RIMT UNIVERSITY MANDI GOBINDGARH PUNJAB

RIMT
UNIVERSITY

Study Scheme & Syllabus
(As per National education policy (NEP) 2020, INDIA)

For

B.Sc. (Hons.) Biotechnology (3-Year /4-Year with Research option)

Syllabi Applicable for Admissions in 2025 Onwards

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SECTION 1
Vision & Mission of the University

VISION

To become one of the most preferred learning places and a centre of excellence to promote and nurture future leaders who would facilitate the desired change in the society.

MISSION

- To impart teaching and learning through cutting-edge technologies supported by the world class infrastructure

- To empower and transform young minds into capable leaders and responsible citizens of India instilled with high ethical and moral values.

SECTION 2

Vision and Mission of the Department

DEPARTMENT OF LIFE SCIENCES

Vision

Science is all about sense and sensibility of life. Modern science and technology have changed our life in many ways. Aeroplanes, automobiles, communications satellites, computers, plastics, and television are few of the scientific and technological inventions that have transformed human life and the ideas behind all these ubiquitous technologies come from basic sciences.

- School is committed to innovation and excellence in teaching and research and preparing the students to be successful in science-related careers that are essential for meeting global needs.
- School advances knowledge through multidisciplinary education and research in all streams of basic sciences and applied sciences viz; Botany, Zoology, Biotechnology and Microbiology.
- The B.Sc. programmes are mainly focused on multi-disciplinary research based teaching with emphasis on dissertations.
- Each student is given perfect hands on training on current techniques in basic sciences.

Mission

- To transform education through academic excellence in sciences, providing analytical and application oriented teaching, innovative and world class pedagogy, nurture professionals who, with their commitment and integrity, can make a difference in their respective profession and in turn transform the society.
- Department of Life Sciences in School of Biosciences in RIMT University disseminating the knowledge in the field of Life Sciences through teaching & learning process.
- It offers various graduates, post graduate and doctorate courses in field of Botany, Zoology, Biotechnology and Microbiology.

- The Department is well equipped with teaching and research laboratories. Students can opt for CSIR NET exam; it will give a great career scope in research.
- The knowledge of Plant sciences is essential for development and management of forests, parks, waste lands etc. Few of the industries which can work with are: Forest Services, Land Management Agencies, Food companies, Seed & Nursery companies, National Parks, Plant Resource Laboratories, Plant health inspection services, Arboretum, Chemical industries, Educational institutes, Biological supply houses.
- The students can work in healthcare, agriculture, environment and industrial biotechnology through innovation and collaboration. The field of Microbiology has immense scope, due to advancement of field of science and technology, and in many areas like medicine, pharmacy, dairy industry, clinical research, water industry, agriculture, chemical technology and nanotechnology.
- For higher studies also, students can go for various doctorate fellowships and Post doctorate fellowships for higher education in India and abroad as well.

SECTION 3

About the Program

This B.Sc. Biotechnology Program is an Outcome-Based Education (OBE) model, structured as a 4-year, 8-semester full-time program comprising 175 credit hours. It is designed under the Choice Based Credit System (CBCS) with a Grading Evaluation System. The program includes core courses, elective courses, ability enhancement courses, value added courses and skill enhancement courses. The thoughtfully crafted curriculum elevates the B.Sc. Biotechnology program by focusing on OBE principles to develop professionals equipped with in-depth knowledge, practical skills, and a strong ethical foundation. The program emphasizes understanding the biological system-environment interface and encourages a global perspective. These goals are achieved through an updated curriculum, rigorous academic practices, industry collaborations, hands-on training, and vibrant student activities.

SECTION 4

PEOs , POs and PSOs

Program Educational Objectives (PEOs)

PEO1	To broaden and deepen the students' knowledge through a flexible research-driven program that aligns with academic and industry demands.
PEO2	To improve career prospects in industry, clinical environments both locally and internationally, or as preparation for further education, through state-of-the-art in-house lab experiences and external dissertation work, fostering global competencies.
PEO3	To foster critical thinking and a comprehensive understanding of bioethics, instilling a strong value system in students.
PEO4	To contribute to global think tanks by combining innovation with existing policies, protecting intellectual products, and equipping students with entrepreneurial skills that support personal and national growth.

Program Outcomes (POs)

PO 1	A solid foundation in both fundamental and advanced areas of biotechnology.
PO 2	Capability to integrate different technologies through interdisciplinary learning.
PO 3	Development of independent critical thinking.
PO 4	Proficiency in effective communication.
PO 5	Training students in essential biotechnology laboratory techniques.
PO 6	Awareness of the global, economic, environmental, and societal impacts of biotechnological solutions.
PO 7	Understanding of professional ethics and responsibilities.
PO 8	Ability to design, perform, and analyze scientific experiments.
PO 9	Awareness of current issues that can be addressed with biotechnology and life science expertise.
PO 10	Recognition of the importance of lifelong learning and the ability to pursue it.

Program Specific Outcomes (PSOs)

Upon successful completion of the B.Sc. Biotechnology programme, the students will be able to:

PSO1:	Grasp the fundamental concepts in key subfields such as Biochemistry, Microbiology, Molecular biology, Genetics Immunology as well as the foundational principles of Bioprocess engineering and Fermentation.
PSO2:	Equip students with technological expertise by integrating both disciplinary and interdisciplinary areas of biotechnology.
PSO3:	Understand the significance of Bioethics, Intellectual Property Rights (IPR), entrepreneurship, and communication and management skills to foster the next generation of Indian industrial leaders.
PSO4:	Gain proficiency in biotechnology, supporting its application in industry and research.

SECTION 5

Curriculum/Scheme with Examination Grading Scheme

INDUCTION PROGRAM

Induction Program (Mandatory)	
Duration	03 weeks
Frequency	Induction program for students to be offered right at the start of the first year
Activities	• Physical Activity • Sports, Yoga & Stress Management • Creative Arts • Universal Human Values • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch & Innovations

Semester wise Summary of The Programme: B.Sc. Biotechnology

S. No.	**Semester**	**No. of Contact Hours**	**Marks**	**Credits**
1	I	24	1000	21
2	II	28	1200	22
3	III	28	1200	23
4	IV	28	1200	23
5	V	27	1100	22
6	VI	27	1100	22
7	VII	18	700	22
8	VIII	17	600	22
TOTAL		197	8100	177

EXAMINATION GRADING SCHEME

Marks Percentage Range	Grade	Grade Point	Qualitative Meaning
80-100	O	10	Outstanding
70-79	A+	9	Excellent
60-69	A	8	Very Good
55-59	B+	7	Good
50-54	B	6	Above Average
45-49	C	5	Average
40-44	P	4	Pass
0-39	F	3	Fail
AB			Absent

Percentage Calculation: CGPA *10

SECTION 6
Scheme and Detailed Syllabus with Course Outcomes

Scheme of Study

B.Sc. (Hons.) Biotechnology (3-Year/4-Year with Research option) (as per NEP 2020)
Applicable for Batch: 2024, Session 2024-2026

Semester Wise Scheme						
Name of Degree: B.Sc. Hons. (Biotechnology)					**Total Credits:177**	
First Semester						
Course Code	**Course Type**	**Course Name**	**L**	**T**	**P**	**C**
BBIO-1101	DSC	Cell Biology	3	0	0	3
BBIO-1171	DSC	Practical -I related to (Cell Biology)	0	0	2	1
BBIO-1102	DSC	Biochemistry & Metabolism	3	0	0	3
BBIO-1172	DSC	Practical -II related to (Biochemistry & Metabolism)	0	0	2	1
BMCR-1101	GE	General Microbiology	3	0	0	3
BMCR-1171	GE	Practical -III related to General Microbiology	0	0	2	1
BMEB-1101	SEC	Medicinal Botany	2	0	0	2
BENG-1101	AEC	Communicative English	2	0	0	2
BBIO-1104	VAC	VAC I (as per university rules)	2	0	0	2
BEVS-1002	VAC	Environmental Science & Energy Management	3	0	0	3
		Total	**18**	**0**	**6**	**21**
Second Semester						
Course Code	**Course Type**	**Course Name**	**L**	**T**	**P**	**C**
BBIO-1201	DSC	Bioanalytical techniques	3	0	0	3
BBIO-1271	DSC	Practical-I related to (Bio-analytical techniques)	0	0	2	1
BBIO-1202	DSC	Industrial fermentation	3	0	0	3
BBIO-1272	DSC	Practical-II related to (Industrial fermentation)	0	0	2	1
BMCR-1202	GE	Fundamentals of genetics	3	0	0	3
BMCR-1272	GE	Practical -II related to Fundamentals of genetics	0	0	2	1
BCAA-1130	SEC	Fundamental of Computer	2	0	0	2
BCAA-1131	SEC	Fundamental of Computer (Lab)	0	0	2	1
BENG-1271	AEC	Communicative English in Practice	0	0	2	1
BMCR-1203	VAC	VAC II (as per university rules)	2	0	0	2
BMCR-1273	VAC	VAC II (Lab)	0	0	2	1
BEDU-1224	VAC	Drug Abuse,7 Road Safety and traffic rule	3	0	0	3
		Total	**16**	**0**	**12**	**22**
Third Semester						
Course Code	**Course Type**	**Course Name**	**L**	**T**	**P**	**C**
BBIO-2301	DSC	Bioprocess Engineering and Technology	3	0	0	3
BBIO-2371	DSC	Practical-I related to (Bioprocess Technology)	0	0	2	1
BBIO-2302	DSC	Enzymology	3	0	0	3
BBIO-2372	DSC	Practical-II related to (Enzymology)	0	0	2	1
BBIO-2303	DSC	Mammalian Physiology	3	0	0	3
BBIO-2373	DSC	Practical-III related to (Mammalian Physiology)	0	0	2	1
BMCR-2302	GE	Environmental microbiology	3	0	0	3
BMCR-2372	GE	Practical-IV related to (Environmental microbiology)	0	0	2	1
BBIO-2303	SEC	Basics of Forensic Science	2	0	0	2

