



SYLLABUS FOR

M.Sc Biotechnology

(Two Year Course- Semester System)

(Effective from Academic Session 2026-2028 Onward)

SCHOOL OF APPLIED SCIENCES

SURESH GYAN VIHAR UNIVERSITY, JAIPUR

Rajasthan-302017

Programme outcomes (POs)

Students will be able to

PO 1	PG Graduands are Professionally Competent with characteristic Knowledge-bank, Skill set, Mind-set and Pragmatic Wisdom in their chosen fields.
PO2	PG Graduands demonstrate the desired sense of being seasoned and exhibit unequivocal Spiritedness with excellent qualities of productive contribution to society and nation in the arena Science and Technology.
PO3	PG Graduands are mentored such that they exert Leadership Latitude in their chosen fields with commitment to novelty and distinction.
PO4	PG Graduands are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining Cultural and Civilized personality.
PO5	PG Graduands get ability to apply the process of science by formulating hypotheses and design experiments based on the scientific method.
PO6	PG Graduands get ability to foster an innovative mindset and entrepreneurial skills to translate biotechnological research into commercial products or services.
PO7	PG Graduands enhance critical thinking and problem-solving skills to address complex scientific challenges and innovate solutions.
PO8	PG Graduands are directed to develop proficiency in designing and conducting data analyses using statistical software and tools, interpreting results, and drawing meaningful conclusions.

Program Specific Outcomes (PSOs)

PSO 1	Development and enhancement of skills required in the Bioprocess industry and medical field.
PSO2	Ability to perform analytical techniques/experimental techniques in industrial scenario for the products recovery aid in the development of new therapeutics as drugs/biobased products.
PSO3	Provoking the analysis of biological data using indifferent approaches based on basic computational and bioinformatics skills.

School of Applied Sciences
Teaching and Examination Scheme for
M.Sc Biotechnology
(Effective from Academic Session 2026-27)

Year: I

Semester: I (Autumn/Pavas)

S.No	Course Code	Course Name	Course type	Credit	Contact hrs/Week			Exam hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	University Core									
1.	SODECA-IX	Social Outreach, Discipline & Extra Curriculum Activities-IX	AECC	2	0	0	0	-	100	-
B	Program Core									
1.	BT9001	Biochemistry	DCC	3	3	0	0	3	40	60
2.	BT9002	Immunology and Immunotechnology	DCC	3	3	0	0	3	40	60
3.	BT9003	Cell and Molecular Biology	DCC	3	3	0	0	3	40	60
4.	BT9004	Bioanalytical Techniques	DCC	3	3	0	0	3	40	60
5.	BT9005	Cell and Molecular Biology Lab	DCC	2	0	0	3	3	60	40
6.	BT9006	Biochemistry and Immunology Lab	DCC	2	0	0	3	3	60	40
7.	BT9007	Introduction to Computational Biology and AI	SEC	2	0	0	3	3	60	40
8.	BT9008	Bioanalytical Techniques Lab	DCC	2	0	0	3	3	60	40
TOTAL CREDITS				22						

L= Lecture, T=Tutorial, P= Practical, S= Seminar, CIE=Continuous Internal Evaluation, ESE= End Semester Examination

Signature of Concerned Teacher

Signature of Convener-BOS

Signature of Member Secretary

School of Applied Sciences
Teaching and Examination Scheme for
M.Sc Biotechnology
(Effective from Academic Session 2026-27)

Year: I

Semester: II (Spring/Basant)

S.No	Course Code	Course Name	Course type	Credit	Contact hrs/Week			Exam hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	University Core									
1.	SODECA-X	Social Outreach, Discipline & Extra Curriculum Activities-X	AECC	2	0	0	0	-	100	-
B	Program Core									
1.	BTX001	Genetic Engineering and Application	DCC	3	3	0	0	3	40	60
2.	BTX002	Genetics and Microbiology	DCC	3	3	0	0	3	40	60
3.	BTX003	Bioinformatics	DCC	3	3	0	0	3	40	60
4.	BTX004	Research Methodology and Scientific Communication Skills	SEC	2	0	0	3	3	100	-
5.	BTX005	Genetic Engineering and Application Lab	DCC	2	0	0	3	3	60	40
6.	BTX006	Genetics and Microbiology Lab	DCC	2	0	0	3	3	60	40
7.	BTX007	Bioinformatics Lab	DCC	2	0	0	3	3	60	40
8.	BTX015	Project Proposal Preparation and Presentation	SEC	2	0	0	3	3	100	-
C	Program Elective (Choose any one)									
1.	BTX009	Nanobiotechnology	DSE	3	3	0	0	3	40	60
2.	BTX010	Drug Designing and Development	DSE	3	3	0	0	3	40	60
3.	BTX011	Antivirals and Vaccine Development	DSE	3	3	0	0	3	40	60
4.	BTX012	Molecular Diagnostics	DSE	3	3	0	0	3	40	60
5.	BTX013	Bio-entrepreneurship and Bio-business management	DSE	3	3	0	0	3	40	60
6.	BTX014	Artificial Intelligence in Biotechnology	DSE	3	3	0	0	3	40	60
7.	BTXMO C1	MOOC (through SWAYAM/NPTEL etc) Under Credit Transfer Scheme	DSE/G EC	3	3	0	0	3	40	60
TOTAL CREDITS				24						

L= Lecture, T=Tutorial, P= Practical, S= Seminar, CIE=Continuous Internal Evaluation, ESE= End Semester Examination

Signature of Concerned Teacher

Signature of Convener-BOS

Signature of Member Secretary

School of Applied Sciences
Teaching and Examination Scheme for
M.Sc Biotechnology
(Effective from Academic Session 2026-27)

Year: II

Semester: III (Autumn/Pavas)

S.No	Course Code	Course Name	Course type	Credit	Contact hrs/Week			Exam hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	University Core									
1.	SODECA-XI	Social Outreach, Discipline & Extra Curriculum Activities-XI	AECC	2	0	0	0	-	100	-
B	Program Core									
1.	BTY001	Bioprocess Engineering	DCC	3	3	0	0	3	40	60
2.	BTY002	Animal Biotechnology	DCC	3	3	0	0	3	40	60
3.	BTY003	Biostatistics and Data Analysis	GEC	3	3	0	0	3	40	60
4.	BTY004	Plant Biotechnology	DCC	3	3	0	0	3	40	60
5.	BTY007	Bioprocess Engineering Lab	DCC	2	0	0	3	3	60	40
6.	BTY008	Animal and Plant Biotechnology lab	DCC	2	0	0	3	3	60	40
7.	BTY010	Industrial Summer Project	SEC	1	0	0	3	3	100	-
8.	BTY011	Intellectual Property rights, Biosafety & Bioethics	GEC	3	3	0	0	3	40	60
C	Program Elective (Choose any one)									
1.	BTY012	Pharmaceutical Biotechnology	DSE	3	3	0	0	3	40	60
2.	BTY013	Advanced Clinical Biochemistry	DSE	3	3	0	0	3	40	60
3.	BTY014	Food and Dairy Technology	DSE	3	3	0	0	3	40	60
4.	BTY015	Environmental Biotechnology	DSE	3	3	0	0	3	40	60
5.	BTY016	System Biology and Gemome engineering	DSE	3	3	0	0	3	40	60
6.	BTYMO C1	MOOC (through SWAYAM/NPTEL etc) <i>Under Credit Transfer Scheme</i>	DSE	3	3	0	0	3	40	60
TOTAL CREDITS				25						

L= Lecture, T=Tutorial, P= Practical, S= Seminar, CIE=Continuous Internal Evaluation, ESE= End Semester Examination

Signature of Concerned Teacher

Signature of Convener-BOS

Signature of Member Secretary



School of Applied Sciences
Teaching and Examination Scheme for
M.Sc Biotechnology
(Effective from Academic Session 2026-27)

Year: II

Semester: IV (Spring/Basant)

S.No	Course Code	Course Name	Course type	Credit	Contact hrs/Week			Exam hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
Program Core										
1.	BTZ001	Dissertation/ Project work	DPR	18	0	0	3	3	0	100
2.	BTZ002	Seminar/Review Paper writing	SEC	2	0	0	3	3	100	-
TOTAL CREDITS				20						

Signature of Concerned Teacher

Signature of Convener-BOS

Signature of Member Secretary

For the Award of
M.Sc Biotechnology (2 yr course)

Type of Course	No. of courses in the proposed scheme	No. of credits	Minimum Requirement of no. of Credits for M.Sc Degree
AECC	3	6	
SEC	5	9	
DCC	20 (Th + Lab)	30+ 16	
GEC	2	6	
DSE	2	6	
DPR	1	18	
Total Credits		91	80 (Minimum)

SEMESTER-I

BT9001	BIOCHEMISTRY	
Version	III	
Prerequisite	All students are expected to have a general knowledge of biomolecules and its chemistry.	
Learning objective	The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.	
Course Outcome	<p>On completion of this course, students should be able to:</p> <p>CO1: Explain the chemical basis of life, including water properties, pH, buffers, and biomolecular hierarchy.</p> <p>CO 2: Students will be equipped with a deep understanding of sugars and lipids, their structures, functions, and importance in biological systems.</p> <p>CO 3: Evaluate the structure-function relationship of proteins, analyze enzyme catalysis, and interpret enzyme kinetics, including Michaelis-Menten equations and the role of enzymes in metabolic regulation.</p> <p>CO 4: Students will be able to analyze the structure and Function of DNA, RNA, and Lipids and will have a comprehensive understanding of lipid self-assembly, bio-membrane organization, membrane-bound proteins, and transport phenomena</p> <p>CO 5: Understanding and analysis of the role of vitamins in daily life and the key metabolic pathways involved in energy production, nucleotide biosynthesis, and lipid metabolism.</p>	
Unit - I	Chemical basis of life	8 hours
Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies.		
Unit -II	Carbohydrates	7 hours
Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.		
Unit - III	Protein structure and enzyme kinetics	
<p>Amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin <i>etc.</i>; basic principles of protein purification.</p> <p>Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; concept of catalytic antibodies.</p>		
Unit-IV	Structure and function of DNA, RNA and Lipids	7 hours
Self-assembly of lipids, micelle, bio membrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a		

