specific gravity of milk. 5. To determine surface tension of milk. 6. To check the efficiency of sterilization of milk by Turbidity test. 7. To prepare casein and calculate its yield. 8. Preparation of Flavoured milk. 9. Preparation of Butter. 10. Preparation of ice-cream. 11. Preparation of Shrikhand. 12. Preparation of Khoa. 13. Preparation of Paneer. 14. Visit to Dairy Industry.	

Learning Resources:

1. Technology of Indian Milk Products, Aneja RP, Mathur BN, Chandhan RC & Banerjee A. K. Dairy India Publ., Delhi, 2002.
2. Outlines of Dairy Technology, De S. Oxford University Press Publ., New Delhi.1980.
3. Dairy Processing – Improving Quality, Smit G., CRC-Woodhead Publ. 2003.
4. Dairy Technology, Principles of Milk Properties and Processes, Walstra P, Geurts TJ, Noomen A, Jellema A & Van Boekel MAJS, Marcel Dekker, 1999.
5. Dairy Science and Technology, Pieter Walstra, Jan T. M. Wouters and Tom J. Geurts, Second Edition, Taylor & Francis Group, LLC, 2006.
6. Dairy Processing & Quality Assurance, Ramesh C. Chandan, John Wiley & Sons, Inc. 2008.
7. Milk and Milk Processing, Singh, and Shivashraya, New India Publishing Agency (NIPA), 2020.
8. Milk and Milk Products: Technology, chemistry and microbiology, Alan H. Varnam, Springer Science & Business Media Publishers, 2012.
9. Modern Dairy Technology: Advances in Milk Products, Robinson, R. K., Springer Science & Business Media Publishers, 2012.
10. Advanced Dairy Science and Technology, Trevor J. Britz and Richard K. Robinson, Blackwell Publishing Ltd, 2008.

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UG First Year

Basket III: Ability Enhancement Courses (AEC)

(AEC offered to the Science & Technology students in Sem.-III)

Sr. No.	BoS Proposing AEC	Code	Course Title	Credits	Hrs.
1	English	101ENG7101	English for Professionals	02	30

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UG Second Year

Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken English Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
6. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

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Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
DSC/DSE/ GE/OE/Minor	100	10	10	20	10	-	-	40	60	100
DSC	75	05	10	15	10	-	-	30	45	75
Lab Course/AIPC/ OJT/FP	50	-	-	-	-	05	20	-	25	50
VSC/SEC/ AEC/VEC/CC	50	05	05	10	05	-	-	20	30	50

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)
6. CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Marks.

Summary of cross cutting issues:

Biotechnology encompasses a wide range of technologies that manipulate biological matter and processes to create useful products. These technologies range from traditional practices like brewing and bread-making to advanced genetic modifications in plants, animals, and humans. The curriculum is designed to address several cross-cutting issues critical to student development in areas such as Professional Ethics, Gender, Environment and Sustainability, and Human Values. These aspects are integrated into various courses to ensure that students develop both technical expertise and ethical responsibility.

Cross-cutting issues relevant to Professional Ethics, Gender, Environment and Sustainability, and Human Values into the curriculum:

Sr. No.	Course Name	Code	Relevant to Professional Ethics	Description
1	Immunology and Virology	DSC V	Professional Ethics	Students will acquire practical skills in immunological techniques.
2	Metabolism	DSC VI	Professional Ethics	Students will develop expertise in metabolic pathways and processes.
3	Molecular Biology	DSC VII	Professional Ethics	Students will gain proficiency in molecular biology techniques, preparing them for lab-based roles.
4	Biocatalysis and Enzyme Engineering	DSC VIII	Professional Ethics	Students will specialize in enzyme technology and its applications.
5	Applied Microbiology	Minor I	Professional Ethics, Environment and Sustainability	Students will understand microbial roles in environmental cycles and sustainability practices.
6	Clinical Microbiology	Minor II	Professional Ethics	Students will develop skills for diagnosing and managing microbial diseases.
7	Good Laboratory Practices	SEC III	Professional Ethics	Students will learn industry-standard lab practices, ensuring safety and compliance.