BPB1-2301	AEC	Punjabi I	2	0	0	2
AG_VAC_017-T	VAC	VAC III	2	0	0	2
AG_VAC_017-P	VAC	Practical VAC III	0	0	2	1
		Total	**18**	**0**	**10**	**23**
Fourth Semester Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**T**	**P**	**C**
BBIO-2401	DSC	Molecular biology	3	0	0	3
BBIO-2471	DSC	Practical-I related to (Molecular biology)	0	0	2	1
BBIO-2402	DSC	Immunology	3	0	0	3
BBIO-2472	DSC	Practical-II related to (Immunology)	0	0	2	1
BBIO-2403	DSC	Plant anatomy and Physiology	3	0	0	3
BBIO-2473	DSC	Practical-III related to (Plant anatomy Physiology)	0	0	2	1
BMCR-2402	GE	Microbial genetics	3	0	0	3
BMCR-2472	GE	Practical-I related to (Microbial genetics	0	0	2	1
BMCR-2404	SEC	Microbes in sustainable agriculture	2	0	0	2
BPB1-2401	AEC	Punjabi II	2	0	0	2
BMCR-2403	VAC	VAC IV	2	0	0	2
BMCR-2473	VAC	VAC IV (Lab)	0	0	2	1
		Total	**18**	**0**	**10**	**23**
Fifth Semester Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**T**	**P**	**C**
BBIO-3501	DSC	Genetic engineering	3	0	0	3
BBIO-3571	DSC	Practical -I related to (Genetic engineering Technology)	0	0	2	1
BBIO-3502	DSC	Plant Biotechnology	3	0	0	3
BBIO-3572	DSC	Practical -II related to (Plant Biotechnology)	0	0	2	1
BBIO-3503	DSC	Animal Biotechnology	3	0	0	3
BBIO-3573	DSC	Practical -III related to (Animal Biotechnology)	0	0	2	1
BBIO-3504	DSE	Biostatistics	3	0	0	3
BBIO-3574	DSE	Practical -IV related to (Biostatistics)	0	0	2	1
BMCR-3501	GE	Molecular diagnostics	3	0	0	3
BMCR-3571	GE	Practical -V related to (Molecular diagnostics)	0	0	2	1
BBIO-3575	SEC	Project-I	2	0	0	2
		Total	**17**	**0**	**10**	**22**
Sixth Semester Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**T**	**P**	**C**
BBIO-3601	DSC	Bioinformatics	3	0	0	3
BBIO-3671	DSC	Practical -I related to (Bioinformatics)	0	0	2	1
BBIO-3602	DSC	Genomics and Proteomics	3	0	0	3
BBIO-3672	DSC	Practical -II related to (Genomics and Proteomics)	0	0	2	1
BBIO-3603	DSC	Cell and Tissue culture	3	0	0	3
BBIO-3673	DSC	Practical -III related to (Cell and Tissue culture)	0	0	2	1
BBIO-3604	DSE	Pharmaceutical Biotechnology	3	0	0	3
BBIO-3674	DSE	Practical -IV related to Pharmaceutical Biotechnology	0	0	2	1
BMCR-3602	GE	Agro & Industrial Biotechnology	3	0	0	3
BMCR-3672	GE	Practical -IV related to (Agro & Industrial Biotechnology	0	0	2	1
BBIO-3675	SEC	Project-II	2	0	0	2
		Total	**17**	**0**	**10**	**22**

Seventh Semester Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**T**	**P**	**C**
BBIO-4701	DSC	Environmental biotechnology	3	0	0	3
BBIO-4771	DSC	Practical related to Environmental Biotechnology	0	0	2	1
BBIO-4702	DSE	Biotechnology and Human Welfare	4	0	0	4
BBIO-4703	DSE	Scientific Writing & Presentation Skills	4	0	0	4
BBIO-4704	GE	Microbial Physiology	3	0	0	3
BBIO-4774	GE	Practical related to (Microbial Physiology)	0	0	2	1
BBIO-4775	Dissertation	Dissertation	0	0	0	6
		Total	**14**	**0**	**4**	**22**
Eight Semester Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**T**	**P**	**C**
BBIO-4801	DSC	Microbial Biotechnology	3	0	0	3
BBIO-4871	DSC	Practical-I related to (Microbial biotechnology)	0	0	2	1
BBIO-4802	DSE	Nanotechnology	4	0	0	4
BBIO-4803	DSE	Intellectual Property right and Related Ethical Issues	4	0	0	4
BBIO-4804	DSE	Entrepreneurship Development	4	0	0	4
BBIO-4875	Dissertation	Dissertation	0	0	0	6
		Total	**15**	**0**	**2**	**22**

Detailed Syllabus with Course Outcomes

B.Sc. (Hons.) Biotechnology (3-Year /4-Year with Research option)

SUBJECT TITLE: CELL BIOLOGY
SUBJECT CODE: BBIO-1101-T
SEMESTER: I
CONTACT HOURS: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

I

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of the course: This course will orient the students with structures and basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, and cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization, and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition, and membrane transport.	10 hours
UNIT-II	Membrane: Vacuolar system, cytoskeleton, and cell motility: Structure and function of microtubules, Microfilaments, and Intermediate filaments. Endoplasmic reticulum: Structure, and function including a role in protein segregation. Golgi complex: Structure, biogenesis, and functions including a role in protein secretion.	10 hours
UNIT-III	Lysosomes: Vacuoles and microbodies: Structure and functions Ribosomes: Structures and function including a role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.	10 hours
UNIT-IV	Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extracellular matrix, macromolecules, regulation of receptor expression, and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.	15 hours

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Cell structure, cytosol, compartmentalization of eukaryotic cells, and cell fractionation.
CO2: Vacuolar system, cytoskeleton, cell motility, structure and function of microtubules, microfilaments and Intermediate filaments
CO3: Vacuoles, microbodies, ribosomes, mitochondria, chloroplasts
CO4: Extracellular Matrix, signal transduction, cancer

TEXT BOOKS

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons.Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8thedition.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009.The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

SUBJECT TITLE: PRACTICALS PERTAINING TO CELL BIOLOGY
SUBJECT CODE: BBIO-1171-P
SEMESTER : I
CONTACT HOURS/WEEK: 2

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

CELL BIOLOGY

1. Study the effect of temperature and organic solvents on the semi-permeable membrane; Demonstration of dialysis.
2. Study of plasmolysis and de-plasmolysis; Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
3. Study of the structure of any Prokaryotic and Eukaryotic cell; Microtomy, Fixation, block making, section cutting, double staining of animal tissues like liver, esophagus, stomach, pancreas, intestine, kidney, ovary, and testes.
4. Cell division in onion root tip/ insect gonads; Preparation of nuclear, mitochondrial & cytoplasmic fractions.

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Student will study temperature and solvent effects on membranes and learn dialysis principles for solute separation.
CO2: Student will learn cell fractionation and enzyme activity in organelles using sprouted seed or any other suitable source
CO3: This process involves microtomy, fixation, block making, section cutting, and double staining to study the structure of any Prokaryotic and Eukaryotic cell.
CO4: This experiment provides fundamental insights into cellular division and compartment-specific processes for research or educational purposes.

SUBJECT TITLE: BIOCHEMISTRY AND METABOLISM
SUBJECT CODE: BBIO-1102-T
SEMESTER: I
CONTACT HOURS: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective and outcome of course: Students will explain the synthesis of proteins, lipids, carbohydrates, and nucleic acids and their role in metabolic pathways along with their regulation at the transcriptional, translational and post translation levels including RNA and protein folding, modification and degradation.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Introduction to Biochemistry: A historical perspective. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Levels of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins. Carbohydrates: Structure, Function, and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions	10 hours
UNIT-II	Lipids: Structure and functions: Classification, nomenclature and properties of fatty acids, essential fatty acids.Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids,Nucleosides& Nucleotides, purines &pyrimidines,. Biologically important nucleotides, Doublehelical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation andrenaturation of DNA.	10 hours
UNIT-III	Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxalphosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions.	10 hours
UNIT-IV	Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.	15 hours

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Introduction to Biochemistry

CO2: Structure and functions; Classification, nomenclature and properties of Lipids, Amino acids and Carbohydrates.

CO3: Nomenclature and classification of Enzymes

CO4: Carbohydrates Metabolism: Reactions, energetics and regulation.

Text book

1. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

SUBJECT TITLE: PRACTICALS PERTAINING TO BIOCHEMISTRY & METABOLISM

SUBJECT CODE: BBIO-1172-P
SEMESTER: I
CONTACT HOURS/WEEK: 2

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

BIOCHEMISTRY AND METABOLISM

1. To study the activity of enzyme under optimum conditions and determine the pH optima, temperature optima, Km value, Vmax value and; effect of inhibitors (inorganic phosphates) on the enzyme activity.
2. Principles of Colorimetry:
   (i) Verification of Beer's law, estimation of protein.
   (ii) To study relation between absorbance and % transmission.
3. Preparation of buffers; Estimation of blood glucose by glucose oxidase method.
4. Qualitative tests for Carbohydrates, lipids and proteins and their separation of by paper chromatography

Course outcomes:
On successful completion of this course, the student will get/learn:

CO1: This study explores the impact of environmental factors on the enzyme digestion and comprehensive understanding of the enzyme's functional parameters and inhibitor interactions.
CO2: Give insight into spectrophotometric techniques and understanding of how light absorption and transmission relate to solute concentration.
CO3: Standard glucose curve for reliable quantifications.
CO4: Identification of specific molecules based on color changes and chromatographic separation, aiding in understanding bimolecular diversity and properties.

SUBJECT TITLE: GENERAL MICROBIOLOGY
Subject code: BMCR-1101
Semester: I
CONTACT HOURS: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Sr. No	Contents	Contact Hours
UNIT-I	**Fundamentals, History and Evolution of Microbiology:** Classification of microorganisms: Microbial taxonomy, criteria used including molecularapproaches, Microbial phylogeny, and current classification of bacteria.Microbial Diversity: Distribution and Characterization of Prokaryotic and Eukaryotic Cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi,Protozoa, and Unique features of viruses.	10 hours
UNIT-II	**Cultivation and Maintenance of microorganisms:** Nutritional categories of micro-organisms,methods of isolation, Purification and preservation	10hours
UNIT-III	**Microbial growth**: Growth curve, Generation time, synchronous batch and	20 hours

	continuous culture, measurement of growth and factors affecting growth of bacteria. **Microbial Metabolism:** Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.	
UNIT-IV	**Control of Microorganisms:** By physical, chemical and chemotherapeutic AgentsWater Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewagecomposition and its disposal. **Food Microbiology:** Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods	**20 hours**

TEXT BOOKS

1. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings

REFERENCES

2. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
3. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
4. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

SUBJECT TITLE: PRACTICALS PERTAINING TO GENERAL MICROBIOLOGY
Subject code: BMCR-1171
Semester: I
CONTACT HOURS: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Internal Assessment: 50
End Term Exam: 50
Duration of Exam; 3 Hrs

PRACTICALS

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

SUBJECT TITLE: MEDICINAL BOTANY
Subject code: BMEB-1101
Semester: I
CONTACT HOURS: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

S.No.	Content
Section A	History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations. Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; ex-situ conservation: Botanic Gardens, Ethno-medicinal plant Gardens.
Section B	Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany (ethnomedicines), ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac and infertility.
Section C	Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding. Application of natural products to certain diseasesdiabetics, Blood pressure and skin diseases. World centres of primary diversity and secondary centres of cultivated Medicinal plants; crop domestication genes in Medicinal Plants; Uses and introduction to current research paradigms in major medicinal plants**.**

Books

1. Thakur, R.S., Puri, H.S. and Hussain, A. (1989). Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.
2. Walter, K.S. and Gellett, H.J. (1998). IUCN Red List of Threatened Plants. The World Conservation Union, IUCN, Gland, Switzerland and Cambridge, U.K.
3. Dey, S.C. (1994). Gardening for Pleasure. Sterling Publishers Pvt. Ltd., Noida (India)

SUGGESTED READINGS

1. Trivedi P C.(2006). Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, (2008). Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
3. Blumethal M., Goldberg, A and Brinckmann, J. (2000). Herbal Medicine : Expanded Commission E Monographs, Integrative Medicinal communication Newton, M.A., U.S.A.
4. Sharma, V. and Alam, A. (2018). Ethnobotany. Rastogi Publications, Meerut (UP), India.

