Syllabus Book

for

4 Years Undergraduate Programme

B.Sc. Biotechnology

Centurion UNIVERSITY

Shaping Lives...
Empowering Communities...

School of Biotechnology

Centurion University of Technology and Management

India's First and Best Skill University

ACCREDITED WITH GRADE A+ NAAC

www.cutm.ac.in

Constituent Campuses

Bhubaneswar | Paralakhemundi | Rayagada | Bolangir | Chattarpur | Balasore

Programme Outcomes (POs)

PO-01	Fundamental knowledge: Graduates will acquire a strong foundational understanding of core concepts in biotechnology and other related subjects.
PO-02	Problem analysis: Identify, formulate, review literature and analyse Biotechnology problems to design, conduct experiments, analyse data and interpret data.
PO-03	Design /development of solutions: Design solution for Biotechnology 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	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in Biotechnology.
PO-05	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to Biotechnology activities with an understanding of the limitations.
PO-06	Biotechnology and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to Biotechnology practice.
PO-07	Environment and sustainability: Understand the impact of the Biotechnology Engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.
PO-08	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the Biotechnology practice.

PO-09	Individual and team work: Function affectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings in Biotechnology.
PO-10	Communication: Communicate effectively on complex engineering activities with the engineering 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-11	Project Management and finance: Demonstrate knowledge & understanding of the Biotechnology engineering principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments in Biotechnology.
PO-12	Life- long learning: Recognize the need for, and the preparation and ability to engage in independent research and lifelong learning in the broadest contest of technological changes in Biotechnology.

Programme Specific Outcomes (PSOs)

PSO-1	Core Competence in Biotechnology Applications: Graduates will develop expertise in applying biotechnological tools and techniques to address challenges in fields such as healthcare, agriculture, environment, and industrial biotechnology, fostering innovative solutions.
PSO-2	Practical and Analytical Skills: Graduates will acquire practical skills in molecular biology, genetic engineering, microbiology, and bioinformatics, enabling them to design experiments, analyze data, and interpret results effectively in research and industry settings.
PSO-3	Entrepreneurship and Sustainable Development: Graduates will demonstrate the ability to identify opportunities in biotechnology for entrepreneurship and contribute to sustainable development by designing eco-friendly and socially responsible biotechnological solutions

Details of the Courses for B.Sc. Biotechnology

Choice-based Credit System (CBCS) Structure

Basket	Type of Course	Minimum Credit Requirement			
		4 years UG		3 years UG	
		Credit	Approx. Weightage	Credit	Approx. Weightage
I	Major (Core) Courses	80	50 %	60	50 %
II	Minor (Domain) Courses	32	20 %	24	20 %
III	Multi-Disciplinary Courses	9	5.6 %	9	7.5 %
IV	Skill Courses	9	5.6 %	9	7.5 %
	Ability Enhancement Courses	8	5 %	8	7 %
	Value Added Courses	6	3.8 %	6	5 %
V	Summer Internship / Dissertation	16	10 %	4	3 %
TOTAL		**160**	**100 %**	**120**	**100 %**

Basket- I

Sl. No.	Course Type	Course Code	Course Title	Credit	Type (T+P+Pj)
1	Major (Core)	CUTM4115	Cell Biology	4	3+1+0
2	Major (Core)	CUTM4116	Molecular Biology	4	3+1+0
3	Major (Core)	CUTM4117	Microbial Biotechnology	4	3+1+0
4	Major (Core)	CUTM1562	Concepts of Genetics	4	2+1+1
5	Major (Core)	CUTM4119	Biochemistry	4	3+1+0
6	Major (Core)	CUTM1127	Immunology	4	3+1+0
7	Major (Core)	CUTM1430	Developmental Biology and Phytotomy	4	3+1+0
8	Major (Core)	CUTM1428	Plant Physiology and Metabolism	4	3+1+0
9	Major (Core)	CUTM4121	Bioanalytical Techniques	4	3+1+0
10	Major (Core)	CUTM4353	Metabolic Engineering	4	3+1+0
11	Major (Core)	CUTM4351	Genetic Engineering	4	3+1+0
12	Major (Core)	CUTM4350	Fermentation Biotechnology	4	3+1+0
13	Major (Core)	CUTM1569	IPR, Biosafety and Bio-entrepreneurship	4	2+0+2
14	Major (Core)	CUTM4355	Cancer Biology	4	3+1+0
15	Major (Core)	CUTM1565	Biostatistics and Bioinformatics	4	2+2+0
16	Major (Core)	MPC203T	Computer Aided Drug Designing	4	4+0+0
17	Major (Core)	CUTM1567	Frontiers in Genomics	4	3+1+0
18	Major (Core)	CUTM4120	Animal Biotechnology	4	2+1+1

19	Major (Core)	CUTM1439	Plant Biotechnology	4	3+1+0
20	Major (Core)	CUTM1674	Environmental Science	4	3+0+1

Credits to be completed from Basket I ≥ 60 for 3 years exit and 80 for 4 years exit.

Basket- II

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
15	Minor Stream	CUTM4332	Medical Microbiology	3	2+1+0
16	Minor Stream	CUTM2375	Nanobiotechnology	3	2+0+1
17	Minor Stream	CUTM1171	Phyto-Pharmacology	4	2+1+1

Credits to be completed from Basket II ≥ 24 for 3 years exit and 32 for 4 years exit.

Basket- III

Sl. No.	Course Type	Course Code	Course Title	Credit	Type (T+P+Pj)
1	Multidisciplinary	CUTM1005	Probability & Statistics	3	2+0+1
2	Multidisciplinary	CUTM1400	Bio and Biomimetic Nanomaterials	4	3+0+1
3	Multidisciplinary	CUTM1008	Applied Analytical Chemistry	3	2+1+0

Credits to be completed from Basket III ≥ 09 for 3 years and 4 years exit.

Basket- IV

Sl. No.	Course Type	Course Code	Course Title	Credit	Type (T+P+Pj)
1	Ability Enhancement Courses (AEC)	CUTM1021	Design Thinking	2	0+0+2
2	Ability Enhancement Courses (AEC)	CUTM1016	Job Readiness	6	0+6+0
3	Skill Enhancement Courses (SEC)	CUTMXXXX	Skill I	4	0+3+1
4	Skill Enhancement Courses (SEC)	CUTMXXXX	Skill II	4	0+2+2
5	Skill Enhancement Courses (SEC)	CUTMXXXX	Skill III	4	0+2+2
6	Value Added Courses (VAC)	CUTM1013	Project Management	3	2+0+1
7	Value Added Courses (VAC)	CUTM1014	Gender, Human Rights and Ethics	3	2+0+1
8	Value Added Courses (VAC)	CUTM1015	Climate Change, Sustainability and Organisation	3	2+0+1

For AEC, Credits to be completed ≥ 08 for 3 years and 4 years exit.
For SEC, Credits to be completed ≥ 09 for 3 years and 4 years exit.
For VAC, Credits to be completed ≥ 06 for 3 years and 4 years exit.

Basket- V

Sl. No.	Course Type	Course Code	Course Title	Credit	Type (T+P+Pj)
1	Summer Internship	CUTM1578	Summer Internship I	2	0+0+2
2	Summer Internship	CUTM1579	Summer Internship II	2	0+0+2
3	Project	CUTM1849	Project	12	0+0+12

For Internships, Credits to be completed ≥ 02-04 for 3 years and 4 years exit.
For Research Project / Dissertation, Credits to be completed ≥ 12 4 years exit. Not applicable for 3rd year exit.

Semester-wise course distribution

Semester I

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM4115	Cell Biology	4	3+1+0
CUTM4116	Molecular Biology	4	3+1+0
CUTM4117	Microbial Biotechnology	4	3+1+0
CUTM1400	Bio and Biomimetic Nanomaterials	4	3+0+1
CUTM1015	Climate Change, Sustainability and Organisation	3	2+0+1
CUTM1016	Job Readiness	6	0+6+0

Semester II

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM4121	Bioanalytical Techniques	4	3+1+0
CUTM4119	Biochemistry	4	3+1+0
CUTM1562	Concepts of Genetics	4	2+1+1
CUTM1430	Developmental Biology and Phytotomy	4	3+1+0
CUTM1014	Gender, Human Rights and Ethics	3	2+0+1
CUTM1013	Project Management	3	2+0+1

Semester III

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM1127	Immunology	4	3+1+0
CUTM1428	Plant Physiology and Metabolism	4	3+1+0
CUTM1005	Probability & Statistics	3	2+0+1
CUTMXXXX	Skill I	4	0+2+2
CUTM1008	Applied Analytical Chemistry	3	2+1+0
CUTM1021	Design Thinking	2	0+0+2

Semester IV

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM1674	Environmental Science	4	3+0+1
CUTMXXXX	Domain Subject I	3	1+2+0
CUTMXXXX	Domain Subject II	3	1+2+0
CUTMXXXX	Domain Subject III	3	1+2+0
CUTMXXXX	Skill II	4	0+2+2
CUTM1578	Summer Internship I	2	0+0+2

Semester V

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM1569	IPR, Biosafety and Bioentrepreneurship	4	2+0+2
CUTM1565	Biostatistics and Bioinformatics	4	2+2+0
CUTMXXXX	Domain Subject IV	3	0+3+0
CUTMXXXX	Domain Subject V	3	0+3+0
CUTMXXXX	Domain Subject VI	3	0+3+0
CUTMXXXX	Skill III	4	0+2+2

Semester VI

Course Code	Course Title	Credit	Type (T+P+Pj)
MPC203T	Computer Aided Drug Designing	4	4+0+0
CUTM4120	Animal Biotechnology	4	2+1+1
CUTM1439	Plant Biotechnology	4	3+1+0
CUTMXXXX	Domain Project	11	0+0+11
CUTM1579	Summer Internship II	2	0+0+2