BT9002	IMMUNOLOGY AND IMMUNOTECHNOLOGY	
Version	III	
Prerequisite	All students are Expected To have knowledge of the immune system and viruses.	
Learning objective	The objectives of this course are to learn about structural features of components of the immune system as well as their function. The major emphasis of this course will be on development of the immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict the nature of the immune response that develops against bacterial, viral or parasitic infection.	
Course Outcome	<p>On completion of this course, students should be able to:</p> <p>CO1: Explain the fundamental concepts of immunology, including innate and acquired immunity and the role of primary and secondary lymphoid organs.</p> <p>CO2: Describe the immune responses generated by B and T lymphocytes, including immunoglobulins, cell signaling, and antigen processing and presentation.</p> <p>CO3: Analyze antigen-antibody interactions and apply advanced immunological techniques for assessing immune reactions.</p> <p>CO4: Evaluate different types of vaccines, vaccine technologies, and the principles behind active and passive immunization.</p> <p>CO5: Discuss clinical immunology aspects, including immunity to infections, hypersensitivity, autoimmunity, transplantation, tumor immunology, and immunodeficiency.</p>	
Unit-I	Immunology: fundamental concepts and overview of the immune system 8 hours	
	Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.	
Unit-II	Immune responses generated by B and T lymphocytes	
	Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self-discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.	
Unit-III	Antigen-antibody interactions	
	Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.	
Unit-IV	Vaccinology	

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.	
Unit-V	Clinical immunology
Immunity to infection: bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immune deficiencies, acquired or secondary immune deficiencies, autoimmune disorder, anaphylactic shock, immune senescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.	
Reference books	<ol style="list-style-type: none"> Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). <i>Kuby Immunology</i>. New York: W.H. Freeman. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). <i>Clinical Immunology</i>. London: Gower Medical Pub. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). <i>Janeway's Immunobiology</i>. New York: Garland Science. Paul, W. E. (2012). <i>Fundamental Immunology</i>. New York: Raven Press. Goding, J. W. (1996). <i>Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology</i>. London: Academic Press. Parham, P. (2005). <i>The Immune System</i>. New York: Garland Science.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	2	1	1	1	2	1
CO2	2	2	1	2	2	1	2	2	2	3	2
CO3	1	1	2	1	1	1	1	3	1	1	1
CO4	3	2	1	2	2	2	2	1	2	3	3
CO5	1	3	2	1	1	1	1	2	3	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BT9003	CELL AND MOLECULAR BIOLOGY
Version	III
Prerequisite	All students are expected to have a basic knowledge of cell and its organelles.
Learning Objective	The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.
Course Outcome	<p>CO1: Explain the universal features and internal organization of cells, including cell membranes, intracellular organelles, and the nuclear compartment.</p> <p>CO2: Describe the processes and regulation of the cell cycle, cell division, cell differentiation, cell interactions, and modes of cell death.</p> <p>CO3: Analyze molecular mechanisms of cellular signaling, membrane transport, and intracellular vesicular trafficking.</p> <p>CO4: Discuss chromatin structure, dynamics, and transcriptional and post-transcriptional control mechanisms.</p> <p>CO5: Understand genome instability, mutations, proto-oncogenes, oncogenes, tumor suppressor genes, and their roles in cell transformation.</p>
Unit-I	Dynamic organization of cell
	Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.
Unit-II	Cell Division And Cell Cycle
	Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans- membrane signaling; cell motility and migration; cell death: different modes of cell death and their regulation.
Unit-III	Cellular signaling, transport and trafficking
	Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.
Unit-IV	Chromatin structure and dynamics
	Chromatin organization - histone and DNA interaction: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin- Writers,-Readers and -Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, transcriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs).
Unit-V	Genome instability and cell transformation

Mutations, proto-oncogenes, oncogenes and tumor suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and intergenic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.

Reference books	<ol style="list-style-type: none"> 1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science. 2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman. 3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning. 4. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland. 5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings. 6. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	1	2	1	1	2
CO2	2	2	1	3	2	2	2	3	2	2	3
CO3	3	1	1	1	2	2	1	1	1	1	1
CO4	1	3	2	2	3	2	3	2	1	3	2
CO5	2	2	3	1	1	3	2	1	2	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BT9004	Bioanalytical Techniques
Version	I
Prerequisite	All students are expected to have a basic knowledge of tools and techniques used in life sciences.
Learning objective	The Learning Objective Of Course are: 1. To create an understanding regarding the technical applications of various tools which are being used in life sciences. 2. To develop an understanding about tools and techniques for electrophoretic, centrifugation, spectroscopic techniques, radio chemical methods, and microscopy.
Course Outcome	CO1: Explain the principles and applications of various microscopy techniques, including electron microscopy and centrifugation techniques. CO2: Describe the principles, types, and applications of different spectrophotometric techniques in biology. CO3: Understand the various chromatographic techniques and their applications in the isolation and analysis of biomolecules. CO4: Discuss the principles and applications of electrophoresis techniques and various blotting methods in molecular biology. CO5: Analyze the principles and applications of radio tracer techniques and understand safety measures in handling radioisotopes.
Unit-I	Principles and applications of Microscopy
	Principles and applications, simple, compound, phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM. Centrifugation Techniques: Principles, type of centrifuges, density gradient centrifugation in isolation of cells, cell organelles and biomolecules.
Unit- II	Spectrophotometry
	Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy. Applications of different Spectroscopic techniques in Biology.
Unit-III	Chromatographic Techniques
	Introduction and types of chromatography, paper, thin layer, gas, Gel permeation, ion-exchange, HPLC, FPLC and affinity chromatography and instrumental details of each. Applications of Chromatographic techniques in Biology.
Unit-IV	Electrophoresis
	Paper and gel electrophoresis, Polyacrylamide gel electrophoresis (native and SDS), Agarose gel electrophoresis, Isoelectric focusing. Isotachopheresis. 2-D Electrophoresis, Capillary electrophoresis, Blotting- Southern, Western and Northern blotting, Immunoblotting, Immuno-electrophoresis, Immunostaining and DNA finger printing and ELISA.
Unit-V	Radiotracer technique
	Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry. Safety measures in handling radioisotopes. RIA, non-radiolabelling.

Reference Books	1. Nuclear Magnetic Resonance: Williams 2. Biochemical Techniques theory and practice: White R 3. Analytical Chemistry: Christian G. D. 4. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H. 5. An Introduction to Practical Biochemistry: Plummer D. T. 6. Protein Purification by Robert Scopes, Springer Verlag Publication, 1982 7. Tools in Biochemistry David Cooper 8. Methods of Protein and Nucleic acid Research, Osterman Vol I – III 9. Centrifugation D. Rickwood 10. Practical Biochemistry, V th edition, Keth, Wilson and Walker.
Mode of Examination	written examination
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	2	1	1	1	2	1
CO2	2	2	1	2	2	1	2	2	2	3	2
CO3	1	1	2	1	1	2	1	3	1	1	1
CO4	3	2	1	2	2	2	2	1	2	3	3
CO5	1	3	2	1	1	3	3	2	3	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BT9007	Introduction to Computational Biology and AI	
Version	I	
Prerequisite	Students are expected to have a basic understanding of biology, molecular biology, genetics, and elementary computer operations.	
Learning objective	<p>The course is designed to introduce students to computational approaches and artificial intelligence applications in modern biological sciences. The specific objectives of the course are as follows:</p> <ol style="list-style-type: none"> 1. To provide fundamental knowledge of computational biology and biological databases. 2. To familiarize students with sequence analysis and bioinformatics tools used in biological research. 3. To introduce programming, biological data handling, and visualization approaches. 4. To impart basic concepts of artificial intelligence and machine learning in biological sciences. 5. To expose students to modern applications of computational biology and AI in biotechnology, healthcare, genomics, and drug discovery. 	
Course Outcome	<p>CO1: Understand the principles, scope, and significance of computational biology and artificial intelligence in modern biotechnology.</p> <p>CO2: Analyze biological databases, sequence analysis methods, and computational tools used in biological research.</p> <p>CO3: Apply basic programming and data handling approaches for biological data analysis and visualization.</p> <p>CO4: Evaluate the concepts of artificial intelligence, machine learning, and their applications in biological sciences.</p> <p>CO5: Analyze the role of computational biology and AI in genomics, healthcare, drug discovery, precision medicine, and emerging biotechnological applications.</p>	
Unit-I	Introduction to Computational Biology	8hours
Introduction to computational biology, scope and significance, interdisciplinary nature of computational biology, biological data types, biological databases, computational approaches in biotechnology, role of computation in modern biological sciences, overview of computational tools used in biological research.		
Unit- II	Sequence Analysis Basics	7hours
Introduction to biological sequences, DNA and protein sequence analysis, sequence alignment concepts, Introduction to BLAST, applications of sequence analysis in biotechnology and healthcare.		
Unit-III	Programming and Data Handling	7hours
Introduction to programming concepts, basics of Python/R for biological sciences, handling biological datasets, data preprocessing basics, introduction to data visualization, graphical representation of biological data, overview of computational workflows in biological research.		
Unit-IV	Foundations of Artificial Intelligence	7hours
Introduction to artificial intelligence, history and evolution of AI, AI vs Machine Learning vs Deep Learning, basics of machine learning, supervised and unsupervised learning (conceptual overview), pattern recognition, biological applications of AI and machine learning.		
Unit-V	Applications in Biotechnology	7hours

Applications of computational biology and AI in genomics, drug discovery, precision medicine, agriculture, healthcare, diagnostics, omics technologies, biomedical data analysis, ethical considerations, challenges, and future prospects of AI in biotechnology.	
Reference Books	<ol style="list-style-type: none"> 1. Mount, D.W. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press. 2. Lesk, A.M. (2019). Introduction to Bioinformatics. Oxford University Press. 3. Xiong, J. (2006). Essential Bioinformatics. Cambridge University Press. 4. Baldi, P. and Brunak, S. (2001). Bioinformatics: The Machine Learning Approach. MIT Press. 5. Rashidi, H.H. and Buehler, L.K. (2000). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press. 6. Alpaydin, E. (2021). Introduction to Machine Learning. MIT Press. 7. Goodfellow, I., Bengio, Y., and Courville, A. (2016). Deep Learning. MIT Press. 8. Bishop, C.M. (2006). Pattern Recognition and Machine Learning. Springer. 9. Jones, N.C. and Pevzner, P.A. (2004). An Introduction to Bioinformatics Algorithms. MIT Press.
Mode of Examination	written examination
Recommended By BOS on:	
Approved by academic council on:	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	2	1	1	1	2	1
CO2	2	2	1	2	2	1	2	2	2	3	2
CO3	1	1	2	1	1	2	1	3	1	1	1
CO4	3	2	1	2	2	2	2	1	2	3	3
CO5	1	3	2	1	1	3	3	2	3	1	1