COURSE TITLE: Communicative English in Practice
SUBJECT CODE: BENG-1171
SEMESTER: I

CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	**0**	**2**	**1**

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

To help learners develop their effective communication skills. Developing professional, social and academic skills to harness hidden strengths, capabilities and knowledge equip them to excel in real work environment and Corporate life. To provide an environment to share, develop and improve their communication and interpersonal skills in the English language through activities.

Sr. No.	Content	Contact Hours
UNIT-1	Phonetics: Introduction to phonetic Symbols for better pronunciation (Consonants & Vowels with examples).	**8**
UNIT-2	Soft Skills: Importance, Difference between soft and hard skills, Effective body language, and Importance of Self-confidence. Etiquette & Manner: Social and Professional etiquette; Importance of basic manners.	**8**
UNIT-3	Writing Skills: E-mail and Resume Basic Grammar: formation and use of Tenses. Vocabulary building (as per respective program of course)	**10**
UNIT-4	Speaking Activities: Self-Introduction, Situational Conversation JAM Sessions, Mock Group Discussions, Mock Interview, Mock Presentation	**14**

Note: Open source software should be used to help the students in developing communication skills. Student centered activities such as debate, declaration, group discussions, role play should be used to ensure active participation of students in the Communication Skills Lab.

Each section should be divided into two groups (with the maximum strength not exceeding 30 students) and each group should have 1 classof2 lectures per week.

Course Outcomne: At the completion of the course, students will be able to:

CO1 Understand the basic concept of phonetics for better pronunciation.

CO2 Speak English well and confidently in day-to-day situations.

CO3 Build confidence in oral as well as in written communication.

C04 Write well organized E-mail and Resume.

CO5 Demonstrate the effective interview skills and presentation skills.

CO6 Understand the importence of soft skills and basic etiquette and manners

Good Laboratory Practices (GLP)

Name of the Programme	Course Code	Course Name	Duration	Credits
B.Sc. Biotechnology	GLP11…T	Good Laboratory Practices (GLP)	30 hrs	2.0

Course Objectives:

- To learn the regulations and various guidelines, and how these regulations apply to the manufacturing and distribution of pharmaceutical and biological products.
- To impart knowledge of the principles of GLP/GMP and their practical applications
- To attain knowledge of the safety procedures carried out in bioprocess and chemical plants.
- To familiarize the basic concepts of safety and biosafety guidelines.

Course Outcomes:

- Gain the skills and knowledge necessary to understand and work in GLP/GMP compliant environment.
- Understand the purpose and reasoning of GLP/GMP regulations and their practical applications through key quality systems.
- Understand QA-GMP-QC relationships.
- Gain knowledge of the various safety procedures to be followed in laboratory and production units.

Units	Contents	Np. of hrs.
UNIT-I Introduction to GLP	Introduction, History of GLP, Guidelines on GLP and GMP, Quality assurances in GLP	03
UNIT-II Quality standards and Quality Assurances	Quality Standards- Advantages and Disadvantages, Concept of Quality Control. Quality Assurance- Their functions and advantages Quality assurance and quality management in industry. Customer requirement of quality. Government and trade standards of quality. Federal Food and Drug Laws. Other food laws. Trade and Company Standards Control by National, International, Social Organizations (OECD, FAO, WHO), Society (NSB)	06
UNIT-III Good Manufacturing Practices in Pharmaceutical and Food Industries	Types of validation in Pharma industry. Scope and importance of Validation, Limitations, Organization and Elements of validation (IQ, OQ, PQ and DQ). Cleaning Validation, Validation of Analytical Procedures as per ICH Guidelines Implications of cGMP and Food plant Sanitation. The regulations of cGMPs Planning of Plant Sanitation Programs and Construction factors Hygienic design of food plants and equipment Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, birds, insects and microbes. Cleaning and Disinfection: Physical and Microbiological Approach.	06
UNIT-IV Quality Control	Introduction to Quality control and Total Quality Control in the food industry. Various Quality Attributes of food such as size, shape, texture, color, viscosity and flavor. Instrumental chemical and microbial quality control. Sensory evaluation of food and statistical analysis. Food Regulation and Compliance Food Inspection and Food Law Critical Control Points in Food Industries: Critical Quality control point in different stages of production including raw materials and processing materials Food Quality and Quality control including the HACCP system (Critical quality control points in different stages of production including raw materials and processing materials)	05
UNIT-V Biosafety	Historical Background, Biosafety in Laboratory/institution. Laboratory associated infections and other hazards, assessment of Biological Hazards and levels of biosafety, prudent biosafety practices in the laboratory/institution. Introduction to Biological safety cabinets, Primary Containment of Biohazards, Biosafety Levels, Recommended Biosafety Levels for Infectious Agents and Infected Animal's Biosafety guidelines, Government of India Guidelines Definition of Genetically Modied Organisms (GMOs)	05
UNIT-VI Biosafety and Hazards	Chemical Hazards Classification, Radiation hazards and control of exposure to radiation. Fire triangle, fire prevention methods Industrial hygiene: Introduction, evaluation and control Toxicology: Routes of entry of toxic substances, Toxic studies Safe Housekeeping instrumentation for safe operation, personal protective equipments.	05

References

1. Quality Control of Herbal Drugs- Dr. Pulok a. Mukherjee (Bussiness Horizons Pharmaceutical Publishers)
1. cGMP for Pharmaceuticals- Manohar A. Potdar (Pharma Med Press)
2. Validation of Active Pharmaceuticals-Ira R. Berry (CRC Press)
3. Guidelines on cGMP and Quality of Pharmaceutical Products-S Iyer (DK Publications)
4. Quality Assurance and Quality Management in Pharmaceutical Industry-Y. Anjaneyulu (Pharma Book Syndicate)
5. Quality Assurance in Analytical Chemistry, B.W.Wenclawiak, M.Koch E. Hadjicostas
6. WHO Library Cataloguing in Publication Data
7. Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinical research and development-2nd ed.

SEMESTER-II

SUBJECT TITLE: BIO-ANALYTICAL TOOLS
SUBJECT CODE: BBIO-1201-T
SEMESTER-II
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: To enable the students learn important tools and techniques based on biophysical and biochemical principles so that they can understand application of these techniques in biotechnology.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), absorption and emission spectroscopy	10 hours
UNIT-II	Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles an particle, pH meter.	10 hours
UNIT-III	Introduction to the principle of chromatography techniques; Paper chromatography, thin layer chromatography, column chromatography, silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.	10 hours
UNIT-IV	Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.	15 hours

Course outcomes:
On successful completion of this course, the student will get/learn:

CO1: Various types of microscopy and spectroscopy
CO2: Florimetry, calorimetry, spectrophotometry and centrifugation
CO3: Principle of chromatography
CO4: Principle of electrophoresis

TEXT BOOKS

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

SUBJECT TITLE: PRACTICALS PERTAINING TO BIO-ANALYTICAL TOOLS
SUBJECT CODE: BBIO-1271-P
SEMESTER-II
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

BIO-ANALYTICAL TOOLS

1. Electrophoresis techniques: Gel electrophoresis, SDS-PAGE
2. Preparation of protoplasts from leaves and sub-cellular fractions of rat liver cells.
3. Separation and identification of compound in a given sample by TLC.
4. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

Course outcomes:
On successful completion of this course, the student will get/learn:

CO1: To obtain hands-on-experience in performing various instrumentation techniques.
CO2: This study provides the foundation for molecular studies or functional analysis in both plant and animal system.
CO3: Offers important information about the makeup of the sample and its compositions.
CO4: Molar extinction coefficient which will be obtained experimentally can be used in enzyme kinetics study.

SUBJECT TITLE: INDUSTRIAL FERMENTATIONS
SUBJECT CODE: BBIO-1202-T
SEMESTER-II
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: This course will help students to know how nutrients needed by microorganisms, isolate microorganisms and also identify these microorganisms based on their physiological requirements.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti-cancer agents, amino acids.	10
UNIT-II	Microbial products of pharmacological interest, steroid fermentations and transformations. Overproduction of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic Synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.	10
UNIT-III	Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra-centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.	15
UNIT-IV	Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR	10

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Production of industrial chemicals, biochemicals and chemotherapeutic products

CO2: Microbial products of pharmacological interest

CO3: Purification & characterization of proteins, upstream and downstream processing, solids and liquid handling

CO4: Rate equations for enzyme kinetics, simple and complex reactions

Text books:

1. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
2. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
3. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
4. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

SUBJECT TITLE: PRACTICALS PERTAINING TO INDUSTRIAL FERMENTATIONS
SUBJECT CODE: BBIO-1272-P
SEMESTER-II
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

INDUSTRIAL FERMENTATIONS

1. Isolation of Industrial Microorganisms from various sources (e.g., soil, water, food);Characterization of Industrial Microorganisms based on morphology, biochemical tests.
2. Preparation and Sterilization of Fermentation Media
3. Comparative analysis of design of a batch and continuous fermenter.
4. Calculation of Mathematical derivation of growth kinetics; Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase
    a. etc.)

Course outcomes:
On successful completion of this course, the student will get/learn:

CO1: Microbial Isolation and Characterization Skills
CO2: Media Preparation and Sterilization Techniques
CO3: Fermentation Design and Process Optimization
CO4: Analytical and Assay Techniques for Product Recovery

SUBJECT TITLE: Fundamentals of Computer
SUBJECT CODE: BCAA1130
SEMESTER: I/II (First Year)
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	**0**	0	**3**

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs
Course Objective:

- To impart basic knowledge of Computer system
- Learn and use the internet.
- Learn to work on application software.