Semester VII

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM4353	Metabolic Engineering	4	3+1+0
CUTM4351	Genetic Engineering	4	3+1+0
CUTM4350	Fermentation Biotechnology	4	3+1+0
CUTM4355	Cancer Biology	4	3+1+0
CUTMXXXX	Elective I	4/3	
CUTMXXXX	Skill IV	4	0+2+2

Semester VIII

Course Code	Course Title	Credit	Type (T+P+Pj)
CUTM1567	Frontiers in Genomics	4	3+1+0
CUTM1849	Project	12	0+0+12
CUTM1579	Summer Internship II	2	0+0+2

Core Courses

Cell Biology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4115	Cell Biology	4	3-1-0	Nil

Course Objectives

- To study structure and functions of cell organelles.
- Exposure on transportations through cell membrane.
- To introduce the concept of cell signaling.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To memorize the features of prokaryote and eukaryote cells, cell organelles, the composition and spatial organization of the cell.	PO1 (3), PO2 (3), PO3 (2), PO8 (3), PSO1 (2), PSO2 (2) PSO3 (3)
CO2	To identify the molecular mechanisms regulating and controlling cell division and the cell cycle.	PO1 (3), PO2 (1), PO3 (2), PO4 (1), PSO1 (3) PSO3 (2)
CO3	To compare and relate the different principles related to extracellular signals, signal amplification, transmission, and termination.	PO1 (3), PO2 (2), PO3 (2), PO4 (1) PSO1 (3) PSO3 (2)
CO4	To outline the ways in which cell biology throws light on cell junctions, signaling, programmed cell death.	PO1 (3), PO2 (1), PO3 (1), PO4 (1), PO9 (1), PO10 (1), PO11 (1) PSO1 (1), PSO3 (2)
CO5	To predict the development of cancer and summarize different types of onco genes.	PO1 (3), PO2 (2), PO3 (3), PO4 (3), PO6 (2), PO8 (1), PSO1 (1), PSO2 (3), PSO (2)

Course Contents

Module I

An Overview of Cells: History, Cell theory, Structure and Function of Cell and its Organelles: Biological membranes – architecture, Cell types: prokaryotes vs. eukaryotes; from single cell to multi-cellular organism; Different molecules of cell- water, salt and mineral ions etc.

Module II

Nucleus - Nuclear envelope, transport across nuclear membrane, Nucleolus, Mitochondria, Chloroplasts, Lysosomes, Gloxysomes and Peroxisomes**,** endoplasmic reticulum, ribosomes, Golgi complex (Structural organization, function, marker enzymes of the above organelles.

Module III

Cell cycle and its regulation, Cellular communication and cell mobility: Cell cycle: G0/G1, S, G2 and M phages (Cell Division: Mitosis, meiosis and cytokinesis); regulation of cell cycle.

Module IV

Cell adhesion and roles of different adhesion molecules, gap junctions, Extra- Cellular Matrix (ECM), Cell-cell interaction and cell- ECM interaction, The cytoskeleton, Microtubule- based movement and microfilament -based movement.

Module V

Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors (G-PCR), Tyrosine Kinase, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, bacterial chemotaxis, Programmed Cell Death (Apoptosis), Intrinsic and Extrinsic apoptotic pathway, Caspase enzyme; Biology and elementary knowledge of development and causes of cancer; Tumor viruses, Oncogenes and tumor suppressor genes.

Practice

1. Demonstration of the technique of microscopy.
2. Study of the electron micrographs of bacterial cell.
3. Study of the different fungal cells.
4. Study of different stages of mitosis using plant root tips.
5. Study of the structure of cell organelles through electron micrographs.
6. Identification and study of cancer cells by photomicrographs.

Text Books

1. Geoffrey M.Cooper, The Cell: A molecular approach, Sixth edition.
2. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA

Reference Books

1. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley- Blackwell.
2. Benjamin Lewin, Gene IX, 9thEdition, Jones and Barlett Publishers.
3. Becker's World of the Cell. 8th edition. Pearson, Hardin J, Bertoni G and Kleinsmith L. J. (2010).
4. Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc. Karp G. (2010).
5. Cell and Molecular Biology. 8th edition. Lipincott, Williams and Wilkins, Philadelphia. De Robertis, EDP and De Robertis EMF. (2006).

Molecular Biology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4116	Molecular Biology	4	3-1-0	Nil

Course Objectives

- To provide depth knowledge of biological or medicinal processes through the investigation of the underlying molecular mechanisms.
- Understanding of chemical and molecular processes that occur in and between cells.
- Understanding of gene expression and protein functions.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To learn the molecular structure of cell, cell cycle and transport system.	PO1 (3), PO3 (1), PO4 (1), PO5 (1), PO12 (1), PSO1 (2), PSO2 (2) PSO3 (3)
CO2	To discuss molecular nature of genetic material and evolution of DNA and RNA, gene and genetic codes.	PO1 (3), PO2 (1), PO3 (2), PO4 (2), PO5 (1), PO12 (1), PSO1 (2), PSO3 (3)
CO3	To compare and relate the regulation of gene expression, DNA replication and post-replication modification of DNA.	PO1 (3), PO2 (1), PO3 (2), PO4 (2), PO5 (1), PSO1 (3), PSO3 (2)
CO4	To outline the process of protein biosynthesis.	PO1 (3), PO3 (1), PO5 (1), PO12 (1), PSO1 (2)
CO5	To examine DNA amplification by PCR technique and quantitative analysis of protein via project mode.	PO1 (3), PO2 (2), PO3 (3), PO4 (3), PO5 (3), PO8 (3), PO9 (3), PO10 (2), PO11 (3) PSO2 (2) PSO3 (3)

Course content

Module I

Introduction to molecular biology, Evolution and Molecular structure of cell and its organelles. Types of cells. Including different kinds of prokaryotic and eukaryotic cells. Cell growth, Cell adhesion, cell junctions and extra cellular matrix organelles, Cell cycle, Cell membrane and its structure (fluid-mosaic model). Factors influencing on membrane fluidity, asymmetry of membrane and membrane transport (active and passive)

Module II

Molecular Nature of the Genetic Material in Prokaryotic and Eukaryotic Cells: Molecular biology of Genes, DNA: Molecular structure, types: Primary, secondary and tertiary, Double

helix, types, Transferring information from DNA to RNA, Synthesis of RNA, Translation RNA: Molecular structure, types. Evolution of DNA and RNA, Gene and genetic codes

Module III

General Concept on Regulation of the Gene Expression, Regulating the Metabolism: The Lac-Operon system, Catabolic repression, Trp Operon system: regulating the biosynthesis of the tryptophan, Gene expression in Eukaryotic cells, Plasmids: types, maintenance and functions. DNA Replication and Gene Expression: DNA Replication: Semi conservative Nature of DNA Replication, DNA Replication in prokaryotic Cells, DNA Replication in Eukaryotic cell, Enzymes involved in DNA Replication: DNA polymerases, Proofreading, post-replication Modification of DNA.

Module IV

Transferring information from DNA to RNA, Synthesis of RNA(Transcription), RNA polymerase, Initiation and Termination of Transcription, Post and co- transcription modification of the RNA**.**

Module V

Protein Biosynthesis**:** Translation of the genetic code, Translation of m RNA, Role of r-RNA in protein synthesis, Forming the polypeptides- elongation, Termination of the protein biosynthesis.

Practice

1. Isolation of genomic DNA from plant/animal tissue.
2. Quantification of isolated DNA via electrophoresis method.
3. Quantification of isolated DNA via spectrophotometry method.
4. DNA amplification by PCR technique.
5. Analysis of PCR amplification via agarose gel electrophoresis.

Text Books

1. Molecular Biology of the gene (7th Ed) by James D. Watson.
   E-booklink-https://www.pdfdrive.com/molecular-biology-of-the-gene-e158278674.html
2. Genes XII by Lewin's.
   E-book link- https://www.pdfdrive.com/lewins-genes-xii-e168024578.html
3. Molecular cell biology (5th Ed) by Lodish H.
   E-booklink-https://www.pdfdrive.com/molecular-cell-biology-lodish-5th-ed-e15674865.html

Reference Books

1. Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008).
2. The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009).

Microbial Biotechnology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4117	Microbial Biotechnology	4	3-1-0	Cell biology

Objectives

- To impart knowledge on the basic concept of cell organization in microorganisms.
- To study in detail the growth, genetic organization of microorganisms and impact of environment on their growth.
- To highlight the roles and characteristics of microorganisms in field of Biotechnology.

Course outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To learn classification, characteristics, growth conditions and cultural characteristics of different microorganisms.	PO1 (3), PO2 (2), PO3 (1), PO4 (2), PO5 (3), PO10 (1), PSO1 (2), PSO2 (1) PSO3 (1)
CO2	To discuss on the importance of different microorganisms for environment and their Genome organization.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5 (3), PO6 (1), PO7 (3), PO8 (1), PO9 (2), PO10 (1), PSO1 (3), PSO2 (1) PSO3 (3)
CO3	To apply the knowledge on classification of microbes using genome mapping and microbial metabolism.	PO1 (3), PO2 (2), PO3 (1), PO4 (2), PO5 (2), PSO1 (2), PSO3 (3)
CO4	To design experiments on isolation and identification of different microorganisms and their growth kinetics.	PO1 (1), PO2 (2), PO3 (3), PO4 (3), PO5 (2), PSO1 (3), PSO2 (2), PSO3 (3)
CO5	To summarize the roles and application of different microbes in Biotechnology.	PO1 (3),PO2 (2),PO5 (1), PO6 (3), PO7 (1), PO8 (2) PSO1 (2), PSO3 (3)

Course contents

Module I

Microbial World; Microscope and its types, Phase contrast microscope, Electron microscope, SEM, TEM, STEM; Microscopic examination of microorganisms: Gram and acid-fast staining, negative-staining.

Module II

Classification and Identification of microorganisms; Bacteria, morphology and fine structure of bacteria, cultivation of bacteria, reproduction & growth, pure cultures and cultural characteristics - nutritional types in bacteria; Culture media types; Phases of growth.