SEMESTER-II

BTX001	GENETIC ENGINEERING AND APPLICATION	
Version	III	
Prerequisite	All students are expected to have a general and basic knowledge of molecular biology and Genetics.	
Learning Objective	The Learning Objectives of course are: to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.	
Course Outcome	<p>CO1: Understand the impact of genetic engineering in modern society and the fundamental requirements for conducting genetic engineering experiments.</p> <p>CO2: Explain the various vectors used in genetic engineering and their applications in maximizing gene expression.</p> <p>CO3: Describe the principles and types of PCR techniques, and their applications in molecular diagnostics and mutation detection.</p> <p>CO4: Discuss the methods for gene manipulation, construction of libraries, and study of protein-DNA interactions.</p> <p>CO5: Understand gene silencing techniques, genome editing technologies, and the creation of transgenic organisms.</p>	
Unit-I	Introduction to tools for genetic engineering	
	Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labeling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence <i>in situ</i> hybridization.	
Unit-II	Vectors in genetic engineering	
	Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Blue script vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmides; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag <i>etc.</i> ; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and <i>Pichia</i> vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.	
Unit-III	PCR techniques	
	Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.	
Unit-IV	Gene manipulation and protein DNA interaction	

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase foot printing; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
Unit-V	Gene silencing and genome editing technologies
Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems e.g. fruit flies gene targeting; creation of transgenic and knock-out mice; disease model	
Referen ce books	<ol style="list-style-type: none"> 1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). <i>Principles of Gene Manipulation: an Introduction to Genetic Engineering</i>. Oxford: Blackwell Scientific Publications. 2. Green, M. R., & Sambrook, J. (2012). <i>Molecular Cloning: a Laboratory Manual</i>. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Brown, T. A. (2006). <i>Genomes</i> (3rd ed.). New York: Garland Science Pub. 4. Selected papers from scientific journals, particularly Nature & Science. 5. Technical Literature from Strata gene, Promega, Novagen, New England Biolab etc.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommend ed by BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	3	2	1	1	2
CO2	2	2	1	3	2	2	2	3	2	2	3
CO3	3	1	1	1	2	1	1	1	1	1	1
CO4	1	3	2	2	3	2	3	2	3	3	2
CO5	2	2	3	1	1	3	2	1	2	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX002	GENETICS AND MICROBIOLOGY	
Version	III	
Prerequisite	All students are expected to have a general knowledge of molecular biology and some basic concept of Genetics.	
Learning objective	The Learning Objective Of Course is: to take students through basics of genetics and classical genetics covering prokaryotic/ phage genetics to yeast and higher eukaryotic domains. On covering all classical concepts of Mendelian genetics across these life-forms, students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.	
Course Outcome	<p>CO1: Recall the historical developments and fundamental concepts in plant genetics, including the cell cycle and Mendelian genetics.</p> <p>CO2: Explain the genetics of bacteria, bacteriophages, and yeast, including gene mapping and genetic recombination.</p> <p>CO3: Describe microbial characteristics, including morphology, growth, and bacterial genetics.</p> <p>CO4: Classify and compare microbial diversity, including various types of microorganisms and their evolutionary aspects.</p> <p>CO5: Explain the methods for controlling microorganisms and their ecological impact, including sterilization, antibiotics, and host-pathogen interactions.</p>	
Unit-I	Plant genetics	8 hours
Introduction: Historical developments in the field of genetics. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, excessiveness, incomplete dominance, codominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.		
Unit-II	Genetics of bacteria, bacteriophages and Yeast	7 hours
Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene. Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.		
Unit-III	Microbial Characteristics	7 hours
Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.		
Unit-IV	Microbial Diversity	7 hours
Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilicarchae, Thermopiles; eukaryote: algae, fungi, slime molds and protozoa; extremophiles and		

unculturable microbes. Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroid's and prions.	
Unit-V	Control of microorganisms
Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms. Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.	
Reference books	<ol style="list-style-type: none"> Hartl, D. L., & Jones, E. W. (1998). <i>Genetics: Principles and Analysis</i>. Sudbury, MA: Jones and Bartlett. Pierce, B. A. (2005). <i>Genetics: a Conceptual Approach</i>. New York: W.H. Freeman. Tamarin, R. H., & Leavitt, R. W. (1991). <i>Principles of Genetics</i>. Dubuque, IA: Wm. C. Brown. Smith, J. M. (1998). <i>Evolutionary Genetics</i>. Oxford: Oxford University Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	1	2	1	1	2
CO2	2	2	1	3	2	2	2	3	2	2	3
CO3	3	1	1	1	2	1	1	1	1	1	1
CO4	1	3	2	2	3	2	3	2	3	3	2
CO5	2	2	3	1	1	1	2	1	2	2	3

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX003	BIOINFORMATICS	
Version	III	
Prerequisite	To get basic knowledge of biology, computer science, and statistics is the key prerequisite for bioinformatics.	
Learning objective	The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	
Course Outcome	<p>CO1: Recall fundamental concepts of bioinformatics, including genomic research, computational biology, and key bioinformatics resources.</p> <p>CO2: Explain sequence analysis and alignment techniques, including file formats and database submissions.</p> <p>CO3: Apply similarity searching tools such as BLAST and FASTA for sequence alignment and pattern recognition.</p> <p>CO4: Analyze protein identification methods and predict protein structures using primary, secondary, and tertiary prediction techniques.</p> <p>CO5: Evaluate phylogenetic analysis methods and construct phylogenetic trees using tools like ClustalW and MEGA6.</p>	
Unit-I	Introduction To Bioinformatics	7hours
Introduction to genomic research and data generation, Genome projects, requirement of computational biology and bioinformatics, contribution of bioinformatics in biotechnology. Information Resources: NCBI, EBI, ExPasy Entrez & SRS System. Primary Sequence & Structure Databases: Genbank, SwissProt/Uniprot, EMBL, PIR, PDB, KEGG, Prosite, Pfam, etc. Genome Databases (at NCBI, EBI).		
Unit-II	Sequence analysis and Sequence alignment	7hours
Nucleotide sequence analysis: genbank sequence database; submitting DNA sequences to databases and database searching; Sequence File formats: fasta, genbank, embl, Swiss-prot, pdb, nbrf, pir and multiple sequences formats. Sequence alignment; pairwise alignment techniques; Multiple sequence alignment.		
Unit-III	Similarity Searching Tools:	7hours
Sequences Alignment: Brute Force method, Dot matrix method, Global (Needleman- Wunsch) and Local Alignment (Smith-Waterman) using Dynamic programming. BLAST and FASTA, Theory and Algorithms, variants of BLAST and FASTA, PSI-BLAST, Statistical Significance. Sequence Pattern and Profiles: Concepts of motif, pattern and profile.		
Unit IV	Protein Identification and Protein structure prediction	7hours
Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Production of Protein Structure & Modeling Protein Primary & Secondary Structure, Prediction Methods – Introduction to various methods. Tertiary structure prediction (Homology & Threading Methods) Profile.		
Unit-V	Phylogenetic Analysis	8hours
Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny definition and description of Phylogenetic trees and various types of trees Phylogenetic Analysis. Searching Databases: Data Submission. Phylogenetic tree building methods, ClustalW and MEGA6.		

Reference books	<ol style="list-style-type: none"> 1. Lesk, A. M. (2002). <i>Introduction to Bioinformatics</i>. Oxford: Oxford University Press. 2. Mount, D. W. (2001). <i>Bioinformatics: Sequence and Genome Analysis</i>. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Baxevanis, A. D., & Ouellette, B. F. (2001). <i>Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins</i>. New York: Wiley-Interscience. 4. Pevsner, J. (2015). <i>Bioinformatics and Functional Genomics</i>. Hoboken, NJ.: Wiley-Blackwell. 5. Bourne, P. E., & Gu, J. (2009). <i>Structural Bioinformatics</i>. Hoboken, NJ: Wiley-Liss. 6. Lesk, A. M. (2004). <i>Introduction to Protein Science: Architecture and Function</i>
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	1	2	1	3	2
CO2	2	2	1	3	2	2	2	3	2	2	3
CO3	3	1	1	1	2	1	1	1	1	1	1
CO4	1	3	2	2	3	2	3	2	3	3	2
CO5	2	2	3	1	1	1	2	1	2	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX004	RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION SKILLS
Version	III
Prerequisite	All students are expected to have basic knowledge of life sciences and their applications in research.
Learning objective	The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.
Course Outcome	<p>CO1: Understand research methodologies, literature search techniques, and bibliometric analysis in life sciences.</p> <p>CO2: Develop research hypotheses, distinguish between hypothesis-driven and hypothesis-generating research, and apply them effectively in scientific projects.</p> <p>CO3: Design experiments, analyze data using statistical software, and present findings with clarity and precision.</p> <p>CO4: Enhance formal presentation skills, defend research findings, and participate in group discussions effectively.</p> <p>CO5: Master technical writing skills, navigate the scientific publication process, and adhere to ethical standards in scientific communication</p>
Unit-I	Introduction to Research Methodology
	Fundamentals of Research Methodology, Applications in life sciences, Literature Search: Use of databases, framing query with examples, Bibliometric: Citation, Impact factor, Eigen factor.
Unit-II	Problem Identification & Formulation
	Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance
Unit-III	Data Analysis & Paper Writing
	Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing.
Unit-IV	Presentation skills
	Presentation skills - formal presentation skills; preparing and presenting using overhead projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.
Unit-V	Scientific communication
	Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer

review process and problems, recent developments such as open access and non- blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.	
Reference Books	<ol style="list-style-type: none"> 1. Valiela, I. (2001). <i>Doing Science: Design, Analysis, and Communication of Scientific Research</i>. Oxford: Oxford University Press. 2. <i>On Being a Scientist: a Guide to Responsible Conduct in Research</i>. (2009). Washington, D.C.: National Academies Press. 3. Gopen, G. D., & Smith, J. A. <i>The Science of Scientific Writing</i>. American Scientist, 78 (Nov-Dec 1990), 550-558. 4. Mohan, K., & Singh, N. P. (2010). <i>Speaking English Effectively</i>. Delhi: Macmillan India. 5. Movie: Naturally Obsessed, The Making of a Scientist.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOSon:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	1	3	2	3	3	2	3	1
CO2	2	2	1	1	2	2	2	2	1	2	1
CO3	1	2	2	1	1	1	1	1	1	1	1
CO4	2	3	1	2	2	1	1	1	1	2	2
CO5	1	2	1	1	1	2	2	1	1	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX009	Nanobiotechnology	
Version	I	
Prerequisite	Basic principles of Biotechnology and its applications	
Learning Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment	
Course Outcome	<p>CO 1: Recognize key milestones and progress in the development of nanobiotechnology.</p> <p>CO 2: Understand the various types of nanomaterials used in biotechnological applications, including carbon nanotubes and nanowires.</p> <p>CO 3: Understand the various types of transducing elements and their applications in bio-nanotechnology.</p> <p>CO 4: Understand the applications of nanobiotechnology in the treatment of infectious diseases.</p> <p>CO 5: Learn about the detection of food contaminants and the role of nanobiotechnology in the food industry.</p>	
UNIT-I	Introduction of nanobiotechnology	08 hours
Introduction, history and timeline of Nanobiotechnology, types and classification of nanomaterials, properties of nanomaterials, Applications of Nanotechnology in biology		
UNIT-II	Synthesis and Characterization of nanomaterials	08 hours
Nanomaterials for Bio-technological Applications, Carbon Nanotubes, Nanowires, synthesizing nanoparticles, Green Synthesis of Nanoparticles, Surface functionalization of nanoparticles, characterization techniques of nanoparticles (XRD, FTIR, TEM/SEM, DLS, Zeta Potential)		
UNIT –III	Nanobiotechnology detection system	06 hours
Various types of transducing elements and their applications in Bio-Nanotechnology, Electrochemical transducer, optical transducer, biosensors in nanotechnology, Quantum dots, gold nanoparticles as biosensors, DNA detection, small scale system for drug delivery, Lab-on-chip and microfluidic systems		
UNIT-IV	Nanotechnology in chronic and infectious disease	07 hours
Targeted drug delivery systems, Types of Nanocarriers, Nanovaccines, Application of Nanobiotechnology in the treatment of Infectious Diseases, Nanotechnology Applications in Cancer Diagnosis and Therapy		
UNIT-V	Nanotechnology in environment and food sciences	07 hours
Nanotechnology in environment, detection of food contaminants, food industry, Food preservation, Nano-enabled smart food packaging, waste water treatment, Sustainable and biodegradable nanomaterials		
Text Book	<i>Bio-nanotechnology</i> by David S. Goodsell, 2004, Wiley Publications	
Reference Books	<p>1. Rolf E. Hummel, <i>Electronic Properties of materials</i>, Narosa Publishing House</p> <p>2. Raghavan.V., <i>Materials Science & Engineering – A First Course</i>, 5th edition, Prentice Hall of India</p> <p>3. Khanna. O. P., <i>A Text Book of Material Science & Metallurgy</i>, Revised edition, Dhanpat Rai Publications</p>	
Mode of Evaluation:	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT	

Recommended by BOS on :	
Adopted by Faculty on:	
Approved by Academic Council on :	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	3	3	2	3	3	2	3	1
CO2	2	2	1	1	2	2	2	2	1	2	1
CO3	1	2	2	1	1	1	2	1	1	2	1
CO4	3	1	2	2	2	3	1	1	3	2	2
CO5	2	2	1	2	1	1	1	1	1	1	3

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX010	Drug Designing and Development	
Version	I	
Prerequisite	All students are expected to have a basic knowledge of Bioinformatics and drugs	
Learning objective	The learning objective of course are: To create an understanding regarding the Basics of Molecular Modelling and Drug Designing	
Course Outcome	<p>CO 1: Understand the basic concepts and stability profiles of biotechnological products.</p> <p>CO 2: Understand the historical perspectives and basic principles of drug targeting and delivery systems.</p> <p>CO 3: Gain a comprehensive understanding of various types of vaccines, including multivalent subunit vaccines, purified macromolecules, synthetic peptide vaccines, and recombinant antigen vaccines.</p> <p>CO 4: Understand the basic concepts of the drug design cycle, including Structure-Activity Relationship (SAR) and Rational Drug Design.</p> <p>CO 5: Understand the fundamentals of molecular modeling, including quantum mechanical and molecular orbital methods.</p>	
Unit-I	Biotechnological products	8 hours
	Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization.	
Unit-II	Basic principles of molecular dynamics	7 hours
	Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.	
Unit-III	Vaccines	7 hours
	Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotypic vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.	
Unit-IV	Drug Design	7 hours
	Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans' equation	
Unit-V	Molecular Modeling	7 hours
	Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.	
Reference	1. Andrew Leach, Molecular Modelling: Principles and Applications (2nd Edition), Addison	

books	<p>Wesley Longman, Essex, England, 1996.</p> <p>2. Alan Hinchliffe, Modelling Molecular Structures, 2nd Edition, John-Wiley, 2000.</p> <p>3. Alan Hinchliffe, Molecular Modelling for Beginners, John-Wiley, 2003.</p> <p>4. N. Cohen (Ed.), Guide Book on Molecular Modeling in Drug Design, Academic Press, San Diego, 1996.</p> <p>5. D. Frenkel and B. Smith, Understanding Molecular Simulations. From Algorithms to Applications, Academic Press, San Diego, California, 1996.</p> <p>6. C. Rauter and K. Horn, X-ray crystallography and drug design, Elsevier, 1984.</p> <p>7. M. Kalos and P. A. Whitlock, Monte Carlo Methods. John Wiley & Sons, New York, 1986.</p> <p>8. J.A. McCammon and S.C. Harvey. Dynamics of Proteins and Nucleic Acids. Cambridge University Press, Cambridge, 1987.</p> <p>9. D.C. Rapaport. The Art of Molecular Dynamics Simulation. Cambridge University Press, Cambridge, England., 1995</p>
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	1	3	2	3	3	2	3	1
CO2	2	2	1	2	2	2	2	2	1	2	1
CO3	1	2	2	1	1	1	1	1	1	1	1
CO4	2	3	1	2	2	1	1	1	1	2	2
CO5	1	2	1	1	1	2	2	1	1	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX011	Antivirals and Vaccine development
Version	1.0
Prerequisite	All students are expected to have a basic understanding of microbiology, immunology, molecular biology, and infectious diseases.
Learning objective	<ol style="list-style-type: none"> 1. To provide knowledge of antiviral agents, their mechanisms, and therapeutic applications. 2. To familiarize students with conventional and modern vaccine development strategies. 3. To impart understanding of immune responses, vaccine design, and delivery systems. 4. To introduce recent advances in antiviral therapeutics and vaccine technologies. 5. To develop awareness of challenges, safety, and regulatory aspects in antiviral and vaccine development
Course Outcome	<p>CO 1: Understanding the principles and types of conventional vaccines, including killed and attenuated vaccines.</p> <p>CO 2: Understanding the use of animal models in vaccine development and testing.</p> <p>CO 3: Understanding the immune response triggered by vaccines and its role in protection against infectious diseases.</p> <p>CO 4: Understanding the principles and methods of designing and screening antiviral drugs.</p> <p>CO 5: Exploring in silico approaches for drug designing and their applications in drug discovery and development.</p>
Unit-I	Conventional vaccines 5 hours
	Conventional vaccines -killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues.
Unit-II	Animal models 4 hours
	Animal models for infectious diseases and vaccine studies, transgenic and knockout animal models, vaccine potency and safety testing, preclinical evaluation of vaccines and antivirals, toxicity studies, challenge studies, ethical considerations in animal experimentation.
Unit-III	Immune markers 5 hours
	Vaccine induced immune response and immune markers of protection, immunological memory, cytokine profiling, antibody-mediated and cell-mediated immunity, immunogenicity assessment, evaluation of vaccine efficacy and safety.
Unit-IV	Designing and screening for antivirals 5 hours
	Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals-mechanism of action & drug resistance.
Unit-V	Drug designing 5 hours
	Antisense RNA, siRNA, miRNA, ribozymes, in silico approaches for drug designing.

Reference books	<p>1. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tying. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker.</p> <p>2. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons, Incorporated.</p> <p>3. Chimeric Virus -like Particles as Vaccines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor). Latest edition / Pub. Date: November 1996 Publisher: Karger, S. Inc.</p> <p>4. Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Latest edition / Pub. Date: September 2003. Publisher: Elsevier Health Sciences.</p>
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	3	3	1	3	3	2	3	2
CO2	2	1	3	2	2	2	2	2	1	2	1
CO3	1	2	3	1	1	3	1	1	2	1	3
CO4	2	1	1	1	2	1	1	1	1	2	2
CO5	1	2	1	3	1	1	2	1	3	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX012	MOLECULAR DIAGNOSTICS
Version	II
Prerequisite	All students are expected to have a general knowledge of genomics, microbial diseases, inherited diseases and Cancer.
Learning objective	The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.
Course Outcome	<p>CO 1: Comprehensive understanding of DNA, RNA, and protein structures and functions.</p> <p>CO 2: Detailed knowledge of various PCR techniques (Real-time, ARMS, Multiplex) and hybridization methods (ISH, FISH, ISA).</p> <p>CO 3: Understanding of direct detection and identification methods for pathogenic organisms, especially those that are slow-growing or lack in vitro cultivation systems.</p> <p>CO 4: Understanding of new mutational mechanisms and familial cancer syndromes.</p> <p>CO 5: Understanding of genetic aberrations in cancer and their detection using next-generation sequencing.</p>
Unit-I	Genome biology in health and disease
	DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.
Unit-II	Genome: resolution, detection & analysis
	PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis.
Unit-III	Detection and identity of microbial diseases
	Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of <i>in vitro</i> cultivation as well as genotypic markers of microbial resistance to specific antibiotics.
Unit-IV	Detection of inherited diseases
	Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes.
Unit-V	Molecular oncology
	Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.
Reference Books	<ol style="list-style-type: none"> Campbell, A. M., & Heyer, L. J. (2006). <i>Discovering Genomics, Proteomics, and Bioinformatics</i>. San Francisco: Benjamin Cummings. Brooker, R. J. (2009). <i>Genetics: Analysis & Principles</i>. New York, NY: McGraw-Hill. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). <i>Molecular Biotechnology: Principles and</i>