Sr. No	Contents	Contact Hours
THEORY		
UNIT-I	**Introduction to Computers**: Definition, History and generations of Computer. Types of computers: Analogue, Digital, Hybrid, General and Special Purpose Computers. Block Diagram of a Computer: CPU, Input, Process, Output (IPO) Cycle. Features and Applications of computer. **Software**: Definition. Types: System Software, Application Software, Utility Software. Operating System: Popular operating systems (Introduction): Windows, Linux, MacOS. Operating Systems for Handheld Devices (Mobiles/Smartphones).	10
UNIT-II	**Hardware:** Input Devices: Purpose and types. Keyboard, Mouse, Mic, Scanner. Output Devices: Purpose. Hard copy and soft copy outputs. Monitor – LCD, LED, CRT, Projector. Printer – Inkjet, Laser, Speakers, Plotters. **Memory:** Main Memory- RAM, Read Only Memory (ROM). Secondary Memory – Hard Disk, CDROM, DVD, USB, Tape Drives. **How computer boot up**: Connecting different components. POST (Power on Self-Test). Booting Process. Desktop: Meaning. Introduction to icons on Desktop.	10
UNIT-III	**Windows Explorer:** Creating folders and files. Renaming, deleting, copying, and	10

	moving files and folders. **Internet**: Understanding the web and internet. Web browsers. Using Emails – etiquette to write email. Safety guidelines to use internet. Use of Google Meet, MS Team application. **MS Office**: Introduction. MS Word: Creating documents. Styling content (text, alignment). Use of tables, charts.	
UNIT-IV	**MS PowerPoint:** Uses. Creating engaging presentations. Using design, themes. Adding animation to presentations. Use of third-party templates to make presentations more engaging and attractive. **MS Excel:** Uses**.** Creating spreadsheets and adding books. Data handling and processing – Formulae, Graphs/Charts. Filtering data. Formatting – general and conditional.	10

SUBJECT TITLE: Fundamentals of Computer (Lab)
SUBJECT CODE: BCAA1131
SEMESTER: I/II (First Year)
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	**0**	2	**1**

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

Suggestive List of Hands-on Sessions		
	1. Identify computer hardware and software (in the lab) 2. Demonstrate various peripherals and their applications. 3. Illustrate the booting procedure (using windows/Linux OS). 4. Various operating system file management commands (create, copy, move, delete, and rename folders and files) 5. Demonstrate the use of MS Word. a. Create document and showcase adding headings, numbered lists, bulleted lists, formatting of text. b. Create document to show inserting graphs/charts/images and its alignment. c. Use of mail merge. 6. Demonstrate the use of MS PowerPoint: a. Create presentation, choose template/theme, changing template/theme, adding slides and typing content. b. Demonstrate i. Placing Pictures into Placeholders ii. Cropping Photos iii. Sizing Graphics iv. Fixing Stretched/Squished Photos v. Where to Get Photos vi. Crop to Shape & Aspect Ratio c. Demonstrate use of animation feature in PowerPoint. 7. Demonstrate the use of MS Excel: a. Create an excel file, add sheets, enter data (text and values) and format it. b. Show how to enter data and find sum, apply formula to compute average. c. Show to create histogram, pie chart, line graph.	12

Textbooks:

- Computer Fundamentals, P. K. Sinha, BPB Publications, Sixth Edition.
- Introduction to Information Technology, V. Rajaraman, PHI, Second Edition.

- Microsoft Office 2021 All-in-One for Dummies, Peter Weverka, Wiley Publication

Recommended Books:

- Computers Today, Suresh K Basandra, Galgotia Publications.
- Microsoft Office 365 For Beginners: The 1# Crash Course from Beginners To Advanced. Easy Way to Master The Whole Suite in no Time Excel, Word, PowerPoint, OneNote, OneDrive, Outlook, Teams & Access, Leonard J. Ledger.
- LEARN TO MASTER MICROSOFT OFFICE 2016/365, StarEdu Solutions.

Course Outcomes:

CO1: Understand the basics of computers and its parts.

CO2: Apply skills to work with computers.

CO3: Understand the use of internet and communication applications MS Team, Google Meet.

CO4: Learn to use Microsoft Word, PowerPoint, Excel.

CO5: Create documents, presentations, and handle data for day-to-day work.

SEMESTER- III

SUBJECT TITLE: BIOPROCESS ENGINEERING AND TECHNOLOGY
SUBJECT CODE: BBIO-2301-T
SEMESTER-III
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: The course will impart knowledge about the scope and importance of fermentation technology and design. Students will understand various principles of fermentation technology and various manipulations required to enhance the production of bioproducts.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Introduction to Fermentation Technology: Fundamental principles of biochemical engineering. Scope and range of fermentation technology, Substrates for fermentation: Conventional & Nonconventional, By-product utilization in the fermentation industry.	10 hours
UNIT-II	Bioreactor: Bioreactor design, instrumentation and control systems, Introduction to batch, fed-batch, and continuous systems; Brief account of types of fermentation: submerged fermentation, surface fermentation, and solid substrate fermentation.	10 hours
UNIT-III	Upstream processing & downstream processing: Media formulation, Inoculum development, Industrial importance of microorganisms, Microbial growth kinetics, Approaches for genetic improvement of industrial organisms, Media sterilization: batch and continuous systems; sterilization of air, Cell disruption mechanical & non mechanical methods, Purification of fermentation products (Overview of Different processes/methods of downstream processing).	15 hours
UNIT-IV	Fermentation bioproducts: Production of alcoholic beverages: Wine, whiskey, and beer; Citric acid production, Single cell protein production, Penicillin production, Production of industrial enzymes –amylases, cellulases	10 hours

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Understand the Fundamentals of Fermentation Technology
CO2: Analyze Bioreactor Design and Operations
CO3: Perform Upstream and Downstream Processing Techniques
CO4: Develop Knowledge of Fermentation Bioproducts

Text book

1. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology.2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited

SUBJECT TITLE: PRACTICALS PERTAINING TO BIOPROCESS ENGINEERING
SUBJECT CODE: BBIO-2371-P
SEMESTER-III
CONTACT HOURS/WEEK: 2

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3Hrs

BIOPROCESS ENGINEERING

- Introduction to Media preparation, Sterilization and lab safety.
- To isolate the industrially important microorganism from natural resource, Growth kinetics study.
- Discuss the various components of a Bioreactor and its applications; Production of a Bioproduct (e.g., Enzyme or Alcoholic Beverage)
- To calculate the thermal death point (TDP) of a microbial sample.

Course outcomes:
On successful completion of this course, the student will get/learn:

CO1: Understanding sterilization principles and lab safety practices.
CO2: Improved proficiency with aseptic handling, isolation methods, and analytical instrument use and analyze conclusion about the microorganism's growth kinetics.
CO3: All of the bioreactor's parts, as well as their uses and purposes, and their importance in industrial biotechnology are concisely and clearly described
CO4: Capacity to accurately derive inferences from the analysis and interpretation of microbial survival data.

SUBJECT TITLE: ENZYMOLOGY
SUBJECT CODE: BBIO-2302-T
SEMESTER-III
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60

Duration of Exam: 3 Hrs

Objective of course: To provide a comprehensive understanding of enzyme structure, function, kinetics, and regulation, emphasizing their roles in biological systems and industrial applications. Students will also learn techniques for enzyme purification, characterization, and engineering for biotechnological innovations.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Isolation, crystallization and purification of enzymes: Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy	15
UNIT-II	Enzyme Kinetics: Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition typesof inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active sit groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed back control, covalent modification.	10
UNIT-III	Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.	10
UNIT-IV	Enzyme Technology: Methods for large scale production of enzymes, Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes. Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution. Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *invitro* & *in- vivo*.	10

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: To understand the enzyme processes including classification and mechanisms.
CO2: To understand the enzyme kinetics, regulation via feedback product inhibition, and covalent modification
CO3: To understand the mechanisms, regulation, and kinetics of diverse enzyme types with a focus on key models, interactions, and analytical techniques.
CO4: To understand the enzyme production, immobilization, engineering, protein pharmaceuticals, and structure-function analysis.

Text book

1. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.

3. Biochemistry, LubertStryer, 6th Edition, WH Freeman, 2006.
4. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
5. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2002

SUBJECT TITLE: PRACTICALS PERTAINING TO ENZYMOLOGY
SUBJECT CODE: BBIO-2372-P
SEMESTER-I
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

ENZYMOLOGY

1. Enzyme Kinetics: Michaelis-Menten Parameters; Effect of Inhibitors on Enzyme Activity
2. Immobilization of Enzymes;Thermostability of Enzymes
3. Role of Cofactors in Enzyme Activity; Measurement of amylase activity by using spectrophotometer.
4. Quantitative estimation of proteins by Bradford/Lowry's method

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Analyze Enzyme Kinetics and Effect of inhibitors
CO2: Implement methods such as enzyme immobilization and Enzyme Stability
CO3: Cofactor analysis and Interpretation of amylase activity
CO4: Quantify protein Biomolecules

SUBJECT TITLE: ENVIRONMENTAL MICROBIOLOGY
SUBJECT CODE: BMCR-2302-T
SEMESTER-III
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Objective and outcome of course: The aim of this course is to introduce students to the basic understanding of environmental microbiology including the functional diversity of microorganisms in the environment in a relation to human welfare and ecosystem health, microbial interactions with pollutants in the environment and fate of microbial pathogens in environment**.**

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-	Microorganisms and their Habitats:	20

I	Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes, Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter	**hours**
UNIT-II	Microbial Interactions: Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria. Biogeochemical Cycling: Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle	**20 hours**
UNIT-III	Waste Management: Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment	**16 hours**
UNIT-IV	Water Potability: Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.	**16 hours**

Text books:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

References books:

2. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.

3. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg

4. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

Instruction of Question Paper setter

The question paper will consist of three sections: A, B & C. Sections-A will consist of eight questions carrying two marks each from the whole syllabus of concerned paper. Section B will have six questions of four marks each and section C will have two questions of ten marks each from the respective sections of the syllabus.

SUBJECT TITLE: PRACTICALS PERTAINING TO ENVIRONMENTAL MICROBIOLOGY
SUBJECT CODE: BMCR-2371-P
SEMESTER-III
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam; 3 Hrs

ENVIRONMENTAL MICROBIOLOGY

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules**.**

SUBJECT TITLE: MAMMALIAN PHYSIOLOGY
SUBJECT CODE: BBIO-2303-T
SEMESTER-III
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: to provide a course of study in mammalian, principally human, systems physiology, building on knowledge of basic physiological principles.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	**Digestion and Respiration:** Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleicacids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juiceRespiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociationcurve, Chlorideshift	**10 hours**

UNIT-II	**Circulation:** Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism ofcoagulation of blood.Mechanism of working of heart: Cardiac output, cardiac cycle, Origin &conductionofheart beat.	**10 hours**
UNIT-III	**Muscle physiology and osmoregulation:** Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, singlemuscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical &electricalevents of mechanism of muscle contraction.Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation	**10 hours**
UNIT-IV	**Nervous and endocrine coordination:** Mechanism of generation & propagation of nerve impulse, structure of synapse, synapticconduction, saltatory conduction, Neurotransmitters Mechanism of action of hormones (insulin and steroids)Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid andadrenals, hypo & hyper-secretions	**15 hours**

Course outcomes:
On successful completion of this course, the student will get/learn:

CO1: Digestive and Respiratory system of system
CO2: Composition of blood and origin & conductionof heart beat
CO3: Muscle physiology and osmoregulation
CO4: Nervous and endocrine coordination

Text book
1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology.XI Edition.Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology.XI Edition. John wiley&sons,Inc

SUBJECT TITLE: PRACTICALS PERTAINING TO MAMMALIAN PHYSIOLOGY
SUBJECT CODE: BBIO-2373-P
SEMESTER-III
CONTACT HOURS/WEEK: 2

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	**0**	**2**	**1**

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

MAMMALIAN PHYSIOLOGY

- Study of Digestive Enzymes Activity
- Analysis of Oxygen Dissociation Curve
- Determination of Haemoglobin, Blood Grouping and Blood Cell Count, TLC and DLC.
- Demonstration of Muscle Contraction and Nerve Impulse Conduction Using suitable example

Course outcomes:
On successful completion of this course, the student will get/learn:

- **CO1**: Understand Digestive and Respiratory Mechanisms
- **CO2:**Quantify Key Hematological Parameters
- **CO3:**Estimate hemoglobin levels and study blood properties, linking these parameters to physiological functions and health indicators
- **CO4:** Improved understanding of Muscle and Nerve Physiology.