Module III

General characteristics-Morphology and structure of Virus, Classification- isolation and identification-fatal diseases associated with viruses in animals. Algae, Fungi, molds and Protozoa – importance, characteristics, morphology, reproduction, physiology cultivation & their association with other organisms. Genome organization of bacteria, virus, algae and fungi.

Module IV

DNA and RNA present as genetic material in microbes. Types and division of microbes according to their genetic organization. Classification of microbes according to genotyping. Enzymes and their regulation, Microbial metabolism energy production (EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: components of respiratory chain, anaerobic respiration with special reference to dissimilatory nitrate reduction), utilization of energy & biosynthesis (Peptidoglycan), Bacterial Genetics.

Module V

Application of microbes in fuel industry; agriculture, aquatic microbiology; Study of domestic water and waste water.

Practice

1. Study of the principle and applications of important instruments (Autoclave, incubator, Colony counter, digital balance, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
2. Preparation of culture media and sterilization of medium using autoclave and assessment for sterility.
3. Sterilization of glassware using Hot Air Oven and assessment for sterility.
4. Demonstration of the presence of microbes by exposing nutrient agar plates to air.
5. Isolation of fungus.
6. Isolation of bacteria.
7. Bacterial and fungal staining techniques.

Text Books

1. R.K. Sahoo: Introduction to Microbiology, Year 2020, Kindle publication, Amazon, 1st Edition.
2. B. Ray, A. Bhunia: Fundamental food microbiology, CRC press, 5th Edition.
3. Microbiology: An Introduction. 9th edition. Pearson Education. Tortora GJ, Funke BR and Case CL. (2008).

Reference Books

1. Brock Biology of Microorganisms.14th edition. Pearson International Edition. Madigan MT, Martinko J.M, Dunlap P.V and Clark D.P. (2014).
2. Prescott's Microbiology. 9th Edition. McGraw Hill International.

Biochemistry

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4119	Biochemistry	4	3-1-0	Cell Biology

Course Objectives

- To understand the fundamental principles and concepts of plant biochemistry.
- To understand the structure and function of biological macromolecules such as proteins, carbohydrates, lipids, and nucleic acids.
- To understand the enzyme kinetics and role of enzymes in metabolic processes.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge on carbohydrates, their classifications and biomedical importance.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5(2), PSO1 (3), PSO2 (1) PSO3 (2)
CO2	Discuss the basic concepts of amino acids, proteins, and their metabolisms.	PO1 (3), PO2 (3), PO3 (3), PO5 (3), PO9 (2), PO10 (2), PO11 (2), PSO1 (3)
CO3	Illustrate the chemistry, structure, and metabolisms of lipids.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO9 (2), PO10 (2), PO11 (2), PSO1 (1), PSO2 (3) PSO3 (2)
CO4	Analyze the structure, mechanism, and diagnostic values of enzymes.	PO1 (3), PO2 (2), PO3 (2), PO5 (3), PO6 (1), PSO1 (3), PSO2 (1) PSO3 (2)
CO5	Estimate the carbohydrate metabolisms and their role in regulating cell respiration and blood glucose levels.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO8 (2), PO9 (2), PO10 (2), PO11 (2), PSO1 (3), PSO3 (3)

COURSE CONTENT

Module I

Biomedical importance & properties of Carbohydrates, Classification, Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Haworth projection formulae for glucose; chair and boat forms of glucose.

Module II

Overview of proteins and protein structures, Classification, essential & non-essential amino acids. Chemistry of Proteins & their related metabolism, Classification, biomedical importance. Metabolism: Ammonia formation & transport, Transamination, Decarboxylation, Urea cycle, metabolic disorders in urea cycle, catabolism of amino acids.

Module III

Classification, biomedical importance, essential lipids. Brief outline of metabolism: Beta oxidation of fatty acids, Ketogenesis, Cholesterol & it's clinical significance, Lipoproteins in the blood composition & their functions in brief.

Module IV

Apoenzyme and cofactors, prosthetic group, coenzymes, metal cofactors, Classification of enzymes. Active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Enzyme inhibition, enzyme kinetics.

Module V

Glycogenesis & glycogenolysis, Glycolysis, citric acid cycle & its significance, Components of respiratory chain, energy relationships during cell respiration, types of respiration. HMP shunt & Gluconeogenesis, regulation of blood glucose level, Diabetes mellitus: its types, features, hypoglycaemia & its causes.

Practice

1. Preparation of solution, pH & buffers.
2. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars.
3. Quantitative tests for carbohydrates.
4. Qualitative/Quantitative tests for proteins.

Reference Books

1. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.

2. Biochemistry by U. Satyanarayana.

Immunology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTMXXXX	Immunology	4	3-1-0	Cell Biology

Course Objective

- To provide students with a detailed understanding of the structure, components, and functions of the immune system, including innate and adaptive immunity, and their roles in maintaining health and combating diseases.
- To equip students with knowledge of immunological processes such as antigen recognition, immune cell activation, and signaling pathways, along with an understanding of immunological disorders and immune evasion strategies by pathogens.
- To develop the ability to apply immunological principles in designing vaccines, diagnostics, and immunotherapies, with an emphasis on addressing real-world challenges in medicine and biotechnology.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To recognize and learn the theoretical understanding of the classification of immunological processes and types of antigens.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PSO1 (3), PSO2 (1) PSO3 (2)
CO2	To identify the difference between innate and adaptive immunity and understand the antigen-antibody interactions.	PO1(3), PO11(1), PSO1(2), PSO2(1), PSO3(2), PSO1 (3), PSO3 (2)
CO3	To interpret different types of research-based knowledge, contextual experiments and concept on production of antibodies, cell-mediated immune responses, and hypersensitivity reactions.	PO1(2), PO4 (3), PSO1(2), PSO3(2), PSO1 (3), PSO3 (3)
CO4	To examine the types of hypersensitivity reactions.	PO1(3), PSO1(2), PSO3(2), PSO1 (3), PSO2 (2) PSO3 (3)
CO5	To design different types of vaccines and their production.	PO1(3), PSO1(2), PSO3(2), PSO1 (3), PSO2 (3) PSO3 (3)

Course Contents

Module I
Immunity: Classification, Measurement of immunity, Local immunity, Herd immunity.

Module II
Antigens: Types of antigens, Antigenic Determinant or Epitope, Tolerogens, Biological Classes of antigens, Superantigens. Immunoglobulins: Antibody structure, Immunoglobulin classes, Antigenic Determinants on Immunoglobulins.

Module III

Principal pathways of Complement activation, Quantitation of Complement (C) and its Components. Biosynthesis of complement, Complement Deficiencies. Antigen-Antibody Reactions, Antigen-Antibody measurement. Serological Reactions and their parameters.

Module IV

Immune Response: Types of Immune response, Humoral immunity, Production of Antibodies, Cell-mediated Immune Responses, Hypersensitivity Reactions and its Classification.

Module V

Cytokines, Immunological tolerance, Vaccines, Types and their production

Practice

1. Blood grouping
2. Preparation of O and H antigen
3. Quantitative VIDAL test
4. ASO, C-Reactive Protein
5. Rheumatoid factor (RF)
6. ELISA- qualitative
7. Agglutination
8. Precipitation
9. Neutralization and flocculation

Text Books

1. N. Arumugam, Dulsy Fatima, Immunology, Saras Publication, First Edition

2. Sunil Kumar Mohanty, Textbook Of Immunology, Jaypee Brothers Medical Publishers 2nd Edition

Reference Books:

1. Kuby Immunology by Richard A. Golds by Tharmas J. kindt Sixth edition Barbara Osborne. W.H.freeman and company.
2. Fundamental Immunology 7th Edition by Paul, Wolters Kluwer | Lippincott Williams and Wilkins.

Bioanalytical Techniques

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4121	Bioanalytical Techniques	4	3-1-0	Biochemistry

Course Objectives

- To understand the principle and concepts of biological instruments.
- To emphasize on the application of instrumentation.
- To quantify and identify biological compounds using biological instruments.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To demonstrate a comprehensive understanding of the principles and theories behind key bioanalytical techniques.	PO1(2), PO2 (3), PO3 (2), PO6 (1), PO8 (2), PSO1(2), PSO3(2)
CO2	To understand the principles and applications of various spectroscopy techniques such as UV-Vis, IR, NMR, and Mass Spectrometry.	PO1(3), PO2(2), PO4(2), PO5 (1), PO6 (2), PO12 (2) PSO1(2), PSO3(2)
CO3	To perform and interpret data from spectroscopic analyses and explain the principles of different chromatography techniques including HPLC, GC, and TLC.	PO1(2), PO2(3), PO5(2), PO8 (1), PO11 (1), PO12 (3), PSO1(2), PSO3(2)
CO4	To apply the knowledge of chromatographic methods for the separation and analysis of biomolecules.	PO1(3), PO2(2), PO4(1), PO5 (2), PO7 (2), PO9 (1), PO12 (2) PSO1(2), PSO3(2)
CO5	To analyse and develop skills in the quantitative and qualitative analysis of bioanalytical data.	PO1(3), PO2 (2), PO4 (2), PO9 (1), PO11 (2), PO12 (2), PSO1(2), PSO3(2)

Course Contents

Module I

Introduction to microscope, Principles, optics, Types of microscope, Bright field, Dark field, Phase contrast, Fluorescence microscopes, SEM, TEM, and Application

Module II

Introduction to absorption an elimination spectroscopy-UV and visible and absorption method, fluorescence and phosphorescence spectrophotometry, Infrared spectrometers.

