Syllabus Book

for

2 Years Postgraduate Programme

M.Sc. Biotechnology

Centurion UNIVERSITY

Shaping Lives...
Empowering Communities...

School of Biotechnology

Centurion University of Technology and Management

India's First and Best Skill University

www.cutm.ac.in

Constituent Campuses

Bhubaneswar | Paralakhemundi | Rayagada | Bolangir | Chattarpur | Balasore

Programme Outcomes (POs)

PO-01	Disciplinary Knowledge: Graduates will gain in-depth knowledge of biotechnology concepts, including molecular biology, genetic engineering, microbiology, biochemistry, and bioinformatics, with an emphasis on their interdisciplinary applications in research, industry, and societal problem-solving.
PO-02	Analytical Skills: Graduates will develop the ability to design, conduct, and analyze experiments using modern biotechnological tools and techniques, enabling them to address complex biological questions and provide innovative solutions to real-world challenges.
PO-03	Design /development of solutions: Design solution for biotechnological problems and design system component of processes that meet the desired needs with appropriate consideration for the public health and safety, and the cultural, societal and the environmental considerations.
PO-04	Communication: Communicate effectively on complex activities with the committee and with society at large, such as, being able to comprehend and write affective reports and design documentation, make effective presentations in Biotechnology.
PO-05	Environment and sustainability: Graduates will understand and apply biotechnological approaches to address environmental sustainability, public health, food security, and other societal issues while minimizing ecological footprints.
PO-06	Innovation and Entrepreneurship: Graduates will acquire entrepreneurial skills and the ability to identify opportunities for innovation in the biotechnology industry, focusing on product development, commercialization, and creating start-ups aligned with sustainable development goals.
PO-07	Ethics and Professional Responsibility: Graduates will exhibit a strong understanding of professional ethics, bioethics, and intellectual property rights, ensuring responsible conduct in research, industry, and community engagements.
PO-08	Lifelong Learning and Adaptability: Graduates will cultivate a mindset for continuous learning, staying updated with advances in biotechnology and related fields, and adapting to evolving technologies and global trends.

Programme Specific Outcomes (PSOs)

PSO-1	Application of Advanced Biotechnology Techniques: Graduates will acquire the ability to apply advanced molecular, cellular, and computational techniques in fields such as genetic engineering, proteomics, genomics, and synthetic biology to address challenges in agriculture, healthcare, industry, and environmental sustainability
PSO-2	Translational Research and Innovation: Graduates will demonstrate the capability to translate biotechnological research into innovative products, processes, and services, particularly in areas such as biopharmaceuticals, biofuels, diagnostics, and sustainable agriculture, fostering entrepreneurial ventures and industrial growth.
PSO-3	Problem-Solving in Specialized Domains: Graduates will develop expertise in solving complex biological and industrial problems by integrating interdisciplinary knowledge of biotechnology, bioinformatics, and systems biology, with a focus on addressing contemporary challenges like climate change, disease management, and food security.

Details of the Courses for M.Sc. Biotechnology

Basket I

Sl. No.	Course Type	Course Code	Course Title	Credit	Type (T+P+Pj)
1	Major (Core)	CUTM1433	Biochemistry and Enzyme Technology	4	3+1+0
2	Major (Core)	CUTM1437	Cell and Molecular Biology	4	3+1+0
3	Major (Core)	CUTM1451	Immunology and Cancer Biology	4	3+1+0
4	Major (Core)	CUTM1438	Bioanalytical Techniques	4	3+1+0
5	Major (Core)	MRM301T	Research Methodology & Biostatistics	4	4+0+0
6	Major (Core)	CUTM1436	Microbiology	4	3+1+0
7	Major (Core)	CUTM1454	Genetics and epigenetics	4	3+1+0
8	Major (Core)	CUTM1563	Genetic Engineering	4	2+2+0

Credits to be completed from Basket I ≥ 32.

Basket II

Sl. No.	Course Type	Course Code	Course Title	Credit	Type (T+P+Pj)
1	Electives	CUTM1569	IPR, Biosafety and Bioentrepreneurship	4	2+0+2
2	Electives	CUTM2375	Nanobiotechnology	3	2+0+1
3	Electives	CUTM1452	Animal Biotechnology	4	3+1+0
4	Electives	CUTM1439	Plant Biotechnology	4	3+1+0
5	Electives	CUTM1568	Transcriptomics, Proteomics and Metabolomics	4	2+2+0
6	Electives	CUTM3122	Drug Design using Biovia Discovery Studio	4	2+1+0
7	Electives	CUTM3106	Introduction to Nutraceuticals	4	0+2+2

Credits to be completed from Basket II ≥ 20.

Basket III

Sl. No.	Course Type	Course Code	Course Title	Credit	Type (T+P+Pj)
1	Domain (29 Credits) **[Genetics and Genomics]**	CUGE2270	Computational Biology	3	1+2+0
2		CUGE2271	Genetic Engineering and its applications	3	1+2+0
3		CUGE2277	Genetics and Genomics	3	1+2+0
4		CUGE2273	Molecular Genomics	3	0+3+0
5		CUGE2274	Plant Tissue Culture Technologies	3	0+3+0

6		CUGE2275	Techniques in Molecular Biology	3	0+3+0
7		CUGE2276	AELP Project	11	0+0+11
8	Domain (29 Credits) **[Nutraceuticals]**	CUNU2280	Introduction to Nutraceuticals	3	1+2+0
9		CUNU2281	Functional Food	3	1+2+0
10		CUNU2282	Nutrigenetics	3	1+2+0
11		CUNU2283	Development of Personalized Food and Medicine	3	0+1+2
12		CUNU2284	Development of Biopesticides and Biofertilizers	3	0+1+2
13		CUNU2285	Development of Immune Boosters	3	0+1+2
14		CUNU2286	AELP Project	11	11

Credits to be completed from Basket III ≥ 29.

Basket IV

Sl. No.	Course Type	Course Code	Course Title	Credit	Type (T+P+Pj)
1	Skill	CUTMXXXX	Skill Course I	4	0+2+2
2	Skill	CUTMXXXX	Skill Course II	4	0+2+2
3	Summer Internship	CUTM1578	Summer Internship	2	0+0+2

Credits to be completed from Basket I ≥ 10.

Semester-wise course distribution

Semester I

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM1433	Biochemistry and Enzyme Technology	4	3+1+0
CUTM1437	Cell and Molecular Biology	4	3+1+0
CUTM1451	Immunology and Cancer Biology	4	3+1+0
CUTM1436	Microbiology	4	3+1+0
CUTMXXXX	Skill Course I	4	0+2+2

Semester II

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM1595	Research Methodology Biostatistics	4	4+0+0
CUTM1438	Bioanalytical Techniques	4	3+1+0
CUTM1454	Genetics and epigenetics	4	3+1+0
CUTM1563	Genetic Engineering	4	2+2+0
CUTMXXXX	Skill Course II	4	0+2+2
CUTM1578	Summer Internship	2	0+0+2

Semester III

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTMXXXX	Elective I	4	
CUTMXXXX	Elective II	4	
CUTMXXXX	Elective III	4/3	
CUTMXXXX	Domain Subject I	3	1+2+0
CUTMXXXX	Domain Subject II	3	1+2+0
CUTMXXXX	Domain Subject III	3	1+2+0

Semester IV

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTMXXXX	Elective IV	4	
CUTMXXXX	Elective V	4	
CUTMXXXX	Domain Subject IV	3	
CUTMXXXX	Domain Project	11	0+0+11

Core Courses

Biochemistry and Enzyme Technology

Subject Name	Code	Type of course	T-P-Pr (Credit)
Biochemistry and Enzyme Technology	CUTM1433	Theory+ practice	3-1-0 (04)

Course objectives

- To introduce the organic structure of living systems mainly dealing with biomolecules like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology
- To provide knowledge relevant to the plant biochemistry and enzymology principles including fundamental properties of enzymes, enzyme catalytic mechanisms and enzyme kinetics
- To learn techniques employed in enzymes purification and characterization as well as applications of enzyme technology in food, medical, and household industries