8	Dairy Technology	SEC IV	Professional Ethics, Entrepreneurship	Students will gain knowledge in dairy product processing and related business opportunities.
9	Field Projects	AIPC/OJT	Professional Ethics, Gender, Environment and Sustainability	Students will engage in real-world projects, integrating ethical, environmental, and societal aspects.

This revised curriculum provides students with the necessary skills and knowledge to address both technical and ethical challenges in biotechnology across various sectors.

Curricula developed and implemented have relevance to the local, national, regional and global developmental needs

Sr. No.	**Course code**	**Course Name**	**Linkage with Local/National/Regional/Global development**
1	DSC V	Immunology and Virology	Development of basic immunological techniques relevant to healthcare and research.
2	DSC VI	Metabolism	Qualitative and quantitative analysis of metabolites for applications in health and industry.
3	DSC VII	Molecular Biology	Molecular techniques essential for biotechnology, medicine, and research.
4	DSC VIII	Biocatalysis and Enzyme Engineering	Molecular techniques for enzyme applications in industry and biocatalysis.
5	Minor I	Applied Microbiology	Solutions for environmental issues through microbial processes and sustainability.
6	Minor II	Clinical Microbiology	Application of microbiological methods for disease diagnosis and treatment.
7	SEC III	Good Laboratory Practices	Implementation of GLP standards in industries and research institutions.
8	SEC IV	Dairy Technology	Development of technologies for dairy processing and food industry innovations.
9	AIPC/OJT	Field Projects	Hands-on projects addressing local, national, and global challenges in biotechnology and environmental sustainability.

Courses having focus on employability/ entrepreneurship/ skill development

Sr. No.	Name of the Course	Course Code	Activities/Content with a direct bearing on Employability/ Entrepreneurship/ Skill development			Year of introduction
			Employability	**Entrepreneurship**	**Skill development**	
1	Immunology and Virology	DSC V	Provides job opportunities in pathology labs and research institutes.	Supports startups focused on immunological research and diagnostics.	Develops expertise in immunological techniques and diagnostics.	2018-2019
2	Metabolism	DSC VI	Opens career paths in metabolomics and clinical research.	Encourages entrepreneurial ventures in metabolic analysis and diagnostics.	Trains students in the analysis of metabolic pathways and disorders.	2018-2019
3	Molecular Biology	DSC VII	Offers roles in laboratory research and molecular diagnostics.	Facilitates entrepreneurship in molecular biology research and diagnostics.	Provides advanced skills in molecular techniques and genetic analysis.	2018-2019
4	Biocatalysis and Enzyme Engineering	DSC VIII	Prepares students for roles in enzyme technology and biocatalysis industries.	Encourages starting ventures in enzyme-based technologies and applications.	Develops skills in enzyme engineering, biocatalysis, and industrial applications.	2024-25

5	Applied Microbiology	Minor I	Provides employment in bioprocessing, fermentation industries, and environmental microbiology.	Promotes entrepreneurship in microbial technology and bioremediation.	Equips students with practical skills in microbial techniques and applications.	2018-2019
6	Clinical Microbiology	Minor II	Creates job opportunities in clinical diagnostics and microbiology labs.	Supports startup ideas related to clinical microbiology and diagnostics.	Develops expertise in clinical microbiology techniques and pathogen analysis.	2024-25
7	Good Laboratory Practices	SEC III	Enhances employability by providing knowledge of industry-standard practices.	Encourages the establishment of labs with good practices and quality control.	Trains students in maintaining high standards in laboratory operations.	2018-2019
8	Dairy Technology	SEC IV	Opens career paths in dairy industry and dairy biotechnology.	Supports entrepreneurship in dairy processing and technology innovations.	Provides skills in dairy production, quality control, and technology applications.	2024-25
9	Field Projects	AIPC/OJT	Provides practical experience and enhances employability in research and	Encourages project-based entrepreneurial ventures and innovations.	Develops research, project management, and problem-solving skills.	2024-25

			industry projects.			

This restructured content focuses on enhancing employability through practical expertise, fostering entrepreneurship with industry-relevant knowledge, and developing essential skills to meet the demands of contemporary biotechnology fields.