	<p><i>Applications of Recombinant DNA</i>. Washington, DC: ASM Press.</p> <p>4. Coleman, W. B., & Tsongalis, G. J. (2010). <i>Molecular Diagnostics: for the Clinical laboratorian</i> Totowa, NJ: Humana Press.</p>
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	1	3	2	3	3	2	3	1
CO2	2	2	1	1	2	2	2	2	1	2	1
CO3	1	2	2	1	1	1	1	1	1	1	1
CO4	2	3	1	2	2	1	1	1	1	2	2
CO5	1	2	1	1	1	2	2	1	1	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX013	Bio-entrepreneurship and Bio-business management
Version	IV
Prerequisite	Basic understanding of biotechnology, innovation, and scientific research concepts.
Learning objective	Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects.
Course Outcome	<p>CO1: Understanding the scope and significance of bio-entrepreneurship.</p> <p>CO2: Strategies and processes involved in negotiating with financiers, government, and regulatory authorities.</p> <p>CO3: Preparation of business plans, including statutory and legal requirements.</p> <p>CO4: Understanding regulatory compliances and procedures from agencies like CDSCO, NBA, GCP, GLA, and GMP.</p> <p>CO5: Understanding of the various entrepreneurial opportunities in industrial biotechnology and will be equipped with knowledge about the essential requirements, marketing strategies, support schemes, with starting and running a biotech business.</p>
Unit-I	Innovation and entrepreneurship in bio-business
	Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (<i>e.g.</i> pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.
Unit-II	Bio markets - business strategy and marketing
	Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.
Unit-III	Finance and accounting
	Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership Information technology.
Unit-IV	Technology management
	Technology – assessment, development & upgradation, managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP). .
Unit V	Entrepreneurship Opportunity in Industrial Biotechnology

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Bio pesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics.	
Reference Books	<ol style="list-style-type: none"> 1. Adams, D. J., & Sparrow, J. C. (2008). <i>Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences</i>. Bloxham: Scion. 2. Shimasaki, C. D. (2014). <i>Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies</i>. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier. 3. Onetti, A., & Zucchella, A. <i>Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge</i>. Routledge. 4. Jordan, J. F. (2014). <i>Innovation, Commercialization, and Start-Ups in Life Sciences</i>. London: CRC Press. 5. Desai, V. (2009). <i>The Dynamics of Entrepreneurial Development and Management</i>. New Delhi: Himalaya Pub. House.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	3	3	1	3	3	2	3	2
CO2	2	1	1	2	2	2	2	2	1	2	1
CO3	1	2	3	1	1	3	1	1	2	1	3
CO4	2	1	1	1	2	1	1	1	1	2	2
CO5	1	2	1	1	1	1	2	1	3	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX014	Artificial Intelligence in Biotechnology	
Version	I	
Prerequisite	Students are expected to have a basic understanding of molecular biology, genetics, bioinformatics, statistics, and computational biology fundamentals.	
Learning objective	<p>The course is designed to introduce artificial intelligence methodologies and their applications in modern biotechnology and allied biological sciences. The specific objectives of the course are as follows:</p> <ol style="list-style-type: none"> 1. To familiarize students with the fundamental concepts of artificial intelligence, machine learning, and deep learning. 2. To impart knowledge of biological data analysis using AI-based computational approaches. 3. To introduce AI tools and techniques used in genomics, proteomics, healthcare, and drug discovery. 4. To develop understanding of AI-driven solutions in agriculture, industrial biotechnology, and precision medicine. 5. To expose students to ethical, regulatory, and future aspects of AI applications in biotechnology. 	
Course Outcome	<p>CO1: Understand the principles, methodologies, and importance of artificial intelligence in biotechnology and life sciences.</p> <p>CO2: Analyze machine learning approaches and computational techniques used for biological data analysis.</p> <p>CO3: Apply AI tools and computational platforms for genomics, omics, healthcare, and biomedical applications.</p> <p>CO4: Evaluate AI-driven applications in drug discovery, diagnostics, agriculture, industrial biotechnology, and precision medicine.</p> <p>CO5: Assess ethical, regulatory, and future perspectives of artificial intelligence in biotechnology and healthcare.</p>	
Unit-I	Biological Data and Computational Approaches	8 Hours
Biological datasets and data types, omics data, biological data preprocessing, feature extraction, dimensionality reduction, data integration approaches, computational workflows in biotechnology, introduction to predictive analytics in biological systems.		
Unit-II	Machine Learning Techniques in Biotechnology	7 Hours
Supervised and unsupervised learning, classification and regression methods, clustering techniques, pattern recognition, support vector machines, decision trees, naïve Bayes classification, neural networks and deep learning concepts, biological applications of machine learning.		
Unit-III	AI Tools and Platforms for Biotechnology	7 Hours
AI libraries and frameworks (overview), TensorFlow and Keras basics, cloud computing and big data in biotechnology, data visualization techniques, AI-enabled bioinformatics and computational biology platforms.		
Unit-IV	AI Applications in Modern Biotechnology and Precision Healthcare	7 Hours
AI-assisted drug target identification and virtual screening, biomarker discovery, precision medicine and personalized therapeutics, AI in cancer biology and immunotherapy, AI applications in microbiome research, agricultural biotechnology, smart bioprocess optimization, and industrial biotechnology.		
Unit-V	Advanced AI Technologies, Case Studies and Future Perspectives	7 Hours
Deep learning in biological sciences, generative AI in drug and biomolecule design, digital twins in healthcare and biotechnology, AI-driven systems biology and synthetic biology, explainable AI (XAI) in biological decision-making, AI-integrated wearable and biosensing technologies, case studies of AI applications in healthcare and biotechnology industries, ethical and regulatory challenges, data privacy and security, limitations of AI models, future prospects of AI-driven biotechnology and translational medicine		

Reference books	<ol style="list-style-type: none"> 1. Goodfellow, I., Bengio, Y., and Courville, A. (2016). Deep Learning. MIT Press. 2. Alpaydin, E. (2021). Introduction to Machine Learning. MIT Press. 3. Bishop, C.M. (2006). Pattern Recognition and Machine Learning. Springer. 4. Baldi, P. and Brunak, S. (2001). Bioinformatics: The Machine Learning Approach. MIT Press. 5. Charu C. Aggarwal. (2018). Neural Networks and Deep Learning. Springer. 6. Xiong, J. (2006). Essential Bioinformatics. Cambridge University Press. 7. Lesk, A.M. (2019). Introduction to Bioinformatics. Oxford University Press. 8. Rashidi, H.H. and Buehler, L.K. (2000). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press. 9. Gupta, P.K. (Recent Edition). Artificial Intelligence. University Science Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	3	3	2	3	2
CO2	1	1	1	2	2	2	2	2	1	2	1
CO3	2	1	2	1	1	3	1	2	2	1	1
CO4	2	1	1	1	2	1	1	1	1	2	3
CO5	2	2	3	1	2	1	2	3	3	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTX015	PROJECT PROPOSAL PREPARATION AND PRESENTATION
Version	II
Prerequisite	All students are expected to have a general knowledge of Plant and Animal Biotechnology.
Learning objective	The learning objective of course is: to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.
Course Outcome	The student will be able to conceptualize about CO 1: Formulate a scientific question; CO 2: Present scientific approach to solve the problem; CO 3: Interpret, discuss and communicate scientific results in written form; CO 4: Gain experience in writing a scientific proposal; CO 5: Learn how to present and explain their research findings to the audience effectively.
Unit-I	Project proposal preparation
	Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven. Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources. Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, <i>etc.</i> Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.
Unit-II	Poster presentation
	Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.
Unit-III	Oral presentation
	At the end of their project, a presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS	
Approved by academic council	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	2	2	1	3	2
CO2	1	1	1	2	2	2	2	2	1	1	1
CO3	2	2	2	1	1	1	1	3	2	1	2
CO4	3	1	1	1	2	3	1	1	1	3	3
CO5	2	3	3	1	2	1	2	3	3	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

SEMESTER-III

BTY001	BIOPROCESS ENGINEERING
Version	III
Prerequisite	All students are expected to have a general knowledge of application of microbes in biological processes.
Learning Objective	The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of the biotechnology industry.
Course Outcome	The student will be able to conceptualize about CO1: Explain the basic principles and methods for the isolation, screening, and maintenance of industrially important microorganisms along with different modes of bioreactor operation CO2: Interpret and illustrate the relationship between bioprocess variables and significance of strain improvement techniques in optimizing the productivity of microorganisms for industrial applications. CO3: Apply bioprocess engineering principles of upstream and downstream processing to design efficient bioprocesses for different products and solve problems related to scaling up and scale down. CO4: Analyse and assess different strategies for optimizing bioprocess parameters to maximize yield and productivity of industrially important biochemicals and therapeutic products while ensuring product quality. CO5: Assess the environmental and economic impact of bioprocessing techniques in biofuel production and other applications and develop strategies for the efficient isolation, screening, and maintenance of specific microorganisms tailored for industrial applications.
Unit-I	Basic principle of biochemical engineering
Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.	
Unit-II	Bioreactor design and analysis
Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.	
Unit-III	Downstream processing and product recovery
Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.	
Unit-IV	Application of enzyme technology in food processing
Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions <i>e.g.</i> starch and sugar conversion processes; high-fructose corn syrup; inter esterified fat; hydrolyzed protein <i>etc.</i> and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food	