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Learn comprehensive theoretical knowledge on the kingdoms of biomolecules, bioenergetics principals that are the prerequisites and consequences of physiological phenomenon for further manipulations.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5(2), PSO3 (3)
CO2	Know details about the structure and function of proteins, their types, modification and functions.	PO1 (3), PO2 (3), PO3 (3), PO5 (3), PSO(2)
CO3	Construct the chemical structures of carbohydrate, nucleosides, nucleotides and lipids, circulating lipids and inflammatory lipid mediators etc	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3)
CO4	Demonstrating the purification, characterization and estimation of enzymes processes. The biochemical calculation for enzyme kinetics will be discover and cane use in plotting graphs based on kinetics data	PO1 (3), PO2 (2), PO3 (2), PO5 (3), PO6 (1), PSO1 (2)
CO5	Evaluate and apply biochemical calculation for enzyme kinetics. Compare methods for production, purification, characterization and immobilization of enzymes. And their application in industry.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO8 (2), PSO1 (1)

Module I

Structure of atoms and molecules, chemical bonds, Stabilizing Interactions (thermodynamics of folding, conformational entropy, charge charge interaction, Vander wall force, hydrophobic effect, disulfide bonds, prosthetic group, ion binding protein stability), pH, buffer, Acid Base Equilibria, Water; Biological Thermodynamics, Enthalpy and Entropy, Standard Free Energy Concept and Calculation, Biological Energy transducer Cellular energy currency, Energy rich compounds

Module II

Building Block of Proteins**:** Chemical Properties of Proteins, common plant Protein Sources, Protein Databases; Amino acids (genetically coded, Rare genetically coded, modified), Dissociation constant, Isoelectric point, Assay of Amino acids, protein denaturation and renaturation; Prions; Structural Organization: Structural organization of Protein (different models), Dynamics of Protein Structure (globular, Fibrous), chaperon concept; Ramachandran Plot. Specialized Secondary Structure protein structure (TMV, Hemoglobin, Myoglobin, collagen, Carboxypeptidase, RuBisCo); Domain and Motifs: Motifs, domains, Models, Functional relationship between domains and function of proteins, super secondary structures of proteins Classification of proteins based on the structures like Zn finger, lucine zipper proteins etc

Module III

Structure, Models and Stability of Nucleic Acids (DNA/RNA), Nucleotide Databases; Primary and Secondary Structure, Alternate Secondary Structure: Hairpin, Cruciform, triple Helix, G-quadrates etc. Denaturation, Tm value, Protein DNA interaction. Structure types and Nomenclature, Structure Function Relationship Carbohydrate Databases.

Module IV

Classification, structure, properties and functions of fatty acid, essential fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, lipoproteins, membrane protein. Plant Biofuel; Structure and functions of vitamins, Source of phytovitamins, Natural Antioxidants

Module V

Overview of enzyme: Chemical Nature, Characteristics, Classification (IUB), Nomenclature, Enzyme conformation, Active Sites, Ribozyme, isozymes, multi enzyme complex, MichelisMenten equation, Treatment of Data (Briggs-Haldane, lineweaver-burk, Eadie- hofstee, cornish-bowden, Van Slyke-Cullen behavior) Enzyme inhibitiion, Significance of Km. Kcat,Vm; Single substrate, bi substrate, multi substrate reaction, Significance and Evaluation of activation energy; Enzyme catalytic reaction mechanism, chymotrypsin, lysozyme, Serine protease, Alcohol dehydrogenase, carboxypeptidase, Co enzymes and its role in Enzyme action (NAD+/NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate,

B12 etc.); Allosteric enzyme and its mechanism, Acid-base catalysis, covalent catalysis, metal ion catalysis, proximity, orientation effect, site directed mutagenesis of enzyme.

Module VI

Enzyme Purification, Assay, Large Scale production of Enzyme; Enzyme Immobilization (kinetics), enzyme reactor; Biotransformation, Nobel Enzyme; Scope of enzyme technology in medicine, Detergents, Food and breverage industry, Leather Industry, Textile industry etc).

Module VII

Industrial Enzymes – production & applications, Biofuel**:** production of biomethane and bioethanol from agro-food wastes/Microalgae; Nutritional profiling of agricultural products; Biopolymer, Microbial polysaccharides; Dextrans. Polyhydroxyalkanoates, Polyhydroxybutyrate (PHB), Biodegradable plastics

Practice

1. Quantitative estimation of proteins (Biuret, Lowry, BCA and Bradford methods)
2. Quantitative estimation of Carbohydrates/Nucleic Acid
3. Determination of Unknown Concentration of Vitamin C
4. Effects of pH, Temperature, and Substrate Concentration on enzyme activity
5. Extraction and Preparation of Protein lysates
6. Bio-diesel production from Biomass and its Characterization

Text Books:

1. Donald Voet, Judith G. Voet,Biochemistry, Wiley, 4th edition (2011)
2. David L. Nelson; Michael M. Cox,Lehninger Principles of Biochemistry, W.H freeman and Company (2021)
3. Satyanarayana, U. and Chakrapani, U,Biochemistry, Elsevier, 6th edition (2021)

Reference Books:

1. Trevor Palmer, Philip L. Bonner - Enzymes_ Biochemistry, Biotechnology, Clinical Chemistry- Woodhead Publishing – 2nd edition 2007
2. Leskovacs V. Comprehensive enzyme kinetics, Kluwer- 1st edition 2003

Cell and Molecular Biology

Subject Name	Code	Type of course	T-P-Pr (Credit)
Cell and Molecular Biology	CUTM1437	Theory+ practice	3-1-0 (04)

Course objectives

- Explore biological membranes, cytoskeleton, cell division, intercellular communication, and the nucleus, focusing on the structure, function, and interactions of cellular components.
- Study the mechanisms of DNA replication, transcription, RNA processing, and translation, including regulation and post-translational modifications, to understand gene expression and protein synthesis.
- Analyse protein structure, function, and evolution, enzyme catalysis, and protein engineering to comprehend the principles of protein folding, stability, and the creation of novel proteins through various techniques.

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Recall the fundamental components of biological membranes and their roles in cellular function along with basic molecular process of cell.	PO1 (3), PO2 (2), PSO1 (3)
CO2	Understand the mechanisms behind DNA replication, transcription, and translation in both prokaryotic and eukaryotic systems	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5 (3), PO6 (1), PO7 (3), PO8 (1), PSO1 (3), PSO3 (2)
CO3	Apply laboratory techniques such as PCR, gel electrophoresis, and enzyme assays to explore molecular and cellular processes.	PO1 (3), PO2 (2), PO3 (1), PO4 (2), PO5 (2), PSO2 (3), PSO3 (3)
CO4	Analyse the structure-function relationships of proteins and enzymes, understanding how these molecules catalyze biochemical reactions and are regulated within the cell.	PO1 (1), PO2 (2), PO3 (3), PO4 (3), PO5 (2), PSO1 (3), PSO3 (3)
CO5	Evaluate experimental data on cell signalling pathways and gene expression regulation, forming conclusions about cellular responses to various stimuli.	PO1 (3),PO2 (2),PO5 (1), PO6 (3), PO7 (1), PO8 (2), PSO1 (3), PSO3 (3)

Module I

Structure of biological membranes: Cell wall (Prokaryotic versus eukaryotic), the plasma membrane, Membrane proteins, Mobility of membrane proteins, Membrane biogenesis: Cell wall and cell membrane biogenesis, Cell-Cell and cell-matrix interactions: Extracellular matrix and cell-matrix interactions (Matrix structural proteins, Matrix Polysaccharides; Matrix adhesion proteins), Cell-Cell interactions (Adhesion Junctions, Tight Junctions, Gap junctions, Plasmodesmata), Membrane Trafficking (Pumps, channels, transporters): Ions channels, Active transport driven by ATP hydrolysis, Active transport driven by Ion gradients, Passive transport, Facilitated transport, Endocytosis (Phagocytosis, receptor-mediated endocytosis).

Module II

Cytoskeleton, Cell motility and Cell division: Structure and Organization of Actin Filaments: assembly and disassembly of actin filaments, organization of actin filaments, association of actin filaments with the plasma membrane, Intermediate filaments: assembly of intermediate filaments, intracellular organization of intermediate filaments, The microtubule: structure and dynamic organization of microtubules, Eukaryotic cell division: Mitosis and Meiosis, Cell death and cell renewal: Programmed cell death, stem cells and maintenance of adult tissues. Cell cycle and its regulation and check points.