SUBJECT TITLE: BASICS OF FORENSIC SCIENCE
SUBJECT CODE: BBIO-2303-T
SEMESTER-III
CONTACT HOURS/WEEK: 2

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
2	0	0	2

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: To develop the skill to critically evaluate and interpret information from books, research studies, scientific reports, journals, case studies and the internet

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation	5
UNIT-II	Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths. Role of the toxicologist, significance of toxicological findings	10
UNIT-III	General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples. Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification	10
UNIT-IV	Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security	5

Course outcomes:

On successful completion of this course, the student will get/learn:

- **CO1**: Introduction and principles of forensic science
- **CO2:** Classification of fire arms and explosives
- **CO3:** Role and significance of the toxicologist
- **CO4:** Principle of DNA fingerprinting and introduction to Cyber security

SEMESTER-IV

SUBJECT TITLE: MOLECULAR BIOLOGY
SUBJECT CODE: BBIO-2401-T
SEMESTER-IV
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semi conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.	10 hours
UNIT-II	DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translation synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.	10 hours
UNIT-III	Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.	10 hours
UNIT-IV	Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Posttranslational modifications of proteins	15 hours

Course outcomes:

On successful completion of this course, the student will get/learn:

- **CO1:** DNA structure and replication
- **CO2:**DNA damage and repair
- **CO3:**Transcription and RNA processing
- **CO4:**Regulation of gene expression in prokaryotes

Text book

1. Purohit, S.S. Microbiology: Fundamentals and applications (Agrobios, India)
2. R. Y. Stanier, M. Doudoroff, E. A. Adelberg, General microbiology (MacMillian Press
3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

SUBJECT TITLE: PRACTICALS PERTAINING TO MOLECULAR BIOLOGY
SUBJECT CODE: BBIO-2471-P
SEMESTER-IV
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	**0**	**2**	**1**

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

MOLECULAR BIOLOGY

- Good lab practices, calculations and preparation of solutions for Molecular Biology experiments.
- Isolation of chromosomal DNA from bacterial cells and human blood sample
- SDS-PAGE techniques to visualize plasma, serum or DNA.
- Separation of plasma, serum or protein from blood sample.

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Lab Practices, Calculations, and Solution Preparation

CO2: Chromosomal DNA Isolation

CO3: Visualization of Biomolecules

CO4: Blood Component Separation

SUBJECT TITLE: MOLECULAR GENETICS

SUBJECT CODE: BMCR-2302

SEMESTER-IV

CONTACT HOURS/WEEK:3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	**Genome Organization and Mutations** **Genome Organization:** *E. coli*, *Saccharomyces*, *Tetrahymena* **Mutations and Mutagenesis:** Definition and types of mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations **Reversion and Suppression:** True revertants; Intra- and inter-genic suppression; Ames test; Mutator gene	15
UNIT-2	**Plasmids** Types of plasmids – F plasmid, R plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2μ plasmid. Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, regulation of copy number, curing of plasmids.	10
UNIT-3	**Mechanisms of Genetic Exchange** **Transformation**, **Conjugation:** Discovery, mechanism, Hfr and F' strains, Interrupted mating technique, and time of entry mapping), **Transduction**: Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers **Phage Genetics:** Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda	20

UNIT4	**Transposable elements** **Prokaryotic transposable elements**: Insertion Sequences, composite and non-composite transposons, replicative and non-replicative transposition, Mu transposon **Eukaryotic transposable elements**: Yeast (Ty retrotransposon), *Drosophila* (P elements), Maize (Ac/Ds) **Uses of transposons and transposition**	**15**

Text Books:

1. Klug, W.S., Cummings, M.R., Spencer, C., & Palladino, M. (2011). *Concepts of Genetics* (10th Ed.). Benjamin Cummings.
2. Krebs, J., Goldstein, E., & Kilpatrick, S. (2013). *Lewin's Essential Genes* (3rd Ed.). Jones and Bartlett Learning.

Reference Books:

3. Pierce, B.A. (2011). *Genetics: A Conceptual Approach* (4th Ed.). Macmillan Higher Education Learning.
4. Watson, J.D., Baker, T.A., Bell, S.P., et al. (2008). *Molecular Biology of the Gene* (6th Ed.). Benjamin Cummings.
5. Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2008). *Principles of Genetics* (8th Ed.). Wiley-India.
6. Russell, P.J. (2009). *iGenetics: A Molecular Approach* (3rd Ed.). Benjamin Cummings.
7. Sambrook, J., & Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual* (4th Ed.). Cold Spring Harbor Laboratory Press.
8. Maloy, S.R., Cronan, J.E., & Friefelder, D. (2004). *Microbial Genetics* (2nd Ed.). Jones and Bartlett Publishers.

SUBJECT TITLE: PRACTICALS PERTAINING TO MOLECULAR GENETICS
SUBJECT CODE: BMCR-2471-P
SEMESTER-IV
CONTACT HOURS/WEEK:6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	**0**	**6**	**3**

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

MOLECULAR GENETICS

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E. coli*
5. Study different conformations of plasmid DNA through Agarose gel electrophoresis
6. Demonstration of Bacterial Conjugation
7. Demonstration of Bacterial Transformation and Transduction
8. Demonstration of Ames Test

SUBJECT TITLE: IMMUNOLOGY
SUBJECT CODE: BBIO-2402-T
SEMESTER-IV
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Contents of Syllabus:

Sr. No	Contents	Contacts/hr
UNIT-I	Overview of Immune System: Historical perspective of Immunology, Early theories of Immunology, Cells, and organs of the Immune system. Innate and Adaptive Immunity: Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell-mediated and Humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).	10 hours
UNIT-II	Antigens: Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes, Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis	15 hours
UNIT-III	Major Histocompatibility Complex: Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation Cytokines: Properties and functions of cytokines, Therapeutics Cytokines	10 hours
UNIT-IV	Complement System: Components and pathways of complement activation Hypersensitivity: Gell and Coombs' classification and a brief description of various types of hypersensitivities ,Vaccines: Various types of vaccines	10 hours

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Overview of Immune System

CO2: Antigenicity and immunogenicity, Immunoassays

CO3: Major Histocompatibility Complex

CO4: Complement System and Hypersensitivity

SUBJECT TITLE: PRACTICALS PERTAINING TO IMMUNOLOGY
SUBJECT CODE: BBIO-2472-P
SEMESTER-IV
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

IMMUNOLOGY

- Differential leucocytes count, Total leucocytes count and Total RBC count.
- Haemagglutination inhibition assay
- Separation of serum from blood
- Double immunodiffusion test using specific antibody and antigen.

Course outcomes:
On successful completion of this course, the student will get/learn:

CO1: Differential leucocytes count and Total leucocytes count
CO2: Blood Component Separation for Diagnosis.
CO3: Antibody Detection and Quantification
CO4: Precipitin Reaction for Antigen-Antibody Interaction

SUBJECT TITLE: PLANT ANATOMY AND PHYSIOLOGY
SUBJECT CODE: BBIO-2403-T
SEMESTER-IV
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: This study programme focuses on the internal structure and function of plant cells, tissue, and organs.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	**Anatomy:** The shoot and root apical meristem and its histological organization, simple & complex and permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)	10
UNIT-II	**Plant water relations and micro & macro nutrients:** Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro& macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport	15
UNIT-III	**Carbon and nitrogen metabolism:** Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation,calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants	10
UNIT IV	**Growth and development:** Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization	10

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Complete anatomy of plants
CO2: Plant water relations and micro & macro nutrients
CO3: Carbon and nitrogen metabolism
CO4: Growth and development of plants

Text book

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
3. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry

SUBJECT TITLE: PRACTICALS PERTAINING TO PLANT ANATOMY AND PHYSIOLOGY
SUBJECT CODE: BBIO-2473-P
SEMESTER-IV
CONTACT HOURS/WEEK: 2

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

PRACTICAL

- Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf; Demonstration of plasmolysis by *Tradescantia* leaf peel.
- Demonstration of opening & closing of stomata; Demonstration of guttation on leaf tips of grass.
- Separation of photosynthetic pigments by paper chromatography; Demonstration of aerobic respiration.
- Preparation of root nodules from a leguminous plant.

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Plant Anatomy and Cell Behavior Studies
CO2: Plant Water Regulation: Stomatal Dynamics and Guttation
CO3: Photosynthetic Pigment Separation and Aerobic Respiration Demonstration
CO4: Root Nodule Preparation in Leguminous Plants

SEMESTER-V

SUBJECT TITLE: GENETIC ENGINEERING
SUBJECT CODE: BBIO-3501-T
SEMESTER-V
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Objective of course: To explore gene manipulation techniques, including cutting and pasting genes, to understand their applications and implications in genetic engineering.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Introduction to genetic engineering. Why gene cloning and DNA analysis is important. How to clone a gene - What is clone, Overview of the procedure Tools in Recombinant DNA Technology: Restriction and modifying enzymes, Type I , Type II and Type III enzymes and their characteristic features; restriction sequences, isoschizomers, rare cutting enzymes, enzyme cutting similar sequence in different manner. DNAModifyingenzymes:CharacteristicsandapplicationsofNucleases–DNase and RNase, DNA-Pol I, Klenow fragment, T4DNA polymerase, T7 DNA polymerase, T4 Polynucleotide kinase, Phosphatase, Reverse transcriptase, Taq polymerase and Ligase. Terminal deoxyribonucleotidyl transferase.	10
UNIT-II	Basic biology of plasmids and Phage vectors Basic features of plasmids, plasmid classification, Bacteriophage λ, lytic & lysogeny, Promoter control circuits. Linear and circular forms of lambda vector, DNA cloning with single stranded DNA vectors. DNA cloning vectors Cloning vectors for E. coli- Nomenclature, pBR 322, pBR 327, pUC8, pGEM3Z. Insertion and replacement vectors; Vectors based on M13. Methods of identification of recombinants: Insertional inactivation, blue/white selection. Cloning vectors for yeast- YEp, YIp, YRp. AdvancedVectors:cosmid,phagemid,BacterialArtificialChromosomes(BACs), shuttle vectors, yeast artificial chromosomes	15
UNIT-III	Preparation of genomic and cDNA library, Blotting techniques, polymerase chain reaction (PCR) and its applications, Site directed mutagenesis (cassette, primer extension, RT, real time, multiplex, inverse)	10
UNIT IV	DNA sequencing (Maxam-Gilbert, Sanger, pyro). Applications of rDNA technology in industry, medicine, agriculture and pharmacy. Special vectors for expression of foreign genes in *E. coli,* General problems with the production of recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells.	10

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Introduction to Genetic engineering.