Module III

Theory of NMR-environmental effects on NMR spectra-chemical shift-NMR spectrometers, applications of 1H and 13C NMR, Molecular mass spectra, Ion sources. Applications of molecular mass-electron paramagnetic resonance-g values-instrumentation

Module IV

General description of chromatography, Band broadening and optimization of column performance, Adsorption chromatography, Partition Chromatography, Liquid chromatography, Paper chromatography, GC chromatography, Ion exchange chromatography, Affinity chromatography, Size exclusion chromatography, HPLC

Module V

Principle, Procedure, components of centrifugation, Preparative and Analytical centrifuge, Types of centrifugations, and application of centrifugation, principle, procedure and application of gel electrophoresis (Native PAGE, SDS-PAGE, 2D-GE)

Practice

1. Study of Microscope
2. Electrophoresis of macromolecules
3. Centrifugation of blood-blood separation
4. UV and visible spectrophotometry
5. Chromatography of leaf pigments

Text books

1. Keith Wilson and John walker, "Practical Biochemistry Principles and Techniques",8th Edition,2018.

2. Lehninger A.L., Nelson D.L. and M.M. Principles of Biochemistry.CBS publishers and distributers.

Reference Books

1. Kamaraj.P & Arthanareeswari.M, Applied Chemistry,2nd Edition, Sudhandhira Publication,2003.

2. Pranab Kumar Banerjee. "Introduction to Biophysics" S chand and company Publication,2008

3. Friefelder, David. "Molecular Biology".Narosa Publications, 2004.

Fermentation Biotechnology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4350	Fermentation Biotechnology	4	**3-1-0**	Biochemistry

Objectives

- To study the design and construction of fermenter.
- To study the cell growth and product formation.
- To evaluate the kinetics and mechanism of microbial growth.

Course outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To recognize and learn the fermentation technology, its types and the associated kinetics.	PO1 (3), PO2 (3), PO3 (2), PO4 (1), PO5 (1), PO8 (1), PSO1 (2), PSO2 (2) PSO3 (3)
CO2	To identify the bioreactor configurations and measurement of different parameters.	PO1 (3), PO2 (2), PO3 (3), PO4 (1), PO5 (3), PO9 (1), PO10 (1), PO 11 (2), PO12 (1), PSO1 (2), PSO3 (3)
CO3	To interpret different types of fermentation process and its application in biotechnology.	PO1 (3), PO3 (3), PO4 (1), PO5 (2), PO11 (1), PO12 (1), PSO1 (2), PSO3 (1)
CO4	To examine preparation of different fermented products.	PO1 (2), PO2 (3), PO3 (3),PO4 (3), PO5 (3), PO6 (2), PO7 (1), PO8 (2), PO9 (2), PO10 (1), PO11 (2), PO12 (1), PSO1 (2)
CO5	To design different fermentation processes by using microorganisms for development of industrial products.	PO1 (2), PO2 (2), PO3 (3), PO4 (2), PO5 (2), PSO1 (2), PSO2 (2) PSO3 (3)

Course contents

Module I

Introduction to fermentation; History and development of fermentation industry; General requirements of fermentation processes; Crude and synthetic media: molasses, corn-steep liquor, sulphite waste liquor, whey; Isolation, preservation and improvement of industrially important micro- organisms.

Module II

Development of inoculum for industrial fermentations; Kinetics of microbial growth and death; Air and media sterilization; An overview of aerobic and anaerobic fermentation processes and their application in the biotechnology industry; Types of fermentation processes – batch and continuous fermentations, solid-substrate, submerged fermentation and its applications.

Module III

Fermentor; Basic design and construction of fermentor and ancillaries; Fermentation parameters - pH, temperature, foaming and aeration; Measurement and control of bioprocess parameters Bioreactor configuration - batch, continuous stirred-tank, tubular, plug flow, packed bed, air lift, fluidized bed, photobioreactors.

Module IV

Processes involving microbial flocs; Bioreactors containing microbial films; Basic concept of scale-up of bioreactors. Residence time distribution, Concentration distribution and Temperature distribution; Downstream processing - cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.

Module V

Microbial production: Citric acid, glutamic acid, ethanol, penicillin, Vaccine, Vitamin B12, Enzymes (amylase, protease), steroid; Enzyme immobilization: Definition, Methods of immobilization, advantages and applications of immobilization.

Practice

1. Study of different parts of fermenter by photograph/field visit to an industry.
2. Antibiotic Assay - Antimicrobial Sensitivity Test (Disc Diffusion Method).
3. Growth Kinetics Study (Bacterial Growth Curve).
4. Microbial activity study on (qualitative) analysis of: Enzymes: Amylase.
5. Microbial activity study on (qualitative) analysis of: Enzymes: Protease.
6. Microbial activity study on (qualitative) analysis of: Amino acid: Tryptophan utilization.
7. Microbial activity study on (qualitative) analysis of: Substrate: Citrate test (carbon).
8. A visit to any educational institute/industry to see industrial fermenter and other downstream processing operations (Assignment).

Text Books

1. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication
2. Industrial Fermentations- Leland, N. Y. Chemical Publishers.

Reference Books

1. Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA. Okafor N. (2007).
2. Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001).
3. Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company Glaze A.N. and Nikaido H. (1995).

Genetic Engineering

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4351	Genetic Engineering	4	**3-1-0**	Molecular biology

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 outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To learn the concepts of vectors, gene cloning, and gene manipulation.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5(2), PSO1 (3), PSO2 (1) PSO3 (2)
CO2	To describe the different methods of DNA sequencing and their applications.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO9 (2), PO10 (2), PO11 (2), PSO1 (2), PSO3 (2)
CO3	To apply the concepts of PCR, primer designing, PCR-based genotyping and their applications in biotechnology.	PO1 (3), PO2 (3), PO3 (3), PO5 (3), PO9 (2), PO10 (2), PO11 (2), PSO1 (2), PSO2 (3) PSO3 (3)
CO4	To analyze the concepts of gene expression, expression estimation, and recombinant proteins.	PO1 (3), PO2 (2), PO3 (2), PO5 (3), PO6 (1), PSO1 (2), PSO3 (1)
CO5	To design the methods of gene manipulations and gene cloning towards gene silencing and product generation.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO8 (2), PO9 (2), PO10 (2), PO11 (2), PSO1 (2), PSO3 (3)

Course content

Module I

Purification and Separation of Nucleic Acids, Restriction Endonucleases- types, function, and applications, DNA modifying enzymes, Linkers and adaptors, Overview of Cloning- cutting and joining of DNA and vector, Recombinant DNA

Module II

Vectors- Plasmid vectors, phage vectors, cosmids, Construction of genomic library- cDNA library Characteristics of cloning and expression vectors, Vectors for yeast, plant, and mammalian systems, Prokaryotic and eukaryotic expression host systems.

Module III

PCR technology – concept, types, and applications (DNA-finger printing, Genotyping, Marker-assisted selection, Marker development, etc.), Overview of DNA sequencing, Maxam-Gilbert-Sanger methods, Automated DNA sequencing, and Next Generation Sequencing

Module IV

Analysis of gene expression, Real-time PCR, SYBR green assay, Taqman assay, Molecular beacons, Analysis of gene function, Site Directed Mutagenesis, Transposon Mutagenesis, Strategies for the production of recombinant proteins - insulin- human growth hormone-industrially important proteins.

Module V

RNA interference technology, Small double stranded RNAs; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing. Application of genetic engineering – vaccines – human and genetic diseases – transgenics.

Practice

1. Restriction enzyme digestion of Genomic DNA/ Lambda DNA
2. Isolation of gene of interest/DNA fragment by PCR/Gel elution method.
3. Ligation of DNA with cloning vector.
4. Competent cells preparation and transformation into *E.coli*.
5. Screening of positive and negative transformants by blue-white screening.
6. Confirmation of positive transformants by colony PCR.

Text Books

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL,

Reference Books

1. Brown T. A. Gene Cloning, Blackwell Science Publishers.
2. Ernst L and Winnacker. Genes to Clones, Panima Publishing House, New Delhi.

Cancer Biology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4355	Cancer Biology	4	3-1-0	Cell Biology

Course Objectives

- To impart basic concepts of cancer biology, various stages in carcinogenesis, molecular cell biology of cancer, cancer metastasis, and cancer therapy.
- Understanding about the biological aspects of cancer.
- Awareness about the therapeutic aspects of cancer.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To understand the difference between normal cell and cancer cell, its principle. Role of cell cycle in cancer. cell culture techniques. knowledge of cancer culture media, cell stock preservation techniques. Relation between diet and cancer.	PO1 (3) , PO2 (2), PO3 (1), PO4 (1), PO5 (3), PSO1 (3), PSO2 (1) PSO3 (2)
CO2	To identify the molecular event of cell cycle, aspect of cancer metabolism, epigenetics, DNA repair pathways.	PO1 (1) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1 (3)
CO3	To interpret the processes of cancer metastasis, dysregulation factors, the role of oncogenes and growth factors.	PO1 (2) , PO2 (2), PO3 (1), PO4 (3), PO5 (3), PSO1 (3), PSO3 (3)
CO4	To examine the significance of carcinogenesis in the development of cancer. Role of tumor microenvironment, angiogenesis in cancer	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (2), PSO1 (2), PSO2 (1) PSO3 (1)
CO5	To apply the concept of the types of cancer treatment, properties of chemotherapeutic drugs, cancer prevention technologies and early detection.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (3), PSO1 (3)

Course Contents

Module I

Introduction to Cancer --Cell cycle—pRb--Tumor suppressor genes--Knudson's two-hit hypothesis--p53--Myconcoprotein--TGF-b --Cell cycle and cancer-- Different forms of cancer--- Diet and Cancer.

Module II

Stages of Carcinogenesis-Environment, Genetics, and Cancer—Causes of cancer—Classes and Types of Carcinogens—Ecogenetics and Cancer risk— Carcinogen Metabolism—Epigenetics-- DNA, and Human Cancer.

Module III

Signal Transduction-Growth factor signaling-EGF signaling-Oncogenes—Wnt signaling--Immune system in cancer—B cell, T cell, and Cytokine signaling— Neuroendcrine system in cancer-Hormone and Neurotransmitter signaling— Apoptosis—Cancer stem cells

Module IV

Tumor microenvironment in cancer progression—Invasion and Metastasis-Stages in metastasis and the factors involved in the invasive process—Angiogenesis- VEGF signalling

Module V

Current modalities of treatment-Radiation therapy-Surgery-Chemotherapy- Classification of properties of chemotherapeutic drugs—Biological therapy-Cancer prevention and early detection, Imaging and cancer (PET, CT).