Module III

Intercellular communication and the Nucleus: Signaling molecules and their receptors, modes of cell signaling, Cell surface receptors, G Protein- coupled receptors. Receptor protein tyrosine kinases, cytokine receptors, Pathways of Intracellular signal transduction, second messengers, the cAMP Pathway, cGMP, Nuclear organization, traffic between the nucleus and the cytoplasm, chromosomes, Chromatin organization (DNA packaging), Lampbrush chromosome, Polytene chromosome, telocentric chromosome, Inter-phase chromatin, Euchromatin and Heterochromatin, karyotype and its significance, the Nucleolus.

Module IV

Replication, Protein-Nucleic Acid Interactions and Transcription: Prokaryotic and eukaryotic DNA replication: DNA polymerases, replisome, primase, telomerase, inhibitors of replication. DNA synthesis by reverse transcription, Prokaryotic transcription mechanisms, Prokaryotic transcriptional regulation (Operon concept), Eukaryotic transcription –core promoter and general transcription factors (GTFs), Eukaryotic transcription–activating transcription factors and enhancers, Post-Transcriptional Control of Gene Expression.

Module V

RNA Processing, Translation and Protein sorting: RNA-processing, mRNA export. Post transcriptional modification and: RNA splicing, spliceosome, RNA editing, Genetic code. Translation: Protein synthesis, post-translational modifications: Glycosylation, Phosphorylation, Ubiquitination, Inhibitors of transcription and translation. Protein sorting and Targeting: Co translational targeting and post translational targeting. Protein targeting to Mitochondria,Chloroplast, Endoplasmic reticulum, Peroxisome and Plasmamembrane.

Regulation of gene expression in prokaryotes and eukaryotes: role of chromatin in regulating gene expression and gene silencing.

Module VI

Protein Structure, Function and Evolution: Unique principles of protein structure and molecular machines (primary, secondary, tertiary, quaternary structures), Study of protein structures (circulsardichorism, X-ray crystallography and cryo electron microscopy), How proteins have evolved and how analysis of protein structure can help us to understand the evolutionary relationships between different proteins and their function.

Module VII

Enzyme Catalysis and Protein Engineering: How the peptide and protein structures discussed in the preceding module can assume functions, Enzyme catalysis, mechanism and kinetics, Co-operative (allosteric) molecular basis of metabolic regulation, Principles of protein folding and stability, Protein engineering and mechanistic enzymology–how to create novel, functional proteins, by rational design, semi-rational approaches, and by directed evolution.

Practice

1. Temporary and permanent mounts of mitosis and meiosis
2. Permanent mount of giant chromosomes (Lampbrush chromosomes)
3. Isolation of genomic DNA
4. DNA quantification using gel electrophoresis and spectroscopy
5. DNA amplification using PCR
6. *Insilico* membrane-receptor and ligand interaction studies

Text Books:

1. Geoffrey M. Cooper, Robert E. Hausman (2023). The Cell: A Molecular Approach. 9th edition, ASM Press, Washington D.C.
2. Robertis, De and Robertis Lea, Febiger. (2017). Cell and molecular biology 8th Edition

Reference Books:

1. Molecular Biology of the Cell Alberts, B., et al. 6th Rev ed. Taylor & Francis; 2014 ISBN 978-0- 8153-4432-2 (hard), 978-0-8153-4524-4
2. Essential Cell Biology Alberts, B., et al. 4th Rev ed. Garland; 2013 ISBN 9780815344544
3. Lewin's Genes XII Krebs, J.E. et al. Jones & Bartlett; 2018 ISBN 9781284104493
4. Molecular Cell Biology Lodish H. et al. 8th ed. W.H. Freeman and Company; 2016 ISBN 9781464183393.

Immunology and Cancer Biology

Code	Course Title	Course Type	Credits	L-Pr-P (hrs)
CUTM1451	Immunology and Cancer biology	Theory + Practice	4	3-1-0

Objectives

- The primary objective of this course is to help students develop knowledge and skills related to health and disease and role of immune system.
- Students are taught immunology so as to develop understanding of the subject, such as functioning the immune system, the molecular and cellular components and pathways that protect an organism from infectious agents.
- The common cellular and molecular mechanisms that are deregulated in cancerous cells and their contribution to the development of cancer. Role of gene mutation and environmental factors in the development of cancer.

Course Outcome

At the end of the course the student will be able to:

COs	**Course outcomes**	**Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)**
CO1	Understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.	PO1 (3), PO3 (3), PSO1 (3), PSO3 (3)
CO2	Know about biological aspects of cancer, carcinogenesis and cancer therapy.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5 (1), PO8 (2), PSO1 (3), PSO3 (2)
CO3	Apply the principle and application of various immune techniques and they can Will be able to make a strategy for immunological research and execute it.	PO1 (3), PO2 (2), PO3 (1), PO4 (2), PO5 (2), PSO1 (3), PSO3 (3)
CO4	Analyze the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.	PO1 (1), PO2 (2), PO3 (3), PO4 (3), PO5 (2), PSO2 (3)
CO5	Examine the various immune techniques and they can will be able to make a strategy for immunological research and execute it.	PO1 (3),PO2 (2),PO5 (1), PO6 (3), PO7 (1), PSO1 (3), PSO3 (3)

Module I

Hematopoiesis, Cells and Organs of the Immune System, Structure and function of antibodies, Inflammation

Module-II

Development and Signaling of Immune system- Innate Immunity, TLRs and their role in innate, Immune response Adaptive Immunity, Cytokines, Development of B-lymphocyte and T-lymphocyte

Module III

Structure and function of MHC complex -antigen processing cells, Antigen processing and presentation to T lymphocytes, MHC restriction. TCR structure and function

Module-IV

Effector mechanisms and regulation of immune responses: Complement system, hypersensitivity, autoimmunity and tolerance, Transplantation

Module V

Techniques related to immunology Monoclonal Antibodies, Vaccines, Radio, Immunoassay, ELISA, Diffusion.

Module-VI

Biology of cancer cells, Genetics of Cancer, Genetic Variation and Mutation, Two-Hit Hypothesis, Epigenetics of cancer

Module VII

Oncogene and tumour suppressor gene: progression of cancer, Metastasis, Apoptosis in cancer, DNA repair in cancer

Practice

- Demonstration of lymphoid organs
- To isolate the lymphocyte from whole blood by density gradient centrifugation method
- Screening antisera or hybridoma supernatants for specific antibodies
- To detect the presence of an antigen in a sample
- To learn coupling of antibody to enzyme Horse Radish Peroxidase (HRP)
- Study of basic Ouchterlony's double immuno-diffusion method.
- Tumor cell growth in different media

Recommended books:

1 **Text Books**:
Owen, J. A., Punt, J., &Stranford, S. A. (2013). Kuby immunology. seventh Edition, New York: WH Freeman.

2 Robert A. Weinberg, "The Biology of Cancer," Garland Science; 1 Cdr Edition, 2010

Reference Books

1. Owen, J. A., Punt, J., &Stranford, S. A. (2013). Kuby immunology. New York: WH Freeman
2. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology, V Edition, Saunders Publication.
3. Janeway's Immunobiology(2016) 9th Edition, by Kenneth Murphy, Casey Weaver, Garland Science
4. David Male, Jonathan Brostoff, David Roth and Ivan Roitt(2012) Immunology,8th Edition, Elsevier Publication
5. Lauren Pecorino, "Molecular Biology of cancer: Mechanisms, Targets, and Terapeutics," Oxford University.

Bioanalytical Techniques

Subject Name	Code	Type of course	T-P-Pr (Credit)
Bioanalytical Techniques	CUTM1438	Theory+ practice	3-1-0 (04)

Course objectives

- To develop the skill to understand the theory and practice of bioanalytical techniques
- To provide scientific understanding of analytical techniques and detailed implementation of results
- To understand different types of data using appropriate statistical software

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes	**Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)**
CO1	Learn different staining procedures and visualization techniques, Laws of absorption of light, Beer-Lambert's Law, Isotopes and Nature of radioactivity.	PO1(2), PO3 (3), PO5 (2), PSO1(2), PSO3(2)
CO2	Demonstrate principles of various analytical techniques for quantification of biochemical compounds.	PO1(3), PO2(2), PO3 (1) PO4(2), PSO1(2)
CO3	Utilize different instruments for conducting the research work.	PO1(2), PO2(3), PO3(1), PO5(2), PO7(1), PSO2(2)
CO4	Analyze different phyto-constituents using different instruments.	PO1(3), PO2(2), PO4(1), PO5(2), PO8 (2), PSO1(2), PSO3(2)
CO5	Interpret the results of different techniques.	PO1(3), PO3 (3), PSO1(2), PSO3(2)

Module I

Visualization of cells and sub-cellular components by light microscopy and fluorescent microscope, resolving powers of different microscopes, Electron microscope, Scanning and transmission microscopes, fixation and staining techniques for EM, Scanning probe microscopes: AFM and STM.