processing.	
Unit-V	Applications of microbial technology in food process operations and production, biofuels and biorefinery
Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colors and flavors, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery	
Reference books	<ol style="list-style-type: none"> 1. Shuler, M. L., & Kargi, F. (2002). <i>Bioprocess Engineering: Basic Concepts</i>. Upper Saddle River, NJ: Prentice Hall. 2. Stanbury, P. F., & Whitaker, A. (2010). <i>Principles of Fermentation Technology</i>. Oxford: Pergamon Press. 3. Blanch, H. W., & Clark, D. S. (1997). <i>Biochemical Engineering</i>. New York: M. Dekker. 4. Bailey, J. E., & Ollis, D. F. (1986). <i>Biochemical Engineering Fundamentals</i>. New York: McGraw-Hill. 5. El-Mansi, M., & Bryce, C. F. (2007). <i>Fermentation Microbiology and Biotechnology</i>. Boca Raton: CRC/Taylor & Francis.
Mode of Examination	Assignment/Quiz/Viva-Voce/studentseminar/writtenexamination/PPT
Recommended By BOSon	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	2	2	1	3	2
CO2	1	1	1	2	2	2	2	2	1	1	1
CO3	2	2	2	1	1	1	1	3	2	1	2
CO4	3	1	1	1	2	3	1	1	1	3	3
CO5	2	3	3	1	2	1	2	3	3	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY002	ANIMAL BIOTECHNOLOGY
Version	II
Prerequisite	All students are expected to have a general knowledge of Plant and Animal Biotechnology.
Learning objective	The learning objectives of course are: To create an understanding regarding the Plant tissue culture, production of haploid plants, Gene transfer in plant, animal biotechnology and gene regulation in Plants.
Course Outcome	<p>CO 1: Differentiate between primary culture, explant culture, suspension culture, and established cell line cultures.</p> <p>CO 2: Discuss the applications of different types of culture media in biotechnological research and commercial settings.</p> <p>CO 3: Analyze the commercial applications of cell culture, such as in the production of monoclonal antibodies and vaccines.</p> <p>CO 4: Evaluate methods for mass production, harvesting, purification, and assays of biologically important compounds.</p> <p>CO 5: Present findings and research outcomes effectively through reports, presentations, and discussions.</p>
Unit-I	Introduction to animal biotechnology
	Introduction to animal biotechnology. Equipments And required materials for animal cell culture technology. Characteristics of cells in culture; Growth and maintenance of cells in culture; Cells and Cell Lines, Culture media: Natural and Chemical Defined Media; Advantages and Disadvantages of Serum and Protein based media. Isolation and Disaggregation of tissues by Mechanical and Enzymatic Methods. Primary and established cell in cultures. Monoclonal antibodies. Immunotoxins as therapeutic agents Stem cell culture, embryonic stem cells and their applications.
Unit-II	Cell Culture
	Primary culture: behavior of cells, properties, utility; Explant culture; suspension culture; Established cell line cultures: definition of cell lines, maintenance and management, cell adaptation; Measurement of viability and cytotoxicity; Cell cloning; cell synchronization and cell manipulation; Various methods of separation of cell types; advantages and limitations; flow cytometry.
Unit-III	Techniques for Cell Culture
	Basic techniques of mammalian cell cultures in vitro: Serum & protein free defined media and their applications; Measurement of viability and cytotoxicity; Cell synchronization; Cell transformation; Scaling up of animal cell culture; Stem cell cultures; embryonic stem cells and their applications; Somatic cell genetics; Apoptosis: Measurement of cell death.
Unit-IV	Commercial application
	Commercial applications of cell culture: Stem cells and their applications, Hybridoma Technology and Monoclonal antibodies; Tissue culture as a screening system; cytotoxicity and diagnostic tests; Mass production of biologically important compounds (e.g. Vaccines); Harvesting of products; purification and assays; Organ cultures and tissue engineering
Unit-V	ANIMAL GENOMICS
	Genetic distance analysis, breed characterization on the basis of DNA markers, genetic markers for quantitative traits loci, marker assisted selection for incorporation of desirable traits DNA markers with

economic traits, restriction fragment length polymorphism (RFLP) of different structural genes.	
Reference books	<ol style="list-style-type: none"> 1. "Animal Cell Culture: Essential Methods" by John M. Davis 2. Principles of Tissue Culture & Biotechnology" by S. S. Purohit 3. Introduction to Genetic Analysis" by Anthony J. F. Griffiths et al. 4. "Biotechnology: Applying the Genetic Revolution" by David P. Clark and Nanette J. Pazdernik 5. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" by R. Ian Freshney
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	3	3	2	3	2
CO2	1	1	1	2	2	2	2	2	1	2	1
CO3	2	1	2	1	1	3	1	2	2	1	1
CO4	2	1	1	1	2	1	1	1	1	2	3
CO5	2	2	3	1	2	1	2	3	3	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY003	BIOSTATISTICS AND DATA ANALYSIS
Version	III
Prerequisite	All students are expected to have a general knowledge of Mathematics.
Learning objective	The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.
Course Outcome	<p>CO1: Define the scope and importance of biostatistics in biological sciences, including the collection, classification, and tabulation of data.</p> <p>CO2: Apply probability analysis and understand different probability distributions such as Binomial, Poisson, and Normal distributions in biological contexts.</p> <p>CO3: Calculate measures of central tendency (mean, median, mode) and interpret graphical representations (histograms, frequency polygons) of biological data.</p> <p>CO4: Analyze relationships between variables using correlation and regression techniques, including the interpretation of correlation coefficients and regression models.</p> <p>CO5: Evaluate hypothesis testing methods (parametric and non-parametric), including ANOVA and chi-square tests, for biological data analysis and interpretation.</p>
Unit-I	Definitions Scope of biostatistics
	Definitions Scope of biostatistics, probability analysis – variables in biology, collection, classification and tabulation of data–Graphical and diagrammatic representation–scale diagrams–histograms–frequency polygan– Frequency curves. Measures of central tendency–arithmetic mean, median and mode–calculation of mean, median & mode in series of individual observations, discrete series continuous open – end classes. Introduction to statistical software and spreadsheet-based data analysis.
Unit I	Correlation and Regression
	Probability classical & axiomatic definition of probability, Theorems on total and compound Probability), Elementary ideas of Binomial, Poisson and Normal distributions Bivariate Data: Scatter diagram. Correlation and regression Simple correlation – correlation coefficient. Regression-simple, linear regression. Correlation coefficient and its properties, Correlation ratio. Rank – Spearman’s and Kendall’s measures of correlation.
Unit-II	Statistical Inference and Hypothesis Testing
	Basic ideas of significance test–Hypothesis testing level of significance–Test based on student ‘t’, ‘chi’ square and goodness of fit. ‘F’ test - ANOVA. statistical interpretation of biological experiments.
Unit-V	Probability and Data analysis
	Probability: counting, conditional probability, discrete and continuous random variables; probability distributions and their biological applications, data preprocessing and normalization, introduction to statistical computing using GarphPad
Unit-V	Population Statistics
	Concepts of population and sample, advantages of sampling, census and sample surveys, Basic concepts in sampling and designing of a large scale surveys. Types of sample – the convenience sample, Judgment sample and the probability sample; simple random sampling with and without replacement. Unit II Systematic sampling, Stratified sampling, Estimation of mean, Proportion and standard error using the above probability sampling, probability proportional to size sampling, Estimation of sample size for clinical experiments, sources of error in surveys.

Reference books	<ol style="list-style-type: none"> 1. Stroud, K. A., & Booth, D. J. (2009). <i>Foundation Mathematics</i>. New York, NY: Palgrave Macmillan. 2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) <i>Mathematics for Biological Scientists</i>. Garland Science. 3. Billingsley, P. (1986). <i>Probability and Measure</i>. New York: Wiley. 4. Rosner, B. (2000). <i>Fundamentals of Biostatistics</i>. Boston, MA: Duxbury Press. 5. Daniel, W. W. (1987). <i>Biostatistics, a Foundation for Analysis in the Health Sciences</i>.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOSon:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	2	2	1	3	2
CO2	1	1	1	2	2	2	2	2	1	1	1
CO3	2	2	2	1	1	1	1	3	2	1	2
CO4	3	1	1	1	2	3	1	1	1	3	3
CO5	2	3	3	1	2	1	2	3	3	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY004	Plant Biotechnology
Version	I
Prerequisite	All students are expected to have a general knowledge of biology and Stem cells.
Learning objective	Plant biotechnology encompasses the application of scientific techniques and tools to modify plants for specific agricultural, industrial, or pharmaceutical purposes.
Course Outcome	<p>CO 1: Acquire practical skills in the initiation, maintenance, and manipulation of callus and suspension cultures, emphasizing techniques for optimal growth and regeneration.</p> <p>CO 2: Gain knowledge of the principles and techniques involved in the production of haploid plants through anther and ovary culture, including factors influencing efficiency and applications in plant breeding.</p> <p>CO 3: Understand the specific nutritional requirements of plant tissues in vitro, and the formulation of culture media tailored to support micropropagation and other tissue culture techniques.</p> <p>CO 4: Develop skills in experimental design, data interpretation, and troubleshooting common issues encountered in plant tissue culture experiments.</p> <p>CO 5: To cover both theoretical concepts and practical applications of DNA molecular markers and genetic technologies.</p>
Unit-I	Introduction to Plant tissue culture
	Introduction to Plant tissue culture, To competency Initiation and maintenance of callus and suspension culture. Single cell culture. Organogenesis; Shoot-tip culture: rapid clonal propagation and production of virus-free plants. Nutritional requirements, micro propagation, agar culture and suspension culture
Unit-II	Production of haploid plants
	Production of haploid plants through anther and ovary culture. Somatic embryogenesis. Embryo culture and embryo rescue. Protoplast Isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. Cryo-preservation, Germplasm conservation.
Unit-III	Gene transfer in plant
	Gene transfer in plants; Physical and Chemical methods. Agrobacterium and Ti Plasmids, Binary vectors. Plant viruses as vectors. Transgenic plants-application, methods of engineering in pesticide and herbicide resistant plants. Anti-senseRNA technology-altering nutritional contents of plant foods.
Unit-IV	Plant Gene Regulation
	Photo regulation and phytochrome regulation of nuclear and chloroplast genes expression, Molecular biology of light and dark reactions of photosynthesis, genetics of nif gene
Unit-V	Plant Genomics
	DNA molecular markers; Principles, type and applications; RFLP, AFLP, RAPD, SSR, SNP, Structural and functional genomics, gene mapping, genome mapping, gene tagging and comparative genomics and applications, Restriction enzymes and their uses, Salient features of most commonly used vectors i.e. plasmids, bacteriophages, phasmids, Cosmids, BACs and PACs, YACs, binary vectors, expression vectors, Gene cloning and sub-cloning strategies, chromosome walking, genetic transformation, Risk assessment and IPR