CO2: Basic biology of plasmids and Phage vectors

CO3: Preparation of genomic and cDNA library

CO4: Polymerase chain reaction (PCR) and its application

Text book

1. Recombinant DNA by Watson, J.D. et al., 1993, Scientific American Books, New York.
2. Principles of Gene Manipulation by Old., R.W. and Primrose, S.B., 2004, Blackwell Publishing,UK.
3. Methods in Gene Technology by Dale, J.N., 1994, JAI Press Ltd. London, England.
4. Recombinant Principles of gene manipulation and genomics, primrose & Twyman 2006, Blackwell,U.K.
5. Gene cloning and DNA analysis: An introduction by T.A. Brown (5thEd.)2006, Blackwell Science Ltd.
6. Molecular cloning: A laboratory manual vol.I-III SambrookJ.andRussel,DavidN.2001ColdSpring Harbar

SUBJECT TITLE: PRACTICALS PERTAINING TO GENETIC ENGINEERING
SUBJECT CODE: BBIO-3571-P
SEMESTER-V
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

GENETIC ENGINEERING

1. Isolation of Genomic DNA and Plasmid
2. Spectrophotometer analysis of DNA, RNA and Protein.
3. Preparation of competent cells and transformation of competent cells and blue/white selection.
4. Demonstration of PCR and Southern blotting.

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: DNA Extraction
CO2: Purity and concentration
CO3: Preparation and Transformation of Competent Cells
CO4: PCR and Southern Blotting Demonstration

SUBJECT TITLE: PLANT BIOTECHNOLOGY
SUBJECT CODE: BBIO-3502-T
SEMESTER-V
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: To introduce students to the principles, practices and applications of plant biotechnology, plant tissue culture, plant genomics, genetic transformation and molecular breeding of plants.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropropagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation	15
UNIT-II	In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis, Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals	10

UNIT-III	Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation. Nomenclature, methods, applications basis and disadvantages.	10
UNIT IV	Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria	10

Text book

1. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University
2. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice
3. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication
4. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8thedition Principles of Genetics. Wiley India
5. Raven, P.H., Johnson, GB.,Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill
6. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House
7. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin CoSambrook&Russel. Molecular Cloning: A laboratory manual. (3rdedition)

SUBJECT TITLE: PRACTICALS PERTAINING TO PLANT BIOTECHNOLOGY
SUBJECT CODE: BBIO-3572-P
SEMESTER-V
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

PLANT BIOTECHNOLOGY

1 Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2 Preparation of complex nutrient medium (Murashige & Skoog's medium)
3 Significance of growth hormones in culture medium
4 Selection, Prune, sterilize, explant preparation and demonstrate various steps of micro propagation

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Growth nutrient media preparation
CO2: Complex nutrient media preparation
CO3: Growth Hormones in Media
CO4: Establishment of plant tissue cultures and micropropagation for Plant Growth

SUBJECT TITLE: ANIMAL BIOTECHNOLOGY
SUBJECT CODE: BBIO-3503-T
SEMESTER-VI
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: To introduce students to the principles, practices and application of animal biotechnology in Tissue Engineering, Vaccines and biopharmaceuticals.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Gene transfer methods in Animals: Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.	10
UNIT-II	Introduction to transgenesis: Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.	15
UNIT-III	Animal propagation: Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.	10
UNIT IV	Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics	10

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Gene transfer methods in Animals
CO2: Transgenic Animals
CO3: Animal propagation
CO4: Genetic modification in Medicine

Text book

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press,California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientificpublishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applicationsof recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). Anintroduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007).Recombinant DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

SUBJECT TITLE: PRACTICALS III PERTAINING TO ANIMAL BIOTECHNOLOGY
SUBJECT CODE: BBIO-3573-P
SEMESTER-VI
CONTACT HOURS/WEEK: 2

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	**0**	**2**	**1**

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Preparation of Hanks Balanced salt solution and Minimal Essential Growth medium
3. Isolation of lymphocytes for culturing
4. Isolation, Quantification and resolving of DNA on agarose Gel.

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Sterilization techniques apply to prevent the contaminations in experiments.
CO2: Different growth media used for the creation of nutrient-rich environments that support cell culture growth.
CO3: Able to perform and isolate lymphocytes.
CO4: To understand and perform DNA isolation from animal tissue

SUBJECT TITLE: BIOSTATISTICS
SUBJECT CODE: BBIO-3504-T
SEMESTER-V
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	**0**	**0**	**3**

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objectives of the course: This course imparts the knowledge of basic statistical methods to solve problems. The students will be taught to operate various statistical software packages. By the end of the course, the students are able to appreciate the importance of statistics in research and prepare them for a career in research

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.	**10**
UNIT-II	Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.	**15**
UNIT-III	Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)	**10**
UNIT IV	Correlation and Regression. Emphasis on examples from Biological Sciences.	10

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Collection and types of Data
CO2: Probability
CO3: Methods of sampling
CO4: Correlation and Regression

Text book

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press
4. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

SUBJECT TITLE: PRACTICALS IV PERTAINING TO BIOSTATISTICS
SUBJECT CODE: BBIO-3574-P
SEMESTER-V
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Understanding and observing the graphical Representation
CO2: Central Tendency & Dispersion
CO3: Distributions Binomial Poisson Normal
CO4:t, f, z and Chi-square

Sixth semester

SUBJECT TITLE: BIOINFORMATICS
SUBJECT CODE: BBIO-3601-T
SEMESTER-VI
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: The students will be introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis. They will gain knowledge about various Biological databases that provide information about nucleic acids and protein.

Contents of Syllabus:

Sr.No	Contents	Contact Hours
UNIT-I	History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web	**10**
UNIT-II	Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry	**15**
UNIT-III	Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.	**10**
UNIT IV	Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.	**10**

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: History of Bioinformatics

CO2: Protein Information Sources,

CO3: Sequence and Phylogeny analysis

CO4: Searching Databases

Text book

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

SUBJECT TITLE: PRACTICALS PERTAINING TO BIOINFORMATICS
SUBJECT CODE: BBIO-3671-P
SEMESTER-VI
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	**0**	**6**	**3**

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

1. Sequence information resource: EMBL, Genbank, Entrez, Unigene, PIR
2. Understanding and using: PDB, Swissprot, TREMBL
3. Sequence alignment and Multiple sequence alignment BLAST
4. Retrieval of information from nucleotide databases.

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Understanding of common bioinformatics resources.

CO2: Understanding of databases and tools

CO3: Ability to analyze the similarities and differences in sequences.

CO4: Ability to access detailed genetic sequence data for specific organisms or genes.

SUBJECT TITLE: GENOMICS & PROTEOMICS
SUBJECT CODE: BBIO-3602-T
SEMESTER-VI
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: This course aims to provide the knowledge and practical skills of functional genomics and proteomics .The course will teach the techniques used in functional genemics such as microarrays, NGST, mRNA expression and miRNA expression. By the end of the course, students will have the necessary learning to radically advance our understanding of life and transform medicine

Contents of Syllabus:

Sr.No	Contents	Contact Hours
UNIT-I	Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.	**15**
UNIT-II	Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms. Genomes and Databases.	**10**
UNIT-III	Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures Edman degradation.	**10**
UNIT IV	Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.	**10**

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Genomics and DNA sequencing methods
CO2: Managing and Distributing Genome Data
CO3: Protein structure
CO4: Proteomics and Analysis of proteomes

Text book

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,
4. B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III,1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old.Blackwell Science, 2001.
7. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons

SUBJECT TITLE: PRACTICALS PERTAINING TO GENOMICS & PROTEOMICS
SUBJECT CODE: BBIO-3672-T
SEMESTER-VI
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

1. Use of SNP and OMIM databases
2. Detection of Open Reading Frames using ORF Finder, Proteomics 2D PAGE database
3. Softwares for Protein localization, Hydropathy plots
4. Native and SDS-PAGE

Course outcomes:
On successful completion of this course, the student will get/learn:

CO1: SNP databases at NCBI and other site
CO2: OMIM database
CO3: Open Reading Frames using ORF Finder
CO4: Proteomics 2D PAGE database

SUBJECT TITLE: Cell and Tissue Culture Technology
SUBJECT CODE: BBIO-3603-T
SEMESTER-VI
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objectives: To introduce the students to the principles and applications of plant tissue culture and animal cell culture.

Content of syllabus:

Sr.No	Contents	Contact Hours
UNIT-I	Introduction to Plant Cell & Tissue Culture: Introduction to tissue culture: Definition, principle and significance of tissue culture; History& Development of plant tissue culture Culture media composition, preparation of media for Plant Tissue Culture, Sterilization of	**15**

	explants for culturing, Isolation of single cells, culturing techniques of single cell Cryopreservation of plant cells and tissue	
UNIT-II	Plant Cell & Tissue Culture techniques and Applications Callus culture, Protoplast culture, Organ culture, Micropropagation, Virus free plant production, Synthetic Seeds, Physical, genetic, chemical and genotypic factors for In vitro culture. Problems, in plant tissue culture (Recalcitrance, Contamination, Phenolic Browning, Seasonal Variation), Application of plant tissue culture techniques	**10**
UNIT-III	Animal Cell Culture: Introduction of Animal Cell and Tissue Culture, History of development of Animal cell culture techniques, Significance and Applications of tissue culture techniques, Types of Culture Media required for animal cell culture and its components; Growth and maintenance of animal cells in culture, Equipments used in Cell culture, Culture vessels, Aseptic techniques	**10**
UNIT IV	Characteristics of different animal cells in culture: Types of cell culture- Primary culture secondary culture, cell line, organotypic culture, Insect Cell Culture; cryopreservation, contaminations In vitro transformation of animal cells, Cell culture in vaccine production and drug/therapeutics development.	**10**

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Introduction to Plant Cell & Tissue Culture
CO2 Plant Cell & Tissue Culture techniques and Applications
CO3: Animal Cell Culture
CO4: Characteristics of different animal cells in culture

Text book

1. Bhojwani, S.S., Plant Tissue Culture: Theory and Practice. Elsevier.
2. Freshney, R.I : Culture of Animal cells , Wiley Publications , New York.
3. Dixon, R. A., Plant Cell Culture. IRL Press
4. Animal Cells Culture and Media, D. C. Darling and S. J. Morgan, BIOS Scientific Publishers Limited

SUBJECT TITLE: Practical related to Cell and Tissue Culture Technology
SUBJECT CODE: BBIO-3673-P
SEMESTER-VI
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	**0**	**2**	**1**

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

Cell and tissue culture

1. Laboratory set up and orientation to plant tissue culture facility
2. Types of culture medium and its composition for plant tissue culture and Animal tissue culture
3. Preparation & sterilization of culture medium for plant tissue culture and animal tissue culture
4. Callus study from Explant and Inoculation of Explant in callus inducing medium

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Give the students practical experience with a range of PTC techniques.