Module II

Laws of absorption of light, Beer-Lambert's Law, Absorption spectra, Measurement of absorption of light, Factors affecting the absorption properties of chromophores, Ultraviolet-visible absorption spectroscopy: Principle, Instrumentation and application, Fluorescence spectrophotometry: Principle, Instrumentation and application, Mass spectroscopy: Principle, Instrumentation and application.

Module III

Isotopes and Nature of radioactivity, Radioactive decay, Radioisotopes used in Biology, Detection and measurement of radioactivity, Carbon dating, Geiger-Muller counting and liquid scintillation Counting, Safety guidelines related to Radiolabeling techniques. Antibody generation, Detection of molecules using ELISA, RIA, immunoprecipitation, FISH and GISH.

Module IV

Basic principles of sedimentation, Types of centrifuges, Types of rotors, Preparative centrifugation (Differential & density gradient), Analytical ultracentrifugation

Module V

Principles of chromatography (Adsorption and Partition chromatography), Planar chromatography (Paper and Thin-layer chromatography), Column chromatography,Gas chromatography, Gel permeation chromatography, Ion exchange chromatography, Affinity chromatography, HPLC

Module VI

General principles, Electrophoresis of nucleic acids (Agarose gel, pulse- field), Electrophoresis of proteins (SDS-PAGE, native gels) isoelectric focusing and two-dimensional gels, Blotting Techniques-Southern, northern, Western blotting.

Module VII

Electrocardiogram (ECG), Positron emission tomography (PET), Magnetic resonance imaging (MRI), Flow cytometry,Nuclear magnetic resonance, Biostatistics: Measures of central tendency and dispersal; Sampling distribution; Regression and Correlation; t-test; Analysis of variance; Chi-square test.

Practical

1. To study and gain expertise on differential and cytological staining techniques.
2. Quantification of biomolecules using UV-vis Spectrophotometer
3. Detection of antigen/antibodies using ELISA
4. To separate different macromolecules using centrifugation.
5. To separate the phytocompounds by different chromatographic techniques.
6. To study the separation of Protein by SDS PAGE

Text Books:

1. Keith Wilson and John Walker (2018) Principles and techniques of biochemistry and molecular biology.7th. Edition,Cambridge University Press, Cambridge, UK.
2. Voet D and Voet J Biochemistry, 4th Edition. (2020). John Wiley and Sons. New Jersey, USA

Reference Books:

1. Wilson K and Walker J (2018) Principles and techniques of biochemistry and molecular biology.7thEdition, Cambridge University Press, Cambridge, UK.
2. Rodney F Boyer (2019) Biochemistry laboratory: modern theory and techniques.2nd Edition, Pearson Prentice Hall, Boston,USA.

Genetic Engineering

Subject Name	Code	Type of course	T-P-Pr (Credit)
Genetic Engineering	CUTM1563	Theory+ practice	2-2-0 (04)

Objective

- To strengthen the knowledge on various cloning and expression vectors
- To impart the importance of vectors in genetic engineering experiments
- To strengthen the knowledge on various Strategies of gene cloning

Course outcome
At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Understand the concepts of vectors, gene cloning, and gene manipulation.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5(2), PSO (2)
CO2	Demonstrate the concepts of PCR, primer designing, PCR-based genotyping and their applications in biotechnology.	PO1 (3), PO2 (3), PO3 (3), PO5 (3), PSO3(3)
CO3	Utilize on the different methods of DNA sequencing and their applications.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1(2), PSO2 (3)
CO4	Analyze and practice the concepts of gene expression, expression estimation, and recombinant proteins.	PO1 (3), PO2 (2), PO3 (2), PO5 (3), PO6 (1)
CO5	Examine on the applications of gene manipulations and gene cloning towards gene silencing and product generation.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO8 (2), PSO1(3), PSO3(2)

Module I:

Introduction to genetic engineering, 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; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, PCR.

Module II:
Gene cloning vectors: Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors: plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.

Module III:

Insertion of foreign DNA into host cells; Physical, chemical and biological methods of DNA delivery; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Module IV

Gene Tagging- T-DNA tagging, t-DNA tagging strategies, isolation and cloning sequences flanking t-DNA; Types of transposons, transposon tagging; Gene knockout technologies and Gene therapy: Targeted gene transfer, homologous recombination; site-specific mutagenesis

Practice

- Restriction digestion of supplied DNA
- Demonstration of PCR
- Gel elution and purification
- Isolation and purification of plasmid DNA
- Vector cloning and ligation
- Competent cell preparation and transformation of recombinant DNA into *E. coli*.
- Alpha complementation assay in *E. coli.*
- Detection of positive transformants using colony PCR.
- DNA delivery using calcium phosphate method.
- Isolation of total RNA from plant sample.
- Purification and quantification of RNA.
- Reverse transcriptase PCR.
- Southern blotting.
- Western blotting.

BOOKS

1. Analysis of Genes and Genome. R J Reese. Wiley Publications.

2. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch. Cshl Press.

3. Molecular biology of the gene by J.D. Watson, T.'A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. Pearson Publication.

4. Gene Cloning and DNA analysis. T A Brown. Wiley Blawell Publications.

5. Genes and Genome-A changing Perspective. M. Singer and P. Berg. Wiley Publications.

6. Essential Molecular Biology – TA Brown. Wiley Blawell Publications.

Research Methodology & Biostatistics

Subject Name	Code	Type of course	T-P-Pr (Credit)
Research Methodology & Biostatistics	MRM301T	Theory	4-0-0 (04)

Objectives

- Biostatistics and Research Methodology is a graduate-level course designed to provide students with the foundational knowledge and skills necessary to understand and apply statistical methods in biomedical and public health research.
- The course will cover basic statistical concepts, study design, data collection, analysis techniques, and interpretation of results.
- Emphasis will be placed on practical applications through hands-on exercises and real-world examples.

Course Outcome

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Understand fundamental statistical concepts and their relevance in biomedical research.	PO1 (3), PO3 (3), PSO1 (3), PSO3 (3)
CO2	Learn about different types of study designs and their strengths and limitations.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5 (1), PO8 (2), PO10 (1), PSO1 (3), PSO2 (2)
CO3	Acquire skills in data collection, management, and quality assurance.	PO1 (3), PO2 (2), PO3 (1), PO4 (2), PO5 (2), PSO1 (3), PSO3 (3)
CO4	Gain proficiency in using statistical software for data analysis.	PO1 (1), PO2 (2), PO3 (3), PO4 (3), PO5 (2), PSO10 (3), PSO3 (3)
CO5	Interpret statistical results and communicate findings effectively.	PO5 (1), PO6 (3), PO7 (1), PO8 (2), PSO1 (3), PSO2 (2)

Course Outline

MODULE I

General Research Methodology: Research, objective, requirements, practical difficulties, review of literature, study design, types of studies, strategies to eliminate errors/bias, controls, randomization, crossover design, placebo, blinding techniques.

MODULE II

Biostatistics: Definition, application, sample size, importance of sample size, factors influencing sample size, dropouts, statistical tests of significance, type of significance tests, parametric tests (students "t" test, ANOVA, Correlation coefficient, regression), non-

parametric tests (wilcoxan rank tests, analysis of variance, correlation, chi square test), null hypothesis, P values, degree of freedom, interpretation of P values.

MODULE III

Medical Research: History, values in medical ethics, autonomy, beneficence, non-maleficence, double effect, conflicts between autonomy and beneficence/non-maleficence, euthanasia, informed consent, confidentiality, criticisms of orthodox medical ethics, importance of communication, control resolution, guidelines, ethics committees, cultural concerns, truth telling, online business practices, conflicts of interest, referral, vendor relationships, treatment of family members, sexual relationships, fatality.