Reference books	<ol style="list-style-type: none"> Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants by Ralph Bock and Neil J. W. Ashton Plant Cell Culture: Essential Methods edited by M.R. Davey and P. Anthony Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith Experiments in Plant Tissue Culture by T. A. Thorpe
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOSon:	
Approved by academic council	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	2	1	2	2	1	3	1
CO2	1	1	1	1	2	2	2	1	1	1	1
CO3	3	2	2	1	1	1	1	3	2	1	2
CO4	3	3	2	1	2	1	3	1	2	3	3
CO5	2	3	3	1	2	1	1	3	3	1	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY011	INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND BIOETHICS	
Version	II	
Prerequisite	Basic understanding of biological sciences and modern scientific developments.	
Learning objective	<ol style="list-style-type: none"> 1. To introduce the concepts and importance of intellectual property rights in biotechnology and research. 2. To provide knowledge of biosafety principles, regulations, and risk assessment in biological sciences. 3. To develop understanding of ethical issues related to biotechnology and emerging technologies. 4. To familiarize students with legal, social, and environmental aspects of scientific research and innovation. 5. To promote responsible conduct and ethical practices in research, industry, and society. 	
Course Outcome	<p>CO 1: Define and understand the various types of intellectual property: patents, trademarks, copyright, industrial design, traditional knowledge, and geographical indications.</p> <p>CO 2: Understand the different types of patents and the Indian Patent Act 1970 along with recent amendments.</p> <p>CO 3: Understand the principles of biosafety and biosecurity, including biological safety cabinets and primary containment for biohazards.</p> <p>CO 4: Learn about international regulations such as the Cartagena Protocol, OECD consensus documents, and Codex Alimentarius.</p> <p>CO 5: Learn about the ethical considerations in cloning, stem cell research, human and animal experimentation, and animal rights/welfare.</p>	
Unit-I	Introduction To IPR	8 hours
Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.		
Unit-II	Patenting	7 hours
Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Biodiversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting- introduction to existing schemes; publication of patents-gazette of India.		
Unit-III	Biosafety	7 hours
Biosafety and Biosecurity - introduction; biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk		

– environmental risk assessment and food and feed safety assessment	
Unit-IV	National and international regulations 7 hours
International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).	
Unit-V	Bioethics
Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.	
Reference books	<ol style="list-style-type: none"> 1. Ganguli, P. (2001). <i>Intellectual Property Rights: Unleashing the Knowledge Economy</i>. New Delhi: Tata McGraw-Hill Pub. [1] 2. <i>National IPR Policy</i>, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI 3. Kuhse, H. (2010). <i>Bioethics: an Anthology</i>. Malden, MA: Blackwell. 4. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/ 5. Karen F. Greif and Jon F. Merz, <i>Current Controversies in the Biological Sciences - Case Studies of Policy Challenges from New Technologies</i>, MIT Press 6. World Intellectual Property Organisation. http://www.wipo.int 7. International Union for the Protection of New Varieties of Plants. http://www.upov.int
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1	2	2	1	3	2
CO2	1	1	3	2	2	2	2	2	1	1	1
CO3	1	2	2	3	1	3	1	3	1	1	2
CO4	1	1	2	1	3	1	1	1	1	2	3
CO5	2	1	3	1	2	1	3	3	3	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY012	Pharmaceutical Biotechnology
Version	II
Prerequisite	All students are expected to have a basic concept of general biology, chemistry and biochemistry.
Learning objective	Understand the principles and applications of biotechnology in drug development and biopharmaceutical production, including ethical, regulatory, and practical laboratory skills.
Course Outcome	<p>CO 1: Gain a foundational understanding of biotechnology's role and applications in pharmaceutical sciences.</p> <p>CO 2: Understand the sources, forms, mechanisms, and kinetics of drug action, as well as the factors modifying drug effects.</p> <p>CO 3: Perform and understand preclinical evaluations of drug potency, activity, and toxicity, including special toxicity tests.</p> <p>CO 4: Understand the regulatory requirements and processes for preclinical and clinical drug testing and new drug applications.</p> <p>CO 5: Learn and apply GMP principles in the pharmaceutical industry, ensuring compliance with organizational, environmental, and contamination control standards.</p>
Unit-I	Brief introduction to Pharmaceutical Biotechnology
	Brief introduction to Biotechnology with reference to Pharmaceutical Sciences. Enzyme Biotechnology- Methods of enzyme immobilization and applications. Biosensors- Working and applications of biosensors in Pharmaceutical Industries. Brief introduction to Protein Engineering. Basic principles of genetic engineering.
Unit-II	General Pharmacology
	Sources of drugs, different dosage forms and routes of drug administration, mechanism of action of drugs. Combined effect of drugs, factors modifying drug action, tolerance and dependence, Pharmacogenetics, kinetics - Absorption, Distribution, Metabolism and Excretion of drugs.
Unit-III	Preclinical drug evaluation
	Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenicity and mutagenicity
Unit-IV	Regulatory consideration
	Regulatory consideration for pre-clinical testing and clinical testing of drugs, biologics and medical devices. New Drug Applications for Global Pharmaceutical Product
Unit-V	Good manufacturing practices
	Organization and personnel, responsibilities, training, hygiene. Premises: Location, design, plant layout, construction, maintenance and sanitation, environmental control, utilities and services like gas, water, maintenance of sterile areas, control of contamination. Controls on animal houses.

Reference books	<ol style="list-style-type: none"> 1. Laurence Brunton, Bruce A Chabner, Bjorn Knollman (2011) Goodman and Gilman's the Pharmacological Basis of Therapeutics, 12th Edition, and McGraw Hill Education. 2. Roop K Khar, Vyas SP (2013) Lachman/Liebermans: The Theory and Practice of Industrial Pharmacy, 4 th Edition, CBS. 3. Gregg N Milligan, Alan DT Barrett (2015) Vaccinology: An Essential Guide, 1 st Edition, Wiley-Blackwell. 4. Judy Owen, Jenni Punt, Sharon Stranford (2013) Kuby Immunology, 7 th Edition, W. H. Freeman.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOSon:	
Approved by academic councilon:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	2	2	1	3	2
CO2	1	1	1	2	2	2	2	2	1	1	1
CO3	2	2	2	1	1	1	1	3	2	1	2
CO4	3	1	1	1	2	3	1	1	1	3	3
CO5	2	3	3	1	2	1	2	3	3	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY013	ADVANCED CLINICAL BIOCHEMISTRY
Version	II
Prerequisite	All students are expected to have a basic concept of general biology, chemistry and biochemistry.
Learning objective	The learning objective of course are: To create an understanding regarding Blood, its function, neurotransmitters, neurohormones, composition function and regulation of body secretions, organ function test and Cancer.
Course Outcome	<p>CO 1: Understand the detailed composition of blood and its various functions.</p> <p>CO 2: Understand the composition, functions, and regulation of various body secretions, including saliva, gastric, pancreatic, intestinal, and bile secretions.</p> <p>CO 3: Understand liver function tests and related disorders such as jaundice, hepatitis, fatty liver, gallstones, and cirrhosis.</p> <p>CO 4: Understand the clinical significance of enzymes in health and diseases.</p> <p>CO 5: Understanding the role of cancer markers in the diagnosis, prognosis, and monitoring of oral cancer, breast cancer, and gastrointestinal tract cancer.</p>
Unit-I	Blood and its function, Synaptic transmission, Neurotransmitters & Neurohormones.
	Blood composition and its function. Blood-Pressure, Mechanism and regulation of blood coagulation. Thalassemia. Hemorrhagic Disorder–hemophilia, purpura, porphyries, circulating anticoagulants .sickle cell anemia, Synaptic transmission, Neurotransmitters and Neurohormones, Biochemistry of vision.
Unit-II	Composition function and regulation of body secretions
	Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Structure of Nephron, Composition and formation of urine. Clinical significance of urinary components. homeostatic regulation of water and electrolytes. Acid-Base balance, -Acidosis and Alkalosis. Composition and biochemical analysis of CSF and amniotic fluid.
Unit-III	Organ function test
	Liver function test and related disorder: Jaundice, hepatitis, fatty liver and gall stone, Cirrhosis. Renal function test and related disorders, Gastric and pancreatic function test. Diagnostic test for lipo proteins disorders. Obesity– Definition, Genetic and environmental factors leading to obesity
Unit-IV	Enzyme: Clinical significance in health and diseases
	Clinical significance of enzymes in health and diseases. biochemical diagnosis of diseases by enzyme assays. GOT, SGPT, CPK, alkaline phosphatase, cholinesterase and LDH. Inborn errors of metabolism: diabetes mellitus, Gaucher’s disease, taysach’s disease, Niemann pick disease, phenylketonuria, alkaptonuria, albinism, maple syrup disease, Sexual Transmitted Disease
Unit-V	Oncology
	Oncology–Cancer markers for oral Cancer, Breast cancer and gastrointestinal tract cancer. Alphafeto Fetoproteins, Carcinoembryonic Antigens, Leukemia. Freeradicalsindiseases- Introduction, Typesoffree radicals, free radical induced lipid peroxidation. Scavengers–Superoxide Dismutase, catalase, peroxidase and antioxidants