Practice

1. Tumor cell isolation using MACS
2. Tumor cell growth in different media.
3. Tumor cell growth with different proteins
4. Tumor cell regression using plan extract.
5. Morphological analysis of different cancer cell lines.

Text Books

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

Reference Books

1. Lauren Pecorino, “Molecular Biology of cancer: Mechanisms, Targets, and Therapeutics,” Oxford University Press. 3rd edition, 2012.

Animal Biotechnology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4120	Animal Biotechnology	4	3-1-0	Cell Biology

Course Objectives

- To provide the fundamentals of animal cell culture, details of disease and therapy.
- To know the difference between 2D and 3D animal cell culture.
- Acquire the knowledge of gene therapy in biomedical applications.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To understand the various techniques required for culturing the animal cell, its characterization, and authentication.	PO1 (1) , PO2 (3), PO3 (3), PO4 (3), PO5 (3), PSO1 (3), PSO2 (1) PSO3 (2)
CO2	To identify contaminations in cell culture and appraise the importance of animal cell culture techniques in the development of drug, cell and gene therapy.	PO1 (2) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1 (3), PSO3 (1)
CO3	To make use of the concept about molecular techniques and tools in animal conservation	PO1 (3) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1 (3), PSO3 (1)
CO4	To examine different methods used to deliver and manipulate genes in desired cells. Knowledge about 2D and 3D culture.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (3), PSO1 (2), PSO2 (3)
CO5	To apply the principle of gene targeting methods used in the generation of animal models for biomedical research.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (1), PSO1 (2), PSO2 (2)

Course Contents

Module I

Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures; suspension cultures, continuous flow cultures, immobilized cultures. Somatic cell fusion; cell cultures as a source of valuable products.

Module II

Information about organs; culture techniques and preservations. Mammalian cell culture in 2D and 3D. 3D culture platforms (scaffolds, scaffold-free spheroids, gels, bioreactors, and microchips) and 3D printing techniques (particulate leaching, electro-spinning, etc. are used to prepare various 3D platforms.

Module III

Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis;

molecular diagnostic techniques like PCR, in-situ hybridization; northern and southern blotting; RFLP. Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; vaccines and their application in animal infections; gene therapy for animal diseases.

Module IV

Introduction to stem cell culture, definition, properties, proliferation, culture of stem cells. Types of stem cells, embryonic stem cell, adult stem cell, stem cell biology and therapy. Potential benefits of stem cell technology, medical applications of stem cells, ethical and legal issues in use of stem cells

Module V

What is micromanipulation technology; equipment's used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulation; invitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals. Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals

Practice:

1. Animal handling and care.
2. Drug-induced diabetic study.
3. Liver function test (Alanine transaminase (ALT), Aspartate aminotransferase (AST), Alkaline phosphatase (ALP), Gamma-glutamyltransferase (GGT), Bilirubin, Albumin) between the control and diseased animal.
4. Gel electrophoresis.
5. PCR

Text Books

1. Animal biotechnology by P.Ramadas
2. Embryonic stem cells by Kursad and Turksen. 2002. Humana Press.
3. Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour, Laboratory Press
4. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer

Reference Books

1. Louis-Marie Houdebine, Transgenic animals: Generation and Use 7th Edition, CRC Press.
2. Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003,
3. Human Embryonic Stem Cells: The Practical Handbook by Stephen Sullivan and Chad A Cowan.

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

Developmental Biology and Phytotomy

Subject Name	Code	Type of course	T-P-Pr (Credit)
Developmental Biology and Phytotomy	CUTM1430	Theory+ practice	3-1-0 (04)

Course objectives

- The student will be able to know the relationship between the internal structure, function, taxonomy, physiology, ecology and developmental genetics of the organism.
- Evolutionary history and taxonomic variation of vascular plant anatomy
- They will understand the morphology and development of reproductive parts

Course outcome

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

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand and remember the internal structure, tissues involved in developmental stages of plants.	PO1 (3), PO2 (2), PO4 (2), PO5 (3), PO6 (1), PO7 (3), PSO 1 (3), PSO 2 (2), PSO 3 (1)
CO2	Identify the secondary growth, gametophyte development, molecular mechanisms of fruit and seed development.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5 (3), PO6 (1), PO7 (3), PO8 (1), PO9 (2), PO10 (1), PSO 1 (3), PSO 2 (2)
CO3	Interpret different plants by studying the anatomical features and make use of the knowledge for studying the deviations	PO1 (3), PO2 (2), PO3 (1), PO4 (2), PO5 (2), PSO 1 (3), PSO 2 (3)
CO4	Analyze the gametogenesis and pollen-pistil interaction mechanisms.	PO1 (1), PO2 (2), PO3 (3), PO4 (3), PO5 (2), PSO 1 (2), PSO 2 (2)
CO5	Examine the pollen viability and differential behaviour of sperms.	PO1 (3),PO2 (2),PO5 (1), PO6 (3), PO7 (1), PO8 (2), PSO 1 (3), PSO 2 (2)

Module I

Importance in plant development, taxonomy and identification, ecology and pharmacognosy, Simple tissues, complex tissues and their function; Secondary xylem, secondary phloem in angiosperms and gymnosperms (conifers), structure and functions; Meristematic tissue: Structure, classification, distribution and function

Module II

Secondary growth in stem and root; Anomalous secondary growth in dicot and monocot

stems; Cambial types: Vascular cambium and phellegen, structure and functions, cambial activity in grafting and wound healing

Module III

Macro and micro structure and composition, chemical composition and properties of wood, bark and bark products**,** Apo tracheal and para tracheal parenchyma; Hard wood anatomy, organization of wood, sap wood, heard wood; Axial Parenchyma fibers and ray parenchyma and their value in wood identification'; Nodal anatomy.

Module IV

Shoot systems and its derivatives, Theories of organization of meristem in stem, Root systems and its derivatives, Theories of organization of meristem in root, Quiescent center, Coordination of shoot and root development; Root-shoot transition, Ontogeny and phylogeny of vessels, Ontogeny of dorsiventral leaf, arrangement of leaves (Phyllotaxy)

Module V

Meristem tissue in Flower Development, Genetic Control of Flower Development, Anther wall, endothelium, middle layer, tapetum, tapetum-Structure, types and function, Pollen tetrad development and Pollen wall proteins, Pollen viability and Storage, Male gametophyte development, Differential behavior of sperms.

Module VI

Female gametophyte development, Organization of the embryo sac and different types of it. Pollination-pollination mechanism, biotic and abiotic pollination and floral attractants, the stigma-Types and structure, stigmatic exudates, style transmitting tissue, canal cell. Stigma receptivity (recognition and rejection reaction) pollen adhesion, pollen hydration, pollen germination and pollen tube growth and guide, sexual incompatibility (both homorphic and hetermorphic), Double fertilization and In vitro fertilization.

Module VII

Anther culture, Intra-ovarian pollination, Gynogenesis, Types of endosperms, ruminate endosperm, Embryo development in dicot and monocot, polyembryony; apomixes, agamospermy and parthenocarpy, Development and diversity of fruit dispersal.

Practical

1. Study of anatomical details through permanent slides preparation
2. T.S of plants showing secondary growth
3. T.S of plants showing anomalous secondary growth
4. T.S of anthers of angiospermic plants
5. Pollen Viability
6. T.S of ovary of flower showing placentation

Text Books:

1. Pandey S N, Ajanta Chadha (2009) Plant Anatomy and Embryology, Vikas Publishing House

2. Raghavan, V. (1999). Developmental Biology of Flowering Plants. Springer-Verlag, New York

3. Bhojwani, S. S., Bhatnagar, S. P. and Dantu, P.K. (2014). The Embryology of Angiosperms.

Vikas Publishing House, New Delhi.

Reference Books:

1. Eames. A.J. and Macdaniels, L.H,1947, An Introduction to Plant Anatomy, McGrow- Hill, N.Y and London.

2. Easu, K,2017 Esaus Plant Anatomy: Meristems Cells and Tissues Of The Plant Body Their Structure Function And Development, 3Rd Edn by Evert R.F., Wiley India.

3. Richard Crang , Sheila Lyons-Sobaski , Robert Wise,2018, Plant Anatomy, A Concept-Based Approach to the Structure of Seed Plants,Springer, 978-3-319-77208-0

Plant Physiology and Metabolism

Subject Name	Code	Type of course	T-P-Pr (Credit)
Plant Physiology and Metabolism	CUTM1428	Theory+ practice	3-1-0 (04)

Course objectives

- To understand the structure and function of light harvesting complexes and the mechanisms of electron transport system
- To understand the uptake, transport, and translocation of water, ions, solutes, and macromolecules.
- To analyse sensory photobiology, including the structure, function, and mechanisms of action of phytochromes, cryptochromes, and phototropins and to explore glycolysis, fermentation, and the TCA cycle, along with their regulation.

Course outcome

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

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Recollect the concept and mechanisms of photosynthesis and photophosphorylation	PO1 (3), PO2 (2)
CO2	Understand the mechanisms of water and mechanisms of loading and unloading of photo assimilates, Sensory photobiology and stress physiology	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5 (3), PO8 (1), PO9 (2), PO10 (1)
CO3	Apply the knowledge on the mechanisms of cellular respiration, oxidative phosphorylation and lipid metabolism in plant.	PO1 (3), PO2 (2), PO3 (1), PO4 (2), PO5 (2), PO6 (1), PO7 (3)
CO4	Analyse the concepts of hormone receptors, signal transduction, and gene expression in plant responses, sensory photobiology of plants, roles of photo-pigments in various physiological processes	PO1 (1), PO2 (2), PO3 (3), PO4 (3), PO5 (2)
CO5	Interpret the oxidative stress, reactive oxygen species (ROS) and the role of antioxidant enzymes in different stress condition in plant	PO1 (3),PO2 (2),PO5 (1), PO6 (3), PO7 (1), PO8 (2)

Module I

Photosynthesis - Light harvesting complexes; Red drop and Emerson's enhancement effect. Photolysis of water, photophosphorylation, mechanisms of electron transport; Hill Reaction, photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways. Chlororespiration: The relation between Photosynthesis, respiration and Chlororespiration. Regulation of C3 pathway.