MODULE IV

CPCSEA guidelines for laboratory animal facility: Goals, veterinary care, quarantine, surveillance, diagnosis, treatment and control of disease, personal hygiene, location of animal facilities to laboratories, anesthesia, euthanasia, physical facilities, environment, animal husbandry, record keeping, SOPs, personnel and training, transport of lab animals.

MODULE V

Declaration of Helsinki: History, introduction, basic principles for all medical research, and additional principles for medical research combined with medical care.

Reference Books

Singh, Y.K., 2006. Fundamental of research methodology and statistics. New Age International.

Microbiology

Subject Name	Code	Type of course	T-P-Pr (Credit)
Microbiology	CUTM1436	Theory+ practice	3-1-0 (04)

Course Objectives

- To know various Culture media and their applications and also understand various physical and chemical means of sterilization.
- To perform routine culture handling tasks safely and effectively.
- To know the various physical and chemical growth requirements of microbes and get equipped with various methods of microbes culture techniques and their role in various industry.

Course Outcomes

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Learn the basic concepts of microbiology, classification of common microbes, structural and genetic diversity of microbes	PO1 (3), PO2 (2), PO5 (2), PO6 (3), PSO1 (2), PSO3 (2)
CO2	Understand the transmission, replication, life cycle, growth kinetics, and different metabolic process (photosynthesis, respiration, fermentation) of microbes, mode of actions of antibiotics, microbial toxins, probiotics and prebiotics, host pathogen interactions, genetic regulation and genetic mapping	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5 (3), PO6 (1), PO7 (3), PO8 (1), PSO2 (2), PSO3 (3)
CO3	Identify the microbes, culturing techniques, industrial application, solving of problems related to waste water management, degradation of oils, pesticides, toxic chemicals bioleaching, bioremediation etc. by applying acquired knowledge; application of important microorganisms in agriculture, cosmetics, and pharmaceutical industries	PO1 (3), PO2 (2), PO3 (1), PO4 (2), PO5 (2), PSO1 (2), PSO3 (3)
CO4	Categorize important diseases caused by bacteria, protozoa and virus, emergence of multiple-drug resistance strains, interpretation of molecular markers; growth monitoring in culture	PO1 (1), PO2 (2), PO3 (3), PO4 (3), PO5 (2), PSO1 (2), PSO2 (3)
CO5	Adopt the methods of food preservation, microbiological legal standards of selected food and milk products, mass cultivation, single cell protein, microbial enzymes, novel medicines from microbes fermenter design, bioreactors, and maintenance of industrial microorganisms.	PO1 (3),PO2 (2),PO5 (1), PO6 (3), PO7 (1), PO8 (2), PSO1 (2), PSO3 (3)

Module I

Classification, taxonomy, cataloguing virus to ICTV and ICNV; Structural and genetic diversity of viruses; Transmission and Replication; Prions, Viriods, Anti-viral agents, and

Vaccines; Bacterial Classification (phonetic, genetic and phyllogenetic); Bergey's manual of systematic bacteriology; Classification, Identification and Culturing Technique of cyanobacteria; Industrial Application, Cyanotoxins.

Module II

Growth Kinetics, Growth cycle, Logistic growth equation, measurement and growth monitoring in culture, factors affecting growth. photosynthetic pigments, paths of carbon and electron in bacterial photosynthesis; Fermentation, Respiratory metabolism, Embden-Meyerhoff pathway, Entner-Doudroff pathway, Pasteur Effect.

Module III

Microbes and quality of environment, Bio-transformations, Microbes in waste water management; Microbial degradation of pesticides, toxic chemicals, oil; Bioleaching, bioremediation.

Module IV

important microorganisms, Mycorrhizae, Microbial mineralization, Microbial toxins, Biological control; Microbial toxins produced in food items, Probiotics and prebiotics, Methods of food preservation, Microbiological legal standards of selected food and milk products.

Module V

Host pathogen interactions, Pathogenicity of bacteria invasiveness and toxigenicity, Constitutive and inducible host defence mechanism, Important diseases caused by bacteria, protozoa, virus; Antibiotics: Definition, phenomenon of antibiotics, Chemical and biochemical modification of antibiotic structures, assay and Mode of action, Biochemical mechanisms of resistance development, Multiple-drug resistance.

Module VI

Application as nutraceuticals, pharmaceuticals, cosmetic, bio fertilizer; application as biofuel, CO_2 sequestration and pollution control, Mass cultivation, Single cell protein,Sources, Large scale production, recovery; Microbial enzymes of industrial interest, Novel medicines from microbes, Biotechnological application of Microbial enzyme, Use of Microbes in Biotechnology, Culture media (types, Different culturing Technique, Media formulation, Preservation of Microbes, Fermenter design and growth processes; Bioreactors, and Membrane Bio reactors, analysis of different bioreactors, stability of microbial reactors, specialized bioreactors; Isolation, preservation, and Maintenance of Industrial Microorganisms.

Module VII

Lytic and Lysogenic cycle, Conjugation, Transduction, Recombination; Genetic regulation: Operon concept (*Lac, Trp.*), Genetic mapping: Genome mapping of E. *coli*, QTL Mapping. Molecular markers in genome analysis, RAPD, RFLP, AFLP, FISH and GISH.

Practical

1. Working principles and operations of basic equipment of microbiological laboratory.
2. Microbial culture media preparation and sterilization techniques.

3. Isolation of bacteria by different culture methods (Streak, pour and spread plate method).
4. Preparation of bacterial smear and different staining methods (Gram's staining, Acid-fast staining).
5. Preparation of antibiotic disc and antibiotic sensitivity test.
6. Detection of microorganisms in air, soil and water by standard plate count method.

Text Books

1. Dubey R C. (2023). A Textbook of Microbiology. 5th Edition, S Chand & Company.
2. Singh, R.P. Microbiology. 2020-2021 edition
3. Dubey R. C. Maheswari, D. K. (2022). A Textbook of Microbiology. 5th Edition. S. Chand and Company.
4. Dubey R. C. Maheswari D. K. (2023). Practical Microbiology. S. Chand.

Reference Books

1. Pelczar, Michale J. Jr., Chan E.C.S., Krieg Noel R. (2023). Microbiology, 5th Ed, Affiliated East-West Press Private Limited, G-1/16, Ansari Road, New Delhi 110002
2. Prescott, L. M., Harley, J. P. and Klen, D. A. (1999). Microbiology, 7th Ed., McGraw-Hill, New York.
3. Agrios, G. N. (2005). Plant Pathology, 5th Ed, Elsevier Academic press, USA

Genetics and Epigenetics

Subject Name	Code	Type of course	T-P-P	Prerequisite
Genetics and Epigenetics	CUTM1454	Theory and Practice	3-1-0	

Course Objectives

- To explain and provide examples of how continuous traits are "quantitative traits" and that phenotypic variation may be due to genetic variation within a population and/or environmental variation experienced by individuals within a population.
- To explain the polygenic theory of genetic variance and the nature of additive alleles, and the assumptions that accompany these ideas and also able to provide competing hypotheses that explain a distribution data set of phenotypes.
- To discuss epigenetics and its role in cancer, imprinting and X chromosome inactivation.