Reference books	1. Clinical Biochemistry: An Illustrated Colour Text, 4e by Allan Gaw, Michael J. Murphy (2008) 2. Marks' Basic Medical Biochemistry: A Clinical Approach by Michael A. Lieberman and Allan Marks (2008) 3. Textbook of Biochemistry with Clinical Correlations by Thomas M. Devlin. (2010) 4. Clinical Chemistry: Techniques, Principles, Correlations by Michael L. Bishop, Edward P. Fody and Larry E. Schoeff (2009) 5. Clinical Biochemistry (Fundamentals Of Biomedical Science) by Nessar Ahmed (2011) 6. Essentials of Medical Biochemistry: With Clinical Cases by N.V. Bhagavan and Chung-Eun Ha (2011) 7. Medical Biochemistry at a Glance by J. G. Salway (2012)
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOSon:	
Approved by academic councilon:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	2	2	1	3	1
CO2	1	2	1	2	2	2	3	2	2	1	1
CO3	1	2	2	1	3	1	1	3	3	3	3
CO4	3	1	1	1	2	3	1	2	1	1	2
CO5	1	2	3	1	2	1	1	3	2	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY014	Food and dairy Microbiology
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and Microbiology basic principles.
Learning objective	The learning objective of course are: To create an understanding regarding the life science, To Gain knowledge about industrial food fermentations, Quality assurances in foods, foods preservation methods, fermentation of milk products and beverages and Advanced Food Microbiology.
Course Outcome	<p>CO 1: Understanding the use of starter cultures in fermentation processes.</p> <p>CO 2: Understanding mycotoxins in food with reference to Aspergillus species.</p> <p>CO 3: Understanding the role of biosensors in the food industry.</p> <p>CO 4: Studying the microbiology of fermented milk products like acidophilus milk and yogurt.</p> <p>CO 5: Understanding the concept of genetically modified foods.</p>
Unit-I	Industrial Food fermentations
	Starter cultures their biochemical activities, production and preservation of the following fermented foods. a. Soy sauce fermentation by Mouldsb. Fermented vegetables–Sauerkraut. Fermented Meat–Sausages d. Production and application of Bakers Yeast e. Application Microbial enzymes In food industry
Unit-II	Quality Assurance in foods
	Food Infections and intoxications; bacterial with examples of infective and toxic types –Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria. Mycotoxins In Food with reference to Aspergillus Species. Quality Assurance: Microbiological quality standards of food. Government Regulatory practices and policies.FDA, EPA, HACCP, ISI.
Unit-III	Food Preservation methods
	Radiations-UV, Gammaandmicrowave, Temperature Chemical And naturally occurring antimicrobials. Biosensors In The Food Industry.
Unit-IV	Fermentation of Milk products and Beverages
	Microbiology of cheese and beverage fermentation. Microbiology of fermented milk products (acidophilus milk, yoghurt). Role of microorganisms in beverages–tea and coffee fermentations. Vinegar Fermentation
Unit-V	Advanced Food Microbiology
	Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry [Protease,Lipases]. Utilization And Disposal Of Dairy By-product–whey
Reference books	<ol style="list-style-type: none"> 1.FoodMicrobiology.2ndEditionByAdams 2.Basic Food Microbiology by Banwart George. 3.FoodMicrobiology:FundamentalsandFrontiersbyDolle 4.Biotechnology:FoodFermentationMicrobiology,Biochemistryand Technology.Volume2byJoshi. 5.FundamentalsofDairyMicrobiologybyPrajapati. 6.EssentialsofFoodMicrobiology.EditedbyJohnGarbult.ArnoldInternationalStudentsEdition. 7.DairyMicrobiologybyRobinson.VolumeII andI.

Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOSon:	
Approved by academic councilon:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	3	2	1	3	1
CO2	1	2	1	2	1	2	3	3	2	1	1
CO3	3	2	2	2	3	3	1	3	3	3	3
CO4	2	1	1	1	2	3	3	1	1	1	2
CO5	1	2	3	3	3	1	1	3	2	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY015	Environmental Biotechnology
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Environmental Sciences.
Learning objective	The learning objective of course are: To create an understanding regarding Environmental Biotechnology.
Course Outcomes	CO 1: Understanding of various conventional fuels (firewood, plant, animal, water, coal, and gas) and their environmental impacts. CO 2: Comprehensive understanding of bioremediation techniques for soil and water contaminated with oil spills, heavy metals, and detergents. CO 3: In-depth knowledge of municipal waste and industrial effluent treatment processes. CO 4: Awareness of the environmental significance and implications of genetically modified microbes, plants, and animals. CO 5: Overview of biodegradation processes for basic structures found in hydrocarbons and xenobiotics.
Unit-I	Conventional fuels and their environmental impact 8 hours
	Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol
Unit-II	Bioremediation 7 hours
	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by microorganisms- degradation of aromatic and chlorinated hydrocarbons and petroleum products.
Unit-III	Waste Treatment 7 hours
	Treatment of municipal waste and Industrial effluents. Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)
Unit-IV	Biobleaching 7 hours
	Biobleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.
Unit-V	Biodegradation 7 hours
	Overview of Biodegradation, Degradation of Basic Structures found in Hydrocarbons & Xenobiotics, Biodegradation of Xenobiotics, PCBs (PolyChlorinated Biphenyls), DDT, Nitrobenzene, Biomagnification, Wastewater, Primary, Secondary, Tertiary treatment processes, Conventional Air Pollutants & Acid rain & Acid mine drainage, An overview of process of Bioremediation
Reference books	1. Environmental Science, S.C. Santra 2. Environmental Biotechnology, Pradipta Kumar Mohapatra 3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and

	<p>Jesef Winter</p> <p>4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill</p> <p>5. Agricultural Biotechnology, S.S. Purohit</p> <p>6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer</p> <p>7. Introduction to Environmental Biotechnology, Milton Wainwright</p> <p>8. Principles of Environmental Engineering, Gilbert Masters</p> <p>9. Wastewater Engineering – Metcalf & Eddy</p>
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	2	2	1	3	1
CO2	1	2	1	2	2	2	3	2	2	1	1
CO3	1	2	2	1	3	1	1	3	3	3	3
CO4	3	1	1	1	2	3	1	2	1	1	2
CO5	1	2	3	1	2	1	1	3	2	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTY016	Synthetic Biology and Genome Engineering	
Version	1.0	
Prerequisite	Basic understanding of molecular biology, genetics, genetic engineering, microbiology, and recombinant DNA technology.	
Learning objective	<p>The course is designed to provide advanced knowledge of synthetic biology, genome engineering, and their applications in modern biotechnology. The specific objectives of the course are as follows:</p> <ol style="list-style-type: none"> 1. To introduce the principles and concepts of synthetic biology and engineering biology. 2. To impart knowledge of genome editing technologies and synthetic genetic circuit design. 3. To familiarize students with metabolic engineering and systems-level biological engineering approaches. 4. To develop understanding of applications of synthetic biology in healthcare, agriculture, and industrial biotechnology. 5. To create awareness regarding biosafety, biosecurity, ethical concerns, and future prospects of genome engineering technologies. 	
Course Outcomes	<p>CO1: Understand the principles, tools, and components of synthetic biology and engineering biology.</p> <p>CO2: Analyze genome editing technologies and mechanisms used for genetic modifications.</p> <p>CO3: Evaluate synthetic genetic circuits, metabolic engineering, and systems-level biological design approaches.</p> <p>CO4: Apply synthetic biology and genome engineering concepts in healthcare, agriculture, environmental, and industrial biotechnology.</p> <p>CO5: Assess biosafety, bioethical, regulatory, and future aspects of synthetic biology and genome engineering.</p>	
Unit-I	Foundations of Synthetic Biology and Engineering Biology	8 Hours
	Introduction to synthetic biology, engineering principles in biology, biological parts, devices and systems, BioBricks and standardized genetic components, chassis organisms, synthetic genomes, minimal cells, design-build-test-learn cycle, overview of systems biology approaches in biological engineering.	
Unit-II	Genome Engineering and Editing Technologies	7 Hours
	Principles of genome engineering, homologous recombination, zinc finger nucleases (ZFNs), TALENs, CRISPR-Cas systems, CRISPR-Cas9 mechanism and applications, base editing, prime editing, RNA editing technologies, delivery systems for genome editing tools, off-target effects and optimization strategies.	
Unit-III	Synthetic Genetic Circuits and Metabolic Engineering	7 Hours
	Gene circuit design and regulatory networks, toggle switches, oscillators and biosensors, programmable cells, pathway engineering, metabolic flux analysis, synthetic pathways for biomolecule production, microbial cell factories, synthetic control of gene expression, computational approaches in synthetic biology.	
Unit-IV	Applications in Biotechnology and Biomedical Sciences	7 Hours
	Synthetic biology in healthcare and therapeutics, engineered probiotics, synthetic vaccines, CAR-T cell engineering, synthetic biology in agriculture, crop engineering and stress resistance, industrial biotechnology applications, biofuels and biochemicals production,	

	environmental applications and bioremediation, synthetic microbial consortia.
Unit-V	Advanced Trends, Biosafety and Future Perspectives 7 Hours
	Genome-scale engineering, artificial cells and xenobiology, synthetic chromosomes, AI-assisted synthetic biology, synthetic biology startups and translational applications, biosafety and biosecurity issues, ethical and societal implications, regulatory frameworks, dual-use concerns, challenges and future prospects of synthetic biology and genome engineering.
Reference books	<ol style="list-style-type: none"> 1. Voigt, C. (2011). <i>Synthetic Biology: Methods for Part/Device Characterization and Chassis Engineering</i>. Academic Press. 2. Benner, S.A. and Sismour, A.M. (2005). <i>Synthetic Biology. Nature Reviews Genetics</i>. 3. Brown, T.A. (Recent Edition). <i>Gene Cloning and DNA Analysis</i>. Wiley-Blackwell. 4. Cox, M.M., Doudna, J.A., and O'Donnell, M. (2015). <i>Molecular Biology: Principles and Practice</i>. Freeman. 5. Smolke, C.D. (2009). <i>The Metabolic Pathway Engineering Handbook</i>. CRC Press. 6. Nielsen, J. and Keasling, J.D. (2016). <i>Engineering Cellular Metabolism. Cell</i>. 7. Lewin, B. (Recent Edition). <i>Genes</i>. Jones & Bartlett Learning. 8. Glick, B.R., Pasternak, J.J., and Patten, C.L. (Recent Edition). <i>Molecular Biotechnology</i>. ASM Press. 9. Khalil, A.S. and Collins, J.J. (2010). <i>Synthetic Biology: Applications Come of Age. Nature Reviews Genetics</i>.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	2	2	1	3	1
CO2	1	2	1	2	2	2	3	2	2	1	1
CO3	1	2	2	1	3	1	1	3	3	3	3
CO4	3	1	1	1	2	3	1	2	1	1	2
CO5	1	2	3	1	2	1	1	3	2	2	1

1. Slight (low)

2. Moderate (Medium)

3. Substantial (High)

BTZ001	DISSERTATION
Version	II
Prerequisite	All students are expected to have a general knowledge of Microbiology and basic principles of Chemistry.
Learning objective	The learning objectives of course are: to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.
Course Outcome	<p>CO 1: In-depth knowledge of the chosen area of research.</p> <p>CO 2: Capability to critically and systematically integrate knowledge to identify issues that must be addressed within the framework of specific thesis.</p> <p>CO 3: Competence in research design and planning.</p> <p>CO 4: Capability to create, analyze and critically evaluate different technical solutions and Ability to conduct research independently.</p> <p>CO 5: Ability to perform analytical techniques/experimental methods. .</p>
Unit-I	Planning and performing experiments
	Based on the project proposal submitted in earlier semesters, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment.
Unit-II	Thesis writing
	At the end of their project, the thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent applications.
Mode of Examination	student seminar/PPT
Recommended by BOS on:	
Approved by academic council on:	