Module II

Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photo assimilates.

Module III

Plant growth regulator & Elicitors: Physiological effect & mechanism of action of Auxin, Gibberellin, Cytokinin, Ethylene, Abscisic acid, Jasmonic acid, Salicylic acid, Brassinosteroid, Strigolactones, hormone receptor, Signal transduction & Gene expression. Programmed cell death.Sensory photobiology

- Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.

Module IV

Stress Physiology: Plant responses to biotic and abiotic stress, mechanisms of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress. Metabolism: reactive oxygen species (ROS), antioxidant enzymes: catalase, peroxidases, superoxide dismutase, glutathione transferase, glutathione reductase, Halliwell–Asada cycle.

Module V

Cellular Respiration: Glycolysis, Fermentation, TCA cycle and their regulation. Pentose phosphate path ways, alternate oxidase. Shuttle system: Malate - Aspartate shuttle and Glycerol phosphate shuttle. Factor affecting respiration.Gluconeogenesis and its regulation.

Module VI

Oxidative phosphorylation: Mitochondrial electron transport, Chemiosmotic mechanism, ATP-Synthesis: Mechanism of ATP synthesis, Substrate level phosphorylation, oxidative phosphorylation, ATP synthase, Boyers conformational model, Racker’s experiment, role of uncouplers. Inhibitors of oxidative phosphorylation.

Module VII

Lipid metabolism: Fatty acid biosynthesis, synthesis of membrane lipids, storage lipids and their catabolism. α and β-oxidation of fatty acid. Glyoxalatecyle. Nitrogen fixation & Metabolism: Biological Nitrogen fixation, asymbiotic and symbiotic Nitrogen fixation, nodule formation, Nod and Nif genes their regulation and function, mechanism of nitrate uptake and reduction, ammonium transport and assimilation.

Practical

1. Isolation of chloroplast and measurement of electron transport activity
2. Comparative study of photosynthetic pigment in C3 and C4 plant, grown in light and shade condition
3. Extraction of pigments from leaves and preparation of absorption spectra for chlorophyll and carotenoids
4. To compare chlorophyll content in juvenile and matured leaves
5. Estimation of relative leaf water contents in stress and control plant condition
6. Accumulation of proline content comparison in stress and control plant condition

Text Books:

1. Satyanarayana, U. and Chakrapani, U. (2013), Biochemistry, Elsevier
2. Buchanan, Gruissem and Russell (2015). Biochemistry and molecular biology of plants, Willy blackwell

Reference Books:

1. Taiz, L., Zeiger, E., Mller, I.M. and Murphy, A (2018), Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

Metabolic Engineering

Subject Name	Code	T-P-Pr (Credit)	Prerequisite
Metabolic Engineering	CUTM4353	3-1-0 (04)	Bioanalytical techniques

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 (High-3, Medium-2, Low-1)
CO1	Comprehend and explain basic cellular uptake and metabolism of amino acids, nucleotides.	PO1(2), PO3 (3), PO5 (2), PO10(2), PSO1(2), PSO3(2),
CO2	Identify the metabolic flux by using quantification tools and models associated with metabolic flux.	PO1(3), PO2(2), PO3 (1) PO4(2), PO12(1), PSO1(2), PSO3(2)
CO3	Explain the role of enzymes at the level of production and their kinetic regulation.	PO1(2), PO2(3), PO3(1), PO5(2), PO7(1), PSO1(2), PSO3(2)
CO4	Analyze different phyto-constituents using different instruments.	PO1(3), PO2(2), PO5(2), PO8 (2), PSO1(2), PSO3(2), PO11(1)
CO5	Apply 'Omics' technologies in the metabolic engineering area and describe it's role	PO1(3), PO3 (3), PO9 (2), PO10 (1) PSO1(2), PSO3(2)

Module I

Overview of metabolism, Basic concepts of metabolic engineering, Cellular metabolism, Transport processes-Active and passive transports, Biosynthetic and degradation pathways of amino acids, nucleotides, fats. Metabolic flux, Methods for metabolic flux analysis, Application of metabolic flux analysis, Amino acid production by bacteria.

Module II

Metabolic flux analysis for glutamic acid and lysine biosynthetic networks, Fluxes in mammalian cell cultures, Flux analysis and design of culture media. Regulation of metabolic pathways, Regulation of enzymatic activities.

Module III

Enzyme kinetics, Reversible and irreversible inhibitions, Regulatory enzymes, Allosteric enzymes, Cooperativity, Control of enzyme production at transcription, and translation levels, Regulation of metabolic networks.

Module IV

Metabolic control analysis, Control coefficient and elasticity, Functional genomics, proteomics, metabolomics, systems biology.

Module V

Application of metabolic engineering, Enhancement of product yield, Alteration of nitrogen metabolism, Production of antibiotics, vitamins, polyketides etc., Bioconversions.

References Books

1. G. N. Stephanopoulos, A. A. Aristidou, and J. Nielson, Metabolic Engineering: Principles and Methodologies, 1st Edn., Academic Press, 1998.

2. N. V. Torres and E. O. Voit, Pathway Analysis and Optimization in Metabolic Engineering, 1 st Edn., Cambridge University Press, 2002.

3. B. Kholodenko, Metabolic Engineering in the Post Genomic Era, New edition Edn., Taylor & Francis, 2004.

4. S. Cortassa, M.A. Aon, A.A. Iglesias, and D. Lloyd, An Introduction to Metabolic and Cellular Engineering, 1st Edn., World Scientific Pub. Co., 2002.

Computer Aided Drug Design

Code	Course Title	Credit	T-P-PJ	Prerequisite
MPC203T	Computer Aided Drug Design	4	3-1-0	Biochemistry

Course Objectives

- To provide students with an in-depth understanding of the principles, methodologies, and applications of computer-aided drug design, including structure- and ligand-based approaches.
- To equip students with practical skills in using computational tools and software for molecular modeling, virtual screening, and pharmacokinetic property predictions in drug discovery.
- To enable students to apply computational techniques in the design and optimization of novel therapeutic molecules, considering target specificity, efficacy, and safety.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand the basics of bioinformatics, chemo-informatics and how useful for drug designing and discovery process.	PO1 (3) , PO2 (2), PO3 (1), PO4 (1), PO5 (3), PSO1 (3), PSO2 (2), PSO3 (1)
CO2	Acquire the knowledge about protein structure prediction methods, structure visualizations and their importance.	PO1 (1) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1 (3), PSO2 (3)
CO3	Understand the principle, types and various applications of computer aided drug designing and discovery process.	PO1 (2) , PO2 (2), PO3 (1), PO4 (3), PO5 (3), PSO1 (1), PSO2 (2), PSO3 (1)
CO4	Explore the concept and SAR, QSAR and their importance in ligand optimization.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (2), PSO1 (3), PSO2 (2), PSO3 (3)
CO5	Overall understanding the concept and applications for computer aided drug designing and discovery process.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (3), PSO1 (3), PSO2 (2)

Course Contents

Module I

Introduction to Computer Aided Drug Design (CADD) History, different technique sand applications Quantitative Structure Activity Relationships: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, pi- substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters

Module II

Quantitative Structure Activity Relationships: Applications Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages; Deriving 2D-QSAR equations 3D-QSARapproaches and contour map analysis**,** Statistical methods used in QSAR analysis and importance of statistical parameters

Module III

Molecular Modeling and Docking, Molecular and Quantum Mechanics in drug design, Energy Minimization Methods: comparison between global minimum conformation and bioactive conformation, Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AchE & BchE)

Module IV

Molecular Properties and Drug Design, Prediction and analysis of ADMET properties of new molecules and its importance in drug design. De novo drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. Homology modeling and generation of 3D-structure of protein

Module V

Pharmacophore Mapping and Virtual Screening Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore modeling; Conformational search used in pharmacophore mapping. In Silico Drug Design and Virtual Screening Techniques Similarity based methods and Pharmacophore based screening, structure based In-silico virtual screening protocols

Reference Books

1. Computational and structural approaches to drug discovery, Robert M StroudandJanet.F Moore,RCS Publishers.
2. Introduction to Quantitative Drug Design by Y.C. Martin, CRC Press, Taylor&Francisgroup..
3. Drug Design by Ariens Volume 1 to 10,Academic Press, 1975, Elsevier Publishers.
4. Principles of Drug Design by Smith andWilliams, CRC Press, Taylor & Francis.
5. The Organic Chemistry of the Drug Design and Drug action by Richard B. Silverman, Elsevier Publishers.
6. Medicinal Chemistry by Burger, Wiley Publishing Co
7. An Introduction to Medicinal Chemistry –Graham L. Patrick, Oxford University Press.
8. Wilson and Gisvold's Text book of Organic Medicinal andPharmaceutical Chemistry, Ippincott Williams & Wilkins.
9. Comprehensive Medicinal Chemistry – Corwin and Hansch, Pergamon Publishers.

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 (3) , PO2 (2), PO3 (1), PO4 (1), PO5 (3), PSO1 (3), PSO2 (2), PSO3 (1)
CO2	Understand ethical aspects related to biomedical and health care and biotechnology research.	PO1 (1) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1 (3), PSO2 (3)
CO3	Make use of the entrepreneurial skill and the schemes promoted through knowledge centers and various agencies.	PO1 (2) , PO2 (2), PO3 (1), PO4 (3), PO5 (3), PSO1 (1), PSO2 (2), PSO3 (1)
CO4	Discover the scope for entrepreneurship in biosciences.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (2), PSO1 (3), PSO2 (2), PSO3 (3)
CO5	Evaluate the various operations involved in venture creation.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (3), PSO1 (3), PSO2 (2)

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.