Course Outcomes

At the end of the course, students will be able to

COs	Course Outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Understand the role of genetic mechanism in evolution.	PO1 (3) , PO2 (2), PO3 (1), PO4 (1), PO5 (3), PO7 (1), PSO1 (2), PSO2 (2), PSO3 (3)
CO2	Predict the phenotypic classes and their ratios from a monohybrid cross involving dominant and recessive alleles.	PO1 (1) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO8 (1), PSO1 (2), PSO2 (2), PSO3 (3)
CO3	Select from different gene delivery methods that are currently available based on the type of target tissue involved.	PO1 (2) , PO2 (2), PO3 (1), PO4 (3), PO5 (3), PSO1 (2), PSO2 (2)
CO4	Compare different methods used in assisted reproduction and identify the challenges in natural method of conception.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (2), PO11 (1), PSO1 (2), PSO3 (3)
CO5	Analyze the modifications/mechanisms of DNA marks that result in epigenetic changes and also to discuss the role of epigenetics in environmental exposures.	PO1 (3) , PO2 (3), PO3 (2), PO6 (2), PO8 (3), PO12 (1), PSO1 (2), PSO2 (2), PSO3 (3)

MODULE I

Laws of heredity, Co-and incomplete dominance, Gene Linkage and crossing over, Varieties of Gene interractions - lethal genes, Multiple alleles, Pleiotropic genes, Gene epistasis, Structural and numerical alterations of chromosomes and meiotic consequence, Cytoplasmic Inheritance,

Sex-chromosome systems; Different mechanisms of sex determination in animals (Drosophila, Man, Bees and Bonellia)

Module II

Sex linkage: Sex linked genes in man, Sex chromosome disorders in man, Detection of linkage & Linkage maps: Test cross, Test for linkage on the basis of F2 generation, LOD score, Gene mapping, Three point test cross in Drosophila, Construction of linkage maps, Identification of particular linkage groups with specific chromosome, Physical distance and map distance, Interference and coincidence

Module III

Mitotic Recombination, Recombination within gene, Spontaneous and induced mutations, Physical and chemical mutagens, Chromosomal aberrations, meiotic behaviour of deletion, Duplication, Inversion and translocation, Euploids and aneuploids-classification, Origin, Induction, Role of polyploidy in evolution.

Module IV

Human genetics - Chromosomal disorder, Some common human syndromes, Twin study, Superfoetation, Polyembryony, Free Martin, Multiple birth, Amniocentesis and Genetic Counselling, Nature and function of genetic material, Chemical compounds causing genetic damage, Gene mapping and genome analysis.

Module V

Epigenetics vs Genetics, Epigenetics from phenomena to field : overview and concepts, Basic organization of eukaryotic genome, Histone proteins.

Module VI

Histone modifications and the histone code, Chromatin remodelling complex and histone variants, DNA Methylation, Acetylation and Deacetylation, Phosphorylation, Ubiquitylation, Deubiquitylation and Phosphorylation.

Module VII

Dosage compensation in mammals, Genomic imprinting in mammals, Germline and pleuripotent stem cells, Epigenetics and human disease.

Practice

- Preparation of Mitotic chromosomes from the given sample
- To study the karyotyping of chromosomes from the given animal samples.
- To study the chromatin modelling and Chromatin-immunoprecipitation (ChIP)
- Isolation of total histones, and resolution on SDS-PAGE.
- Isolation of DNA from animal cell (Isolation of nuclei (as a source for studies on structure of chromatin) from rat/mouse liver by discontinuous sucrose-density gradient centrifugation.

- Identification of inactivated X chromosomes as barr body from the given sample
- Preparation and study of metaphase chromosomes from mouse bone marrow

Reference & Textbooks

1 Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India.

2 Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3 Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics X Edition. Benjamin Cummings.

4 Russell, P. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

5 Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.

6 Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.

7 Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing

8 Barton, N. H., Briggs, D. E. G., Eisen, J. A.Goldstein, D. B. and Patel, N. H. (2007). Cold Spring, Harbour Laboratory Press.

9 Hall, B. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and BartlettPublishers

10 Campbell, N. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin,Cummings.

11 Epigenetics, C. David Allis and Thomas Jenuwein, (2007)Cold Spring Harbor Laboratory Press, New York, USA .

12 Molecular Biology of Gene, Watson et al., (5th Ed. 2004), Pearson Education, Delhi, INDIA

13 Genetics by P.K Gupta.

Elective Courses

Nanobiotechnology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM2375	Nanobiotechnology	3	2-0-1	Biochemistry

Course Objectives

- To understand the fundamentals of nanobiotechnology.
- To explore applications in healthcare and agriculture.
- To develop skills in nanobiotechnological techniques.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	To discover basic concepts and theories of the subject.	PO1 (3), PO5 (3), PSO1 (2), PSO 3 (2)
CO2	To relate and explain the importance of reduction in materials dimensionality, and its relationship with materials properties.	PO1 (3), PO7 (2), PO6 (2), PSO1(1), PSO2 (3)
CO3	To demonstrate the potential of nanobiotechnology in consumer and biomedical applications.	PO1 (1), PO3 (2), PO4 (1), PSO 1(3)
CO4	To evaluate journal papers on nanoscience/nanotechnology.	PO2 (1), PO3 (3), PO4 (2), PO5 (1), PO7 (2), PSO3 (2)
CO5	To formulate strategies for risk assessment of nanostructures/ particles in various applications.	PO1 (1), PO3 (1),PO4 (1), PO5 (3), PO8 (3)

Course Contents

Module I

Introduction to nanobiotechnology, From Biotechnology to Bionanotechnology,Bionanomachines in action-Modern Biomaterials , The Legacy of Evolution

Module II

Bimolecular Design and Biotechnology, Recombinant DNA technology,Monoclonal antibodies, Biomolecular structure determination, Molecular Medicine

Module III

Functional Principles of Nanobiotechnology, Information Driven Nanoassembly, Energetics, Chemical transformation, Regulation Biomolecular Motors Biomolecular sensing, Self-replication, Machine–Phase Bionanotechnology

Module IV

Nanomedicine, Anti-AIDS drugs-Immunotoxins as cell killers-Artificial blood, Cyclic peptides from nanotubes

Module V

Applications of Nanobiotechnology , Harnessing molecular Motors-DNA computers,Molecular design using Biological selection, Artificial life-Hybrid materials,Biosensors

Recommended Books

1. Bionanotechnology by David S.Goodsell, 2004, Wiley Publications. Pages-337.

Animal Biotechnology

Subject Name	Code	Type of course	T-P-P	Prerequisite
Animal Biotechnology	CUTM1452	Theory and Practice	3-1-0	-

Course Objectives

- To make the student understand the tools and techniques required for the animal cell culture, assisted reproductive technology, development of transgenic animals, and development of animal models.
- The methods of culturing animal cells.
- To utilize animal production technologies for sustainable agriculture and food security

Course Outcomes

At the end of the course, students will be able to

COs	Course Outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Appraise the importance of animal cell culture techniques in the development of novel drug, cell and gene therapy product	PO1 (1) , PO2 (3), PO3 (3), PO4 (3), PO5 (3), PSO1 (2), PSO2 (2), PSO3 (3)
CO2	Make use of the various techniques in cell line authentication and characterization, and identify contaminations in cell culture.	PO1 (2) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO6(3), PSO1 (2), PSO2 (2), PSO3 (3)
CO3	Select from different gene delivery methods that are currently available based on the type of target tissue involved.	PO1 (3) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO7 (2), PSO1 (2), PSO2 (2), PSO3 (3)
CO4	Compare different methods used in assisted reproduction and identify the challenges in natural method of conception.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (3), PO8 (1), PSO1 (2), PSO2 (2), PSO3 (3)
CO5	Apply the principle of gene targeting methods used in the generation of animal models for biomedical research and the concept about molecular techniques in animal conservation.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (1), PO8 (1), PSO1 (2), PSO2 (2), PSO3 (3)

Course outline

Module-I

Overview of animal cell and tissue culture technology,Cell culture laboratory design and basic laboratory equipments, Media preparation, Role of important components of culture media, Common laboratory hazards and safety issues to consider in cell culture laboratory.

Module-II

Types of animal cell culture, Characterization and preservation of animal cells , Advances in cell culture technology, Opportunities and challenges in animal cell and tissue culture technology

Module-III

Overview of transgenic technology, Biopharming through animal transgenesis, Methods of producing transgenic farm animals, Identification and transfer of gene influencing better production and disease resistance.

Module-IV

Gene transfer methods in animals: Microinjection, Retrovirus mediated gene delivery, Embryonic stem cell mediated gene transfer,Knockout model systems & their utility, Animal as bioreactor.

Module-V

Reproduction biotechnologies and their use in livestock, Somatic cell nuclear transfer cloning, In Vitro Fertilization, Embryo production, Preservation and transfer, Sperm and embryo sexing, Intracytoplasmic sperm injection (ICSI), Cryopreservation and gamete banking.

Module-VI

Polyculture of fish for high yield,Edible oyster production, Pearl oyster production, Vermi-culture and vermicomposting for alternative and sustainable agriculture,Fish culture in flow through system and recirculation technology.

Module-VII

Recombinant therapeutics and production of pharmaceuticals; Production of tissues and organs for humans and xenotransplantation, Process of gene therapy, *Pros* and *cons* in gene therapy, Retrovirus and adenovirus mediated gene therapy.

Practice

- Sterilization techniques used in animal cell culture
- Preparation of media for animal cell culture
- Study of primary cell culture technique using chick embryo
- Animal cell batch culture technique
- Vermicompost preparation from plant debris, cattle dung and paper waste
- : Preparation of competent cell (Calcium chloride treatment method)

Text Books

1 Freshney RI (1992) Animal cell culture: a practical approach, Oxford University Press
2 Singh B, Gautam SK (2013) Text Book of Animal Biotechnology, TERI

Reference Books

1 SinghB, Mal G, Gautam SK, Mukesh M (2019) Advances in Animal Biotechnology, Springer
2 Butler M (2003) Animal Cell Culture and Technology, Taylor & Francis

Plant Biotechnology

Subject Name	Code	Type of course	T-P-Pr (Credit)
Plant Biotechnology	CUTM1439	Theory+ practice	3-1-0 (04)

Course objectives

- To understand the basics of tissue culture, its practices and apply knowledge of cellular differentiation and totipotency in plant tissue culture and regeneration.
- To learn the principles of vector-mediated gene transfer and Agrobacterium-mediated genetic transformation in plants, and to optimize protocols for gene transfer.
- To develop and apply genetic engineering techniques, for improved plant variety development and to design edible vaccines and long-shelf-life plants.

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Learn to propagate plants, conduct research, develop disease-free germplasm and advance agricultural and horticultural practices	PO1 (1) , PO2 (3), PO3 (3), PO4 (3), PO5 (3), PSO1 (3)
CO2	Understand different genetic manipulation techniques, to create genetically modified plants, enhance crop traits, and address agricultural challenges	PO1 (2) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1(2), PSO2(3)
CO3	Make use of the enhanced agricultural practices, with advanced knowledge in introducing foreign DNA into plant by utilizing a variety of gene transfer techniques for development of an improved variety	PO1 (3) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1(2), PSO3(2)
CO4	Discovering the knowledge and skills in designing, developing, and evaluating genetically modified plants for enhanced disease resistance	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (3), PO8 (2)
CO5	Evaluating the gene function, mechanisms and skills to manipulate gene expression using techniques like RNA interference (RNAi) in plants.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (1), PSO3(3)

Module I

History, scope, concept of cellular differentiation and Totipotency, Cell culture media and sterilization techniques, Callus culture, nodal and tip culture, Protoplast and Embryo culture, Embryo culture and embryo rescue, protoplast isolation, culture and plant regeneration

Module II

Applications of Plant Tissue Culture: Somatic embryogenesis, Somaclonal variation and crop improvement, Germplasm conservation, Production of Secondary metabolites through Tissue culture, Industrial applications.

Module III

Recombinant DNA technology: Genomic DNA & plasmid DNA isolation and purification, construction of recombinant DNA and expression cassettes, Transformation (mobilization of vectors into competent bacteria), selection and analysis of recombinant clones, genomic DNA and cDNA libraries.

Module IV

Genetic Engineering in Plants: Vector mediated Gene transfer, Molecular basis of crown gall and hairy root diseases, features of Ti and Ri plasmids, mechanism of T-DNA transfer, role of virulence genes, vectors based on PTi & PRi, binary and co-integrate vectors, optimized protocols for Agrobacterium-mediated genetic transformation, physical and chemical methods of gene transfer.

Module V

Methods of Gene transfer in plants: Direct gene transfer methods (particle bombardment/ micro projectile / biolistic, electroporation, microinjection, liposome mediated, silicon carbide fibers), chemical methods (PEG - mediated, calcium phosphate co-precipitation), transgenic monocots and dicots via direct gene transfer, in plant transformation. Integration and fate of transgene, precision of transgene integration by site-specific.

Module VI

Applications of Genetic Engineering: Transgenic plants for disease resistance, nutritional improvement, herbicide tolerance, Long shelf life, edible vaccines.

Module VII

Gene silencing in plants: Antisense RNA technology: Antisense RNA, construction of antisense vectors, applications of antisense technology. Gene silencing: causes (DNA methylation, homology-dependent suppression by antisense gene), strategies for avoiding gene silencing, methods of inducing gene silencing and its application. Regulatory RNA molecules (si RNA and miRNA), RNAi technology and its applications in plants. CRISPR/Cas technology and its applications in plants.

Practical

1. Preparation of tissue culture media
2. Direct Organogenesis: Shoot tip culture
3. Protoplast isolation
4. Micro propagation of plants
5. *Agrobacterium tumefaciens* mediated transformation of tobacco leaves
6. Demonstration of biolistic method of gene transfer through photographs

Text Books

1. Satyanarayana, U. (2020), Biotechnology, Elsevier
2. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2017). Lewin's Genes XII.
3. Jeremy W. Dale , Malcolm von Schantz , Nicholas Plant (2011). From Genes to Genomes: Concepts and Applications of DNA Technology

Reference Books

1. Liebler, D.C. Introduction to Proteomics: Tools for the New Biology. Human Press, Totowa NJ. 2002.
2. Richard J. Reece. Analysis of Genes and Genomes. 2003

IPR, BIOSAFETY AND BIOENTREPRENEURSHIP

SubjectName	Code	Type of course	T-P-Pr (Credit)
IPR, Biosafety and Bioentrepreneurship	CUTM1569	Theory+ practice	2-0-2 (04)

Course Objective

- The risks of handling chemical and biological materials and hazardous, toxic, explosive, inflammable, infective effects of some chemical and biological substances.
- To become familiar with ethical issues in biological research.
- To teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Learn the ethical aspects related to biological, and biotechnology research.	PO1 (1) , PO2 (3), PO3 (3), PO4 (3), PO5 (3)
CO2	Understand ethical aspects related to biomedical and health care and biotechnology research.	PO1 (2) , PO2 (2), PO3 (2), PO4 (3), PO5 (3)
CO3	Make use of the entrepreneurial skill and the schemes promoted through knowledge centers and various agencies.	PO1 (3) , PO2 (2), PO3 (2), PO4 (3), PO5 (3)
CO4	Discover the scope for entrepreneurship in biosciences.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (3)
CO5	Evaluate the various operations involved in venture creation.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (1)

Module I

Types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; plant variety protection and farmers rights; Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; filing of a patent application; role of a Country Patent Office; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications.

Module II

Introduction; historical background; introduction to 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; risk – environmental risk assessment and food and feed safety assessment; risk assessment of transgenic crops, RNAi, genome edited crops

Module III

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.

Module IV

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* 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,

Project: Preparation of proposals for entrepreneurship development programs of public and private agencies (MSME, DBT and BIRAC).

BOOKS

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion.

2. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.

3. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.

Transcriptomics, proteomics and metabolomics

Subject Name	Code	Type of course	T-P-Pr (Credit)
Transcriptomics, Proteomics and Metabolomics	CUTM1568	Theory+ practice	2-2-0 (04)

Course objective

- To comprehend the principles and techniques involved in transcriptomics, proteomics and metabolomics.
- To explore integrative omics approaches.
- To apply omics technologies to real-world challenges.

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Define the fundamental concepts, terminologies, and methodologies associated with transcriptomics, proteomics, and metabolomics.	PO1 (1) , PO2 (3), PO3 (3), PO4 (3), PO5 (3), PSO1 (3)
CO2	Explain and illustrate the workflow and experimental approaches for analyzing transcripts, proteins, and metabolites in biological systems.	PO1 (2) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1 (2), PSO2(2)
CO3	Demonstrate the ability to utilize bioinformatics tools and analytical techniques for processing and interpreting omics data.	PO1 (3) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO2 (3)
CO4	Evaluate omics datasets to identify patterns, correlations, and biological significance, linking molecular data to physiological functions.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (3), PSO1(2), PSO2(1), PSO3(2)
CO5	Design and propose integrative omics-based research strategies to address complex problems in areas such as disease diagnostics, drug discovery, and systems biology.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (1), PSO3(3)

Module I

Global gene expression strategies- Northern blotting, Serial Analysis of Gene Expression (SAGE), Massively Parallel Signature Sequencing (MPSS), Microarray-

construction of microarrays – genomic arrays, cDNA arrays and oligo arrays, Transcriptome profiling.

Module II

Protein interactions; DNA – protein Interactions, yeast two-hybrid systems; affinity tagging, pathway building. Proteomes in different tissues/organs and in response to biotic and abiotic stresses; nuclear and organellar proteomics.

Module III

2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, LC-MS; Proteome databases; Protein sequencing: N-terminal sequencing- Ninhydrin test, Sanger's method, Edman degradation; C-terminal sequencing-types of reducing agents; functional protein microarrays

Module IV

Introduction to metabolomics: Metabolome, Metabolite profiling, Metabolome fingerprinting, Role of Biomarker in metabolomics, Techniques for metabolome analysis.

Practice

- Demonstration of Northern blotting
- Analysis of transcriptome data using JMP Genomics
- Analysis of transcriptome data using open source GALAXY platform.
- Protein separation using SDS-PAGE.
- Protein structure visualization using RasMol.
- Generating Ramchandran plots for protein using web based tool.
- Demonstration of 2D-PAGE.
- Proteome data analysis using web-based tools.
- Demonstration of Mass spectroscopy using virtual lab
- Isolation of secondary metabolite using Clevenger's apparatus.
- Isolation of secondary metabolites using Soxellate apparatus.
- Demonstration of chemical fingerprints of bioactive compounds using HPLC through virtual lab.

Text books

1. Twyman, R.M. Principles of Proteomics. BIOS Scientific Publisher, New York. 2004.
2. Singer M and Berg P Genes and Genomes: A Changing Perspective; University ScienceBooks, CA, USA, 1991.
Liebler, D.C. Introduction to Proteomics: Tools for the New Biology. Human Press, Totowa NJ. 2002.

Reference Books

1. Buchanan B, Gruissem G, and Jones R Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA, 2000.
3. Hammes GD. Spectroscopy for the Biological Sciences; Wiley Interscience, USA, 2005.

Drug Design Using Biovia Discovery Studio

Subject Name	Code	Type of course	T-P-Pr (Credit)
Drug Design Using Biovia Discovery Studio	CUTM3122	Practice+ project	0-2-2 (04)

Course objective

- To practice and familiarized molecular modeling process used in drug discovery.
- To understand the concept of structure and ligand-based drug designing.
- To examine the concept of structure and ligand-based drug designing.

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Understand the Biovia Tools and their application in drug discovery processes.	PO1 (1) , PO2 (3), PO3 (3), PO4 (3), PO5 (3), PSO1 (3)
CO2	Identify potential biological molecules from synthetic and natural sources by using Biovia.	PO1 (2) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1 (2), PSO2(2)
CO3	Evaluate various disease targets and select an ideal target for drug discovery.	PO1 (3) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO2 (3)
CO4	Design novel drug candidates for various diseases by using Biovia Discovery Studio.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (3), PSO1(2), PSO2(1), PSO3(2)
CO5	Repurpose the already existing drugs for safe and effective medication for various diseases.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (1), PSO3(3)

Module I

Introduction to different menu bars of the Drug Discovery Studio.

- Practice 1: Installation of Drug Discovery Studio
- Practice 2: Introduction to different menu bars of Biovia.

Module II

Ligand Structure Handling in Discovery Studio.

- Practice 1: Creating your own Ligand Database using at least 10 natural product molecules.
- Practice 2: Downloading of the Ligand Structure from different sources such as PubChem, Zinc database, Drug Bank, Chemspider, ChemDB and ChemMBL
- Practice3: Design of ligands using Biovia Draw.
- Practice 4: Ligand sketching using Biovia Discovery Studio.

Module III

Protein Structure Handling in Discovery Studio.

- Practice 1: Downloading of the Protein from RSCB data Base.
- Practice 2: Selection of the protein
- Practice 3: Preparation of the protein in Drug Discovery Studio.

Module IV

Receptor -Ligand Interaction Study in Discovery Studio.

- Practice 1: To find the pocket or active site of the protein through SBD sphere.
- Practice 2: To Perform Lib docking.
- Practice 3: To do C-Docking.

Module V

To view the Ligand Interactions.

- Practice 1: To View the Pocket atoms.
- Practice 2: Visualization of Bonds through 2D diagram.

Module VI

Prediction of Ligand properties in Discovery Studio.

- Practice 1: Selection of the ligand by Lipinski Rule of Five.
- Practice 2: Prediction of ADMET properties of ligands using Discovery Studio.

Module VII

In silico data interpretation.

- Practice 1: Data Analysis of Molecular Docking Score.
- Practice 2: Study of various docking interactions such as -CDocker Energy and -CDocker Interaction Energy.
- Practice 3: Interpretation of ADMET Prediction Score,

Project (Any One)

- Create your own Ligand Database using at least 10 natural product molecules and 10 synthetic compounds from published literature with appropriate references enlisted in a word document file.

- Identify a disease protein from plant or animal origin and prepare the suitable protein using Biovia.
- Perform the Molecular docking of ligands prepared in Practice 1 with Protein prepared in Practice 2.
- Prepared a docking report for the molecular docking study performed.
- In silico docking analysis of antidiabetic drugs against GLUT4
- In silico docking analysis of COX inhibitors
- In silico docking analysis of antihyperlipidemic drugs

Text books

- Structure-Based Drug Discovery: An Overview" by Roderick E. Hubbard.
- Computational Drug Discovery and Design" by Riccardo Baron (Editor).
- Principles of Structure-Based Drug Design" by Johann Gasteiger.
- The Art of Drug Synthesis" by Douglas S. Johnson and Jie Jack Li.
- Protein-Ligand Interactions: Methods and Applications" by Holger Gohlke.

Introduction to Nutraceuticals

Subject Name	Code	Type of course	T-P-Pr (Credit)
Introduction to Nutraceuticals	CUTM3122	Practice+ project	0-2-2 (04)

Course objective

- To study the advantages of functional foods over conventional Medicine to avoid potential side-effects.
- To study dietary supplements.
- To distinguish between food, functional food, and supplements.

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes	Mapping COs with POs and PSOs (High-3, Medium-2, Low-1)
CO1	Identify and recall the basic concepts, definitions, and classifications of nutraceuticals and functional foods.	PO1 (1) , PO2 (3), PO3 (3), PO4 (3), PO5 (3), PSO1 (3)
CO2	Explain the biochemical and physiological roles of nutraceuticals in promoting health and preventing diseases.	PO1 (2) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1 (2), PSO2(2)
CO3	Demonstrate the ability to assess the nutritional and therapeutic potential of different nutraceutical products through case studies and market analysis.	PO1 (3) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO2 (3)
CO4	Analyze the regulatory guidelines, quality control measures, and safety concerns related to the production and commercialization of nutraceuticals.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (3), PSO1(2), PSO2(1), PSO3(2)
CO5	Design prototypes for a novel nutraceutical product by integrating knowledge of bioactive compounds, delivery systems, and consumer needs.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (1), PSO3(3)

Module I

Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods, and Phyto-nutraceuticals. The scope involved in the industry, Indian, and global scenario, Food Chemistry, Preservatives, food colors.

Practical

- Milk Analysis: Determination of fat, acidity, lactose, protein, adulterants
- Analysis of water: Collection of the sample, preliminary examination, Total soluble solids, Determination of total hardness, chlorides, dissolved oxygen
- Analysis of fats: acid value, saponification value, iodine number, antioxidants
- Analysis of foods: Determination of reducing and non-reducing sugar, protein, determination of ash/total protein/moisture in dietary fibers
- Anti-nutritional Factors: Trypsin inhibitor, Phytic acid, Antifungal activity of cystatin
- Vitamins: Ascorbic acid by colorimetric method, estimation of Vit A/E
- Pigments: Curcumin, chlorophyll, carotene.

Project

- Project would be given on any of the thrust areas of nutraceuticals.

Text books

- Giuseppe Mazza; Functional Foods: Biochemical and Processing Aspects, Volume 1; CRC Press
- Robert E.C. Wildman; Handbook of Nutraceuticals and Functional Foods, Second Edition; CRC Press
- Massimo Maffei; Dietary Supplements of Plant Origin; CRC Press
- Fereidoon Sahidi, Deepthi K. Weerasinghe; Nutraceutical Beverages, Chemistry, Nutrition and Health Effects; American Chemical Society