CO2: Able in choosing and modifying culture medium for particular commercial and experimental uses.

CO3: Able to ensure that the produced medium are free of contaminants and appropriate for research and tissue growth support

CO4: Provide a foundation for understanding callus formation and optimizing conditions for plant tissue culture and regeneration studies

SUBJECT TITLE: Pharmaceutical Biotechnology
SUBJECT CODE: BBIO-3641-T
SEMESTER-VI
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 40
Duration of Exam: 3 Hrs

Objective of course: The objective of this course is to make students understand the basic concepts involved in pharmaceutical industry. The course will give knowledge about new drug development and approval process. The students will be able to explain the strategies and various steps of new drug discovery process.

Context of Syllabus:

Sr.No	Contents	Contact Hours
UNIT-I	Definition and scope of Pharmaceutical Biotechnology, sources of drugs, classification of pharmacological agents (based on chemistry, mode of action, dosage forms), route of administration, absorption and bioavailability of drugs, distribution and liver detoxification metabolism and drug excretion	**10 hours**
UNIT-II	General classes and properties of phytopharmaceuticals, Extraction of phytochemicals, Phytochemical screening of medicinal plants. Bioassay guided fractionation methods TLC, HPTLC, GC, and HPLC, Role of NMR and Mass spectrometry in drug discovery.	**10 hour**
UNIT-III	Antimicrobial agents, Antibiotics - source, classification, mode of action, Antimicrobial resistance, and Antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activity).Pharmacological Assays - In-vitro assays - chemical (anti-oxidant), Biological (anticancerous and assay system based on enzymes and cells), and immunological (RIA and ELISA) - In vivo assays (Anti-inflammatory and Anti-analgesic).	**15 hour**
UNIT- IV	Vaccines: concept, production and types - Inactivated, Attenuated, toxoid, Recombinant vaccines, Peptide and DNA vaccines, Edible vaccines, nanodrugs. Recombinant proteins, approved rDNA drugs in market, Probiotics, Nutraceuticals, Economic and legal considerations in Pharmaceutical Biotechnology	**10 hour**

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Definition and scope of Pharmaceutical Biotechnology

CO2: General classes and properties of phytopharmaceuticals

CO3: Antimicrobial agents

CO4: Process of drug discovery and development

Text books

1. Satoskar R.S, Nirmala N. Rege, and Bhandarkar S. D, Pharmacology andPharmacotherapeutics (Revised 23rd Edition), Popular Prakashan, Mumbai.
2. *Tripathy K. D, Essentials of Medical Pharmacology (6th edition), Jaypee publishers*
3. Shobarani R Hiremath, Text book of industrial pharmacy, orientlongmanPvt ltd2008.
4. CrommelinDaan J. A., Sindelar D. Robert (3rd edition) PharmaceuticalBiotechnology: Fundamentals and Applications, CRC Press, 2007.
5. Trease, G.E.and Evans, W.C., 2011, Pharmacognosy (12th edition), BailliereTindall Eastbourne, U.K
6. MukherjeP.K.,Quality Control Herbal Drugs–An approach to evaluation of botanicals. Business Horizons Pharmaceutical Publishers, 2005
7. Sambamurthy K., Pharmaceutical Biotechnology (1st edition) New Age International

SUBJECT TITLE: PRACTICALS PERTAINING TO PHARMACEUTICAL BIOTECHNOLOGY
SUBJECT CODE: BBIO-3674-T
SEMESTER-VI
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

Pharmaceutical Biotechnology

1. Preparation of different methods of medicinal plant extracts.
2. Antimicrobial susceptibility tests for microorganisms.
3. Phytochemical screening of Primary metabolites and secondary metabolites.
4. Separation of medicinal plant extracts by chromatography.

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Able to compare different methods for preparing medicinal plant extracts for medicinal applications.
CO2: To acquire expertise in the microbiological methods utilized in the investigation of microorganisms
CO3: Able provide valuable information about the plant's medicinal and nutritional value.
CO4: Learn how to separate and identify different compounds from a mixture of sample.

SUBJECT TITLE: PROJECT WORK
SUBJECT CODE: BBIO-3675-PW
SEMESTER-VI
CONTACT HOURS/WEEK: 2

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	0	2

Internal Assessment: 50
End Term Exam : 50
Duration of Exam: 3Hrs

Seventh semester

SUBJECT TITLE: Environmental biotechnology
SUBJECT CODE: BBIO-4701-T
SEMESTER-VII
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: The course aims to impart knowledge about the environmental issues, its measurement, and various treatments

Sr. No	Contents	Contact Hours
THEORY:		
UNIT-I	Introduction to environmental biotechnology, Non Renewable resources - coal, petroleum, and natural gas. Renewable resources - solar, wind, tidal, biomass, nuclear, geothermal and hydroelectric resources. Current status and environmental impact of renewable and non-renewable resources, Environmental impact of modern fuels.	**10**
UNIT-II	Water pollution and its Control : Water as a scarce natural resource; Need for water management; Measurement of water pollution; Sources of water pollution; Wastewater collection; Wastewater treatment-physical, chemical and biological treatment processes, Microbiology of waster water treatments; Aerobic processes: Activated sludge, Oxidation ditches, Trickling filter, Towers, Rotating discs, Rotating drums, Oxidation ponds; Anaerobic processes: Anaerobic processes; Anaerobic digestion, Anaerobic filters, Upflow anaerobic sludge blanket reactors; Treatment schemes for wastewaters of dairy, distillary, sugar, antibiotic industries.	**15**
UNIT-III	Basics and types of bioremediation, Bioremediation of oil, heavy metals, pesticides contaminated soil and water, Phytoremediation and its types, Biochemical and genetic basis of biodegradation, Xenobiotic compounds and recalcitrance, Biodegradation of pesticides and petroleum products, Biotransformation of heavy metals, Biopolymers and Biodegradable plastics.	**10**
UNIT-1V	Biomonitoring: Bioassays, Biosensors, Biochips, Biological indicators and Biomarkers, Biorestoration of waste land, Bioleaching – microbes involved, Role of Biotechnology in pollution abatement.	**10**

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: To understand environmental issues

CO2: To understand water pollution, its measurement, and various treatments including industrial wastewater management.

CO3: To understand the fundamentals of biodegradation, biotransformation, and bioremediation of organic contaminants and toxic metals.

CO4: To understand and evaluate the applications of biosensors, biochips, and biorestoration in environmental biotechnology.

Text Books

Thakur I. S (2011) *Environmental Biotechnology: Basic Concepts and Applications* (2nd revised edition), I K International Publishing House Pvt. Ltd.

Chatterjee, A. K. (2011). *Introduction to Environmental Biotechnology*. Prentice Hall India.

SUBJECT TITLE: Practical related to Environmental Biotechnology
SUBJECT CODE: BBIO-4771**-T**
SEMESTER-VII
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

Environmental Biotechnology

1. Enumeration of microorganisms from sewage samples and Isolation of cellulolytic organisms from soil.
2. Estimation of total hardness in water and chlorine in water
3. Determination of total alkalinity of water and salinity in water samples.
4. Determination of dissolved oxygen, biological oxygen demand (BOD), chemical oxygen demand (COD) of sewage sample.

Course outcomes:
On successful completion of this course, the student will get/learn:
CO1: To learn microbial enumeration techniques for sewage analysis and isolate cellulolytic organisms, understanding their role in biodegradation.
CO2: To develop skills in assessing water quality
CO3: To gain insights into water chemistry and its environmental impact.
CO4: To measure key water quality parameters (DO, BOD, and COD) to evaluate sewage pollution levels and wastewater treatment efficiency.

SUBJECT TITLE: Biotechnology and Human Welfare
SUBJECT CODE: BBIO-4702-T
SEMESTER-VII
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objectives of the Course: To gain idea about the importance of biotechnology to humans. It will also enable the students to understand the challenges regarding human health and welfare.

Sr. No	Contents	Contact Hours
UNIT-I	Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.	10 hrs.
UNIT-II	Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.	10 hrs
UNIT-III	Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.	10 hrs
UNIT-IV	Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity, Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.	20 hrs

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: To understand protein engineering, enzyme synthesis, and industrial bioprocesses.
CO2: To explore nitrogen fixation, pest resistance, and plant-microbe interactions.
CO3: To gain insights into microbial biodegradation and biopolymer development.
CO4: To apply DNA forensics and biotechnological advances in medicine.

Text books

1. Microbes for a Sustainable Environment and Human Welfare: Advancements and Opportunities. (2021). United States: Nova Science Publishers.
2. Microbes, Environment and Human Welfare. (2020). United States: Nova Science Publishers, Incorporated.

SUBJECT TITLE: Scientific Writing & Presentation Skills
SUBJECT CODE: BBIO-4703-T
SEMESTER-VII
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objectives of the Course: The course aims to develop scientific writing and publishing.

Sr. No	Contents	Contact Hours
UNIT-I	Purpose, audience, and style of scientific writing; primary vs. secondary sources; peer review process, Structuring documents: abstracts, introductions, methods, results, discussions, conclusions, Effective communication principles: clarity, conciseness, coherence, Ethical considerations: plagiarism, authorship, conflicts of interest.	**10 hrs.**
UNIT-II	Developing research questions and hypotheses, Literature review: searching databases, evaluating sources, synthesizing information, Crafting titles and abstracts; writing methods sections, Presenting results: tables, figures, statistical analysis.	**10 hrs**

UNIT-III	Planning presentations: objectives, content structure, visuals., Oral communication: delivery techniques, voice modulation, body language., Designing visual aids: slides, posters, multimedia tools., Handling questions, engaging audience, practice sessions, feedback, Publication process: journal selection, manuscript submission, peer review., Manuscript writing: structure, titles, abstracts, formatting., Responding to reviewer comments, revising manuscripts.	**20 hrs**
UNIT-IV	Ethical publishing: authorship, conflicts of interest, data integrity. Scientific posters and presentations for conferences, Professional online presence: academic profiles, social media, networking, Career development in science communication: writing, editing, journalism.	**20 hrs**

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: To master the principles and ethics of scientific writing, including structuring and clarity.
CO2: To develop and refine research questions, literature reviews, and effective abstracts.
CO3: To navigate the publication process, from manuscript writing to responding to reviewer feedback.
CO4: To learn effective communication and presentation skills.