Environmental Science

Subject Name	Code	T-P-Pr (Credit)	Prerequisite
Environmental Science	CUTM1674	3-0-1 (04)	Nil

Course objectives

- To understand the relationship among human being, natural resource and environment on the historical perspectives.
- To orient students towards the principles of sustainable development goals and train them for conserving Biodiversity and maintaining ecosystem balance.
- To analyze environmental issues and problems critically, and develop strategic environmental management policies and practices.

Course outcome

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

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Explain the historical perspectives of human, natural resource and environment interactions.	PO1(2), PO3 (3), PO5 (2), PO10(2), PSO1(2), PSO3(2),
CO2	Identify, classify, and prospect the natural resources integrated with Sustainable Development Goals.	PO1(3), PO2(2), PO3 (1) PO4(2), PO12(1), PSO1(2), PSO3(2)
CO3	Demonstrate their environmental management competency to combat pollution, waste generation and climate change.	PO1(2), PO2(3), PO3(1), PO5(2), PO7(1), PSO1(2), PSO3(2)
CO4	Analyze issues and concerns of Biodiversity conservation and Ecosystem services at local, regional and global scales.	PO1(3), PO2(2), PO5(2), PO8 (2), PSO1(2), PSO3(2), PO11(1)
CO5	Conduct independent project works and address current environmental challenges complying with Environmental agreements, treaties, acts and laws.	PO1(3), PO3 (3), PO9 (2), PO10 (1) PSO1(2), PSO3(2)

Module I

Introduction to Human and the Environment: Overview of human-environment interactions throughout history; Importance of mastery of fire, the origin of agriculture, and the emergence of city-states; Discussion on the impact of ancient civilisations on the environment. Emergence of Environmentalism: Anthropocentric and eco-centric perspectives; Study of significant thinkers and their contributions to environmental philosophy; Environmental movements, Analysis of critical events such as the UN Conference on Human Environment 1972.

Module II

Understanding Natural Resources: Definition and classification of natural resources; Renewable and Non-renewable, Biotic and abiotic resources, Forest, Grasslands, Wildlife, Water, Mineral, Food, Land, Energy; Introduction to sustainable development: Sustainable Development Goals (SDGs), targets and indicators; Discussion on challenges and strategies for achieving sustainability. World commission on Environment and Development.

Module III

Levels and types of Biodiversity, Biodiversity in India and the world, Biodiversity Hotspots, Land Use and Loss of Biodiversity: deforestation, urbanisation, desertification; trends in biodiversity loss; Case studies on the impact of human activities on biodiversity hotspots. Conservation of Biodiversity and Ecosystems: Understanding biodiversity and its distribution; Discussion on major ecosystem types: forests, grasslands, agriculture, coastal and marine and their characteristics; Ecosystem services: Classification and significance; Exploration of threats to biodiversity and ecosystems; in-situ and ex-situ conservation, protected areas, traditional knowledge, sacred groves, community based conservation.

Module IV

Pollution and its impact; Overview of pollution: air, water, soil, noise, solid waste, hazardous waste; Discussion on transboundary pollution and its consequences; Understanding environmental issues at micro, meso, synoptic, and planetary scales; Case studies highlighting the adverse effects of pollution on human health and ecosystems. Addressing Environmental Pollution and Health: Strategies for pollution control and management; Examination of air, water, soil, and noise pollution and their health impacts; Introduction to waste management practices and their significance. Introduction to environmental management systems such as ISO 14001 and the role of organizations like UNEP and IPCC in global environmental governance; Case studies on the implementation of environmental policies and regulations in different contexts.

Module V

Introduction to environmental laws and regulation: Constitutional provisions - Article 48A, Article 51A(g) and other derived environmental rights; Introduction to environmental legislations on the forest, wildlife and pollution control: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; Noise Pollution (Regulation and Control) Rules, 2000; National Green Tribunal; Climate Change policies, Greenhouse gas emissions and their impact on global climate; Climate change mitigation measures and practices: UNFCCC, Concept of NET ZERO. Environmental Treaties: Major international environmental agreements, conventions and their significance: CBD, CITES, UNCCD, Analysis of India's status and commitments under these agreements.

Suggested readings

- Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.
- Sinha, N. (2020) Wild and Wilful. Harper Collins, India.
- Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK.
- Kanchi Kohli and Manju Menon (2021). Development of Environment Laws in India, Cambridge University Press.

- Ministry of Environment, Forest and Climate Change (2019). A Handbook on International Environment Conventions & Programmes. https://moef.gov.in/wpcontent/uploads/2020/02/ convention-V-16-CURVE-web.pdf
- Headrick, Daniel R. (2020). Humans versus Nature- A Global Environmental History, Oxford University Press.
- Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future.10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson.
- Harper, Charles L. (2017). Environment and Society, Human Perspectives on Environmental Issues 6th Edition. Routledge.
- Jackson, A. R., & Jackson, J. M. (2000). Environmental Science: The Natural Environment and Human Impact. Pearson Education.
- Pittock, Barrie (2009) Climate Change: The Science, Impacts and Solutions. 2nd Edition.Routledge.

Concepts of Genetics

Subject Name	Code	Type of course	T-P-Pr (Credit)
Concepts of Genetics	CUTM1562	Theory+ practice	2-1-1 (04)

Objective

- To describe and identify the purposes of the cell cycle, meiosis and mitosis, and to predict their outcomes.
- To understand the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored.
- To apply the principles of extensions to Mendelian inheritance, including multiple allelism, lethal alleles, gene interactions, and sex-linked transmission.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Recall and describe the fundamental principles of genetics, including Mendelian laws, chromosomal inheritance, and genetic terminology.	PO1 (3), PO3 (1), PO4 (1), PO5 (1), PO12 (1), PSO1 (2), PSO2 (2) PSO3 (3)
CO2	Explain the molecular mechanisms of gene expression, regulation, and genetic variation in prokaryotes and eukaryotes.	PO1 (3), PO2 (1), PO3 (2), PO4 (2), PO5 (1), PO12 (1), PSO1 (2), PSO3 (3)
CO3	Apply genetic principles to solve problems related to inheritance patterns, pedigree analysis, and population genetics.	PO1 (3), PO2 (1), PO3 (2), PO4 (2), PO5 (1), PSO1 (3), PSO3 (2)
CO4	Analyze the impact of mutations, recombination, and chromosomal aberrations on genetic traits and organismal health.	PO1 (3), PO3 (1), PO5 (1), PO12 (1), PSO1 (2)
CO5	Evaluate the ethical implications and applications of genetic technologies, such as gene therapy and genetic testing.	PO1 (3), PO2 (2), PO3 (3), PO4 (3), PO5 (3), PO8 (3), PO9 (3), PO10 (2), PO11 (3) PSO2 (2) PSO3 (3)

Course content

Module I

Mendel's Laws, concept of dominance, segregation, independent assortment; Chromosome theory of inheritance.

Module II

Concept of alleles, types of dominance, lethal alleles, multiple alleles, gene interaction-Epistasis, polygenic inheritance, inheritance of cytoplasmic, mitochondrial and chloroplast genes.

Module III

Linkage, crossing over with linked genes; recombination frequency, coupling and repulsion hypothesis; gene mapping with recombination frequencies; constructing genetic maps with three point test cross, Sex-linked inheritance, Sex determination in plants

Module IV: Gene & chromosome variations

Gene mutations, Chromosomal mutations including Polyploidy, aneuploidy and rearrangements. Meiotic consequences in structural heterozygotes, role in speciation and evolution.

Practice

- Experiments on monohybrid, dihybrid, test cross and backcross.
- Experiments on epistatic interactions including test cross and backcross.
- Karyotyping using photographs.
- Demonstration of linkage vs independent assortment using photographs.
- Determination of recombination frequencies using three points cross.
- Sex determination in plants.
-

Projects

- Demonstration of mutation using chemical mutagens.
- Study of polyploidy using colchicine treatment.
-

Suggest Readings

1. Concepts of Genetics Klug W. S. and Cummings M. R Prentice-Hall
2. Genetics-a Conceptual Approach Pierce B. A. Freeman
3. Genetics- Analysis of Genes and Genomes Hartle D. L. and Jones E. W. Jones & Bartlett
4. Principles of Genetics Snustad D. P. and Simmons M. J. John Wiley & Sons.
5. Genetics Strickberger M. W. Prentice-Hall

Biostatistics and Bioinformatics

Subject Name	Code	Type of course	T-P-P (Credit)
Biostatistics and Bioinformatics	CUTM1565	Theory+Project	2-0-2 (04)

Objective

- To equip students with the knowledge and skills to apply biostatistical methods such as hypothesis testing, regression analysis, and probability theory to analyze biological data effectively.
- To train students in using bioinformatics software, databases, and computational techniques to analyze biological sequences, protein structures, and genomic data.
- To enable students to integrate statistical and bioinformatics methods to solve real - world biological problems, such as identifying biomarkers, analyzing gene expression, and understanding molecular interactions.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Recall and describe fundamental concepts of biostatistics and bioinformatics, including statistical methods, biological databases, and computational tools.	PO1(2), PO2 (3), PO3 (2), PO6 (1), PO8 (2), PSO1(2), PSO3(2)
CO2	Explain the applications of statistical techniques in analyzing biological data and the role of bioinformatics in genomics, proteomics, and systems biology.	PO1(3), PO2(2), PO4(2), PO5 (1), PO6 (2), PO12 (2) PSO1(2), PSO3(2)
CO3	Use statistical software and bioinformatics tools to analyze biological datasets, including gene sequences, protein structures, and expression profiles.	PO1(2), PO2(3), PO5(2), PO8 (1), PO11 (1), PO12 (3), PSO1(2), PSO3(2)
CO4	Analyze experimental and computational data to derive meaningful biological interpretations and identify patterns or anomalies.	PO1(3), PO2(2), PO4(1), PO5 (2), PO7 (2), PO9 (1), PO12 (2) PSO1(2), PSO3(2)
CO5	Evaluate the quality and reliability of statistical models and bioinformatics predictions in the context of real-world biological problems.	PO1(3), PO2 (2), PO4 (2), PO9 (1), PO11 (2), PO12 (2), PSO1(2), PSO3(2)

Course Contents

Module I

Sampling methods, concept of Parametric and non-parametric statistics, Measures of central tendency: Mean, Mode & Median, Measures of dispersion: Mean deviations, coefficient of variance (CV), Standard deviations, skewness and kurtosis. Test of hypothesis; Student t-test and paired t-test; chi square test; Probability distribution (normal, binominal and poison

distributions), Simple Correlation and Regression, Analysis of variance: one way and two-way classification

Module II

Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification of databases, Data access, retrieval and submission, limitations of existing databases

Module III

Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model, Heuristic approach: BLAST, FASTA.

Module IV

Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, GWAS, ENCODE, HUGO projects; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies, visualization tools such as PyMol

Practice

- Sampling and collection of data (Primary and Secondary).
- Calculate the Mean Median Mode, Standard deviation from the supplied data set.
- Representation and Visualization of the collected data (Table Graph, Heat map).
- Calculation of Paired and Unpaired t Test from the supplied data set.
- Test the goodness of fit.
- Demonstration of biological databases: NCBI, EMBL, Swissprot/TrEMBL, UniProt.
- Data retrieval using Entrez and SRS.
- Pairwise Sequence Alignment using BLAST.
- Aligning Multiple Sequences with CLUSTAL W.
- Identification of gene characteristics using ExPaSy tools.
- Demonstration of gene organization using GSDS tool.
- Functional annotation to genes using DeepGO tool.

BOOKS

1. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

2. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press

3. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.

4. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.

Frontiers in Genomics

Subject Name	Code	Type of course	T-P-Pr (Credit)
Frontiers in Genomics	CUTM1567	Theory+ practice	3-1-0 (04)

Objective

- To provide students with an in-depth understanding of the latest advancements in genomics, including next-generation sequencing and high-throughput genomic analysis techniques.
- To equip students with the skills to analyze and interpret genomic data using bioinformatics tools and software, with applications in personalized medicine, agriculture, and evolutionary studies.
- To expose students to cutting-edge topics in genomics such as epigenomics, metagenomics, and functional genomics, highlighting their relevance in modern biological research and their potential for innovation.

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 key concepts and terminologies in genomics, including genome structure, sequencing technologies, and functional genomics.	PO1 (1) , PO2 (3), PO3 (3), PO4 (3), PO5 (3), PSO1 (3)
CO2	Explain the principles and applications of next-generation sequencing, genome editing tools, and comparative genomics in understanding genetic diversity and evolution.	PO1 (2) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1(2), PSO2(3)
CO3	Use bioinformatics tools to analyze genomic data, interpret genome annotations, and identify genes associated with traits and diseases.	PO1 (3) , PO2 (2), PO3 (2), PO4 (3), PO5 (3), PSO1(2), PSO3(2)
CO4	Analyze advancements in genomics, such as epigenomics, metagenomics, and transcriptomics, to explore their implications for personalized medicine and biotechnology.	PO1 (3) , PO2 (3), PO3 (1), PO4 (2), PO5 (3), PO8 (2)
CO5	Design research strategies integrating genomic technologies to address specific biological questions or challenges in healthcare, agriculture, or environmental sustainability.	PO1 (3) , PO2 (3), PO3 (2), PO4 (2), PO5 (1), PSO3(3)

Module I

Introduction to genomics, Brief overview of prokaryotic and eukaryotic genome organization, Extra-chromosomal DNA: bacterial plasmids, Mitochondrial and chloroplast genomes.

Module II

Molecular Mapping of Genome: Genetic mapping- linkage analysis, Choice of mapping populations, markers for genetic mapping; methods and techniques used for genetic mapping; Physical mapping- tools for physical mapping of genes, cytogenetic maps, FISH, radiation hybrid maps, high resolution physical mapping.

Module III

Chemical (Maxim and Gilbert's degradation method) and enzymatic (Sanger's dideoxy synthetic method) methods of DNA sequencing; Genome sequencing strategies- Whole genome, clone-by-clone and hybrid approaches.

Module IV

Next generation sequencing technologies- 454, Illumina, ABI SOliD, single molecule and nanopore sequencing.

Module V

Whole Genome Assembly and challenges, Gene prediction, Functional annotation, Web based servers for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome.

Module VI

Human Genome Sequencing Project, Genome sequencing projects for microbes (including yeast), Genome sequencing projects for plants (Rice, Arabidopsis).

Module VII

Whole genome comparison; Tandem and segmental duplication; DNA based phylogenetic trees; Identification and classification of organisms using 16S rRNA typing/sequencing.

Practice

- Demonstration of genetic mapping.
- Demonstration of web tools for genome analysis.
- Demonstration of genome browsers- ENSEMBL, VISTA and UCSC Genome Browser.
- Demonstration of genome assembly & alignment using Splign.
- Phylogenetic analysis using genomic tools.
- Genome comparison using MOAV tool.

References

1. Azuaje F & Dopazo J. 2005. Data Analysis and Visualization in Genomics and Proteomics. John Wiley & Sons, US

2. Baxevanis. A. D. and Ouellette. B. F. F. (Eds). 2001. Bioinformatics: A Practical guide to the analysis of genes and proteins. Wiley Interscience. New York. 470p.

3. Genomics and Proteomics. Functional and computational aspects. Ed. Sandor Suhai, Heidelberg, Germany.

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 (High-3, Medium-2, Low-1)
CO1	To discover basic concepts and theories of the subject.	PO1 (3), PO5 (3), PO12 (2), PSO1 (3), PSO3 (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 (3), PSO2 (1) PSO3 (2)
CO3	To demonstrate the potential of nanobiotechnology in consumer and biomedical applications.	PO1 (1), PO3 (2), PO4 (1), PO9 (3), PSO1 (3), PSO2 (3) PSO3 (3)
CO4	To evaluate journal papers on nanoscience/nanotechnology.	PO2 (1), PO3 (3), PO4 (2), PO5 (1), PO7 (2), PSO1 (3)
CO5	To formulate strategies for risk assessment of nanostructures/ particles in various applications.	PO1 (1), PO3 (1),PO4 (1), PO5 (3), PO12 (3), PSO1 (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.

Phyto-pharmacology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1171	Phyto-pharmacology	3	2-1-0	Biochemistry

Course Objectives

- To provide students with a deep understanding of the pharmacological actions, therapeutic potential, and mechanisms of action of bioactive compounds derived from plants.
- To equip students with knowledge of how plant-based bioactive molecules are identified, isolated, and evaluated for their efficacy in the development of novel pharmaceutical products.
- To enable students to evaluate the safety, toxicity, and regulatory aspects of plant-derived drugs, emphasizing the importance of quality control and standardization in phytopharmaceutical applications.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Recall the fundamental principles of phytopharmacology, including the classification of medicinal plants, their bioactive compounds, and their pharmacological properties.	PO1 (3), PO5 (3), PO12 (2), PSO1 (3), PSO3 (2)
CO2	Explain the mechanisms of action, therapeutic uses, and potential side effects of plant-derived compounds in treating various diseases.	PO1 (3), PO7 (2), PO6 (2), PSO1 (3), PSO2 (1) PSO3 (2)
CO3	Apply knowledge of phytochemicals to identify suitable plant-based therapies for specific diseases and conditions, using appropriate extraction and formulation methods.	PO1 (1), PO3 (2), PO4 (1), PO9 (3), PSO1 (3), PSO2 (3) PSO3 (3)
CO4	Analyze the pharmacokinetic and pharmacodynamic properties of phytochemicals, assessing their absorption, metabolism, and distribution in the human body.	PO2 (1), PO3 (3), PO4 (2), PO5 (1), PO7 (2), PSO1 (3)
CO5	Evaluate the safety, efficacy, and toxicity of plant-derived drugs, integrating experimental data and regulatory guidelines for their potential use in the pharmaceutical industry.	PO1 (1), PO3 (1),PO4 (1), PO5 (3), PO12 (3), PSO1 (3)

Course Contents

Module I

Introduction, Definition & scope of Pharmacology and Principles of general Pharmacology, Route of Drug Administration, Brief Knowledge of following - CNS depressants, Sedatives, Antiepileptic.

Module II

Different classes of drugs and their pharmacology, Brief Knowledge of following - Antipyretics, Analgesics, Antihypertensive, Anticoagulant, Haemopoetic.

Module III

Different classes of drugs and their pharmacology II, Brief Knowledge of following - Bronchodialators, Expectorants, Digestants, Antacids, Laxatives.

Module IV

Pharmacology of different classes of drugs and posology, Brief Knowledge of following - Diuretic, Antidiabetic, steroids, Contraceptives, Antibiotics, Aoushadha Suvan kala, Anupana- its importance, Posology.

Practice

- Introduction to experimental pharmacology.
- Study of common laboratory animals.
- Common laboratory techniques. Blood withdrawal, serum and plasma separation, anesthetics and euthanasia used for animal studies.
- Study of different routes of drugs administration in mice/rats.
- Study of effect of hepatic-microsomal enzyme inducers on the phenobarbitone sleeping time in mice.
- Effects of skeletal muscle relaxants using rota-rod apparatus.
- Anticonvulsant effect of drugs by MES and PTZ method.
- Study of stereotype and anti-catatonic activity of drugs on rats/mice.
- Study of local anaesthetics by different methods.

Recommended Books

- Harvey, R. A., Clark, M., Finkel, R., Rey, J., & Whalen, K. (2012). Lippincott's illustrated reviews: Pharmacology. Philadelphia.
- Katzung, B. G. (2012). Basic and clinical pharmacology. Mc Graw Hill.
- Dale, M. M., & Haylett, D. G. (2013). Rang & Dale's Pharmacology Flash Cards Updated Edition E-Book. Elsevier Health Sciences.
- Tripathy