Reference Books

1. Matthews, J. R., & Matthews, R. W. Successful Scientific Writing: A Step-by- Step Guide for the Biological and Medical Sciences (4th Edition). Cambridge University Press, 2014.

2. Peat, J., Elliott, E., Baur, L., & Keena, V. Scientific Writing: Easy When You Know How (1st Edition). BMJ Books, 2002.

3. Glasman-Deal, H. Science Research Writing for Non-Native Speakers of English (1st Edition). Imperial College Press, 2010.

4. Silyn-Roberts, H. Writing for Science and Engineering: Papers, Presentations and Reports (2nd Edition). Butterworth-Heinemann, 2012.

5. Hofmann, A. H. Scientific Writing and Communication: Papers, Proposals, and Presentations (2nd Edition). Oxford University Press, 2014.

6. Day, R. A., & Gastel, B. How to Write and Publish a Scientific Paper (8th Edition). Cambridge University Press, 2016.

SUBJECT TITLE: Microbial Physiology
SUBJECT CODE: BBIO-4704-T
SEMESTER-VII
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	**0**	**0**	**3**

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objectives of the Course: This course covers microbial metabolism, growth, and environmental adaptations, emphasizing nutrient classification, transport, and energy generation.

Sr. No	Contents	Contact Hours
UNIT-I	Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.	10 hrs.
UNIT-II	Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity	10 hrs
UNIT-III	Effect of the environment on microbial growth Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogen oxidizing bacteria and methanogens.	10 hrs
UNIT-IV	Phototrophic metabolism. Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle.	15 hrs

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Students will learn nutritional classification & metabolite Transport

CO2: Students will learn about microbial growth dynamics,

CO3: Students will learn about environmental Effects on Microbial Growth

CO4: Students will learn about phototrophic metabolism

Text books

1. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
2. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
3. Kim, B. H., Gadd, G. M. (2008). Bacterial Physiology and Metabolism. United Kingdom: Cambridge University Press.
4. Gupta, R., Gupta, N. (2021). Fundamentals of Bacterial Physiology and Metabolism. Germany: Springer Nature Singapore.

SUBJECT TITLE: Practical related to Microbial Physiology
SUBJECT CODE: BBIO-4772-T
SEMESTER-VII
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

PRACTICALS

1. **To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.**
2. **To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.**
3. **To study the effect of pH and temperature on the growth of *E. coli* and *Aspergillus niger* by dry weight method.**
4. **To demonstration of the thermal death time and decimal reduction time of *E. coli.***

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Students will learn to plot the growth curve using turbidometric method

CO2: Students will learn to plot the growth curve using radial growth measurements

CO3: Students will learn effect of pH and temperature on growth of *e.coli* and *aspergillus niger*

C**O4**: Students will learn about thermal death time and decimal reduction time of *e. coli*

SUBJECT TITLE: Dissertation
SUBJECT CODE: BBIO-4773**-T**
SEMESTER-VII
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	0	6

Internal Assessment: 100
End Term Exam: 100
Duration of Exam: 3 Hrs

Eight Semester Scheme

SUBJECT TITLE: Microbial Biotechnology
SUBJECT CODE: BBI0-4801-T
SEMESTER-VII
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objectives of the Course: This course aims to explore microbial biotechnology and its applications in therapeutics, industry, environment, and food technology, emphasizing genetic engineering, bioprocessing, and bioremediation.

Sr. No	Contents	Contact Hours
UNIT-I	Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast	10 hrs.
UNIT-II	Therapeutic and Industrial Biotechnology Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine) Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors Applications of Microbes in Biotransformations Microbial based transformation of steroids and sterols No. of Hours: 8 Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute	15 hrs
UNIT-III	Microbial Products and their Recovery, Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization, RNAi and its applications in silencing genes	10 hrs
UNIT-IV	Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents,	10 hrs

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Students will understand microbial biotechnology and its applications in health, agriculture, environment, and industry.

CO2: Students will learn about microbial production of therapeutics, industrial bioprocesses, and biotransformations.

CO3: Students will learn about microbial product purification, immobilization, and RNAi applications.

C**O4**: Students will learn about microbial roles in biofuels, biogas, and bioremediation.

Reference books

1. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press

2. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press
3. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.

SUBJECT TITLE: Practical related to Microbial Biotechnology
SUBJECT CODE: BBIO-4871-T
SEMESTER-VII
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50
Duration of Exam: 3 Hrs

1. Production and activity assay of amylase, protease, xylanase or lipase from *Bacillus* species
2. Separation of microbial metabolites using filtration and chromatography.
3. Pigment production from fungi (Trichoderma / Aspergillus / Penicillium) 4
4. Study enzyme immobilization by sodium alginate method; Fermentation of agricultural waste using yeast and estimation of ethanol.

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: To produce and analyze microbial enzymes from *Bacillus* species.
CO2: To lperform microbial metabolite separation using filtration and chromatography.Students will learn about microbial production of therapeutics, industrial bioprocesses, and biotransformations.
CO3: To study fungal pigment production from *Trichoderma, Aspergillus,* or *Penicillium*.
C**O4**: To conduct enzyme immobilization and ethanol fermentation from agricultural waste.

SUBJECT TITLE: Nanotechnology
SUBJECT CODE: BBI0-4802-T
SEMESTER-VII
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objectives of the Course: This course aims to impart knowledge about properties, synthesis, characterization and applications of nanomaterials.

Contents of syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	Introduction to Nanotechnology: Definition and Historical milestones. Scale and Size: Understanding nanometres and their significance, Comparison with other scales (macro, micro). Nanostructures in Biological Systems: Proteins, DNA and Biomimetic nanostructures.	10 hrs.
UNIT-II	Properties and Synthesis of Nanomaterials: Physical properties, Chemical properties, Mechanical properties, Optical properties, Quantum effects. Synthesis of Nanomaterials: Top down and bottom-up approaches. Common synthesis methods: Solgel, chemical vapor deposition, Nanoparticle synthesis using biological methods,	10 hrs
UNIT-III	Characterization Techniques: Microscopy: Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Spectroscopy: UV Vis Spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscopy. Xray Techniques: Xray diffraction (XRD).,	20 hrs
UNIT-IV	Applications of Nanotechnology: Electronics: Nanotransistors, Quantum dots, Nanosensors. Energy: Solar cells, Fuel cells, Batteries. Environment: Water purification, Air filtration, Environmental sensors. Medicine: Drug delivery systems, Diagnostic tools, medical imaging. cancer therapy, Biosensors for biomolecules and pathogens detection, Nanotechnology in DNA sequencing, protein analysis and tissue engineering	20 hrs

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Students will understand basics like definitions, history of nanomaterials

CO2: Students will learn about the properties and synthesis of nanomaterials.

CO3: Students will learn about the characterization of nanomaterials

C**O4**: Students will learn about the applications of nanotechnology.

Reference books

1. Niemeyer, C. M., & Mirkin, C. A. (2004). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH
2. Sozer, N., & Kokini, J. L. (2009). Nanotechnology and Functional Foods: Effective Delivery of Bioactive Ingredients. Wiley-Blackwell.
3. Bharat, B. (2015). Nanotechnology Applications for Clean Water. William Andrew.
4. Kumar, C. S. S. R. (2017). Nanomaterials for Medical Diagnosis and Therapy. Wiley.
5. Kulkarni, S. K. (2019). Nanotechnology: Principles and Practices. CRC Press.

SUBJECT TITLE: Intellectual Property right and Related Ethical Issues
SUBJECT CODE: BBI0-4803-T
SEMESTER-VII
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: The course aims to introduce the students to intellectual property rights, commercialization of biotechnological inventions, and ethical implications of biotechnology.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
THEORY:		
UNIT-I	**Introduction to Intellectual Property Rights: Ownership of Tangible and Intellectual Property. Basic requirements of patentability, patentable subject matter, novelty and the Public Domain; Non obviousness. Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. WTO agreement and TRIPS, Patent Cooperation treaty.**	**20**
UNIT-II	**Regulatory and IPR issues in biotechnology industry: Patents, intellectual property, IPO, WPO, USPO, Regulatory clearances, Rules and Regulation.**	**20**
UNIT-III	**Biosafety: Biosafety Introduction to biosafety and health hazards concerning biotechnology, The Cartagena protocol on biosafety. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP)**	**10**
UNIT IV	**Bioethics: Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies Brief account of bioethics in Biotechnology**	**10**

Text Books:

1. M K Sateesh .Bioethics and Biosafety. Kindle Edition
2. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013

Reference Books:

1. J.E. Smith (2004). Biotechnology (Cambridge Univ.Press).
2. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006
3. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition)

Course outcomes:

On successful completion of this course, the student will get/learn:

CO1: Students will understand the intellectual property rights, patent laws, and international agreements like TRIPS.

CO2: Students will learn entrepreneurship in biotechnology, focusing on product development and production feasibility.

CO3: Students will learn biosafety principles, health hazards, and guidelines like GLP and GMP.

C**O4**: Students will learn about bioethics and ethical issues in biotechnology.

SUBJECT TITLE: Entrepreneurship Development
SUBJECT CODE: BBI0-4804-T
SEMESTER-VII
CONTACT HOURS/WEEK: 3

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Objective of course: The course aims to introduce the students to the defining characteristics of an entrepreneur and familiarize with the concepts related to Strategy, Finance and Planning for conceiving and launching an enterprise.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
THEORY:		
UNIT-I	Introduction: Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.	**15**
UNIT-II	Establishing an Enterprise: Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.	**15**
UNIT-III	Financing management: Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.	**15**
UNIT IV	Marketing Management : Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.	**15**

Course outcomes:
On successful completion of this course, the student will get/learn:
CO1: Students will understand basics of entrepreneurship
CO2: Students will learn about how to establishment enterprise
CO3: Students will learn about financing management
C**O4**: Students will learn about marketing management

Recommended Books:

1. Holt, D.H. (2000). *Entrepreneurship: new venture creation*. New Delhi: Prentice Hall ofIndia.
2. Kaplan, J.M., & Warren, A.C. (2013). *Patterns of Entrepreneurship* (4th ed.). Hoboken, NJ: JohnWiley & Sons, Inc

3. Gupta, C.B., Khanka, S.S. (2004). *Entrepreneurship and Small Business Management.* NewDelhi: Sultan Chand & Sons.

4. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and LeadingBiotech Companies.* Oxford: Academic Press.

5. Soetaert, W., & Vandamme, E. (2010). *Industrial Biotechnology: Sustainable Growth and Economic Success.* Weinheim: John Wiley & Sons.

SUBJECT TITLE: Dissertation
SUBJECT CODE: BBIO-4872-T
SEMESTER-VII
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	0	6

Internal Assessment: 100
End Term Exam: 100
Duration of Exam: 3 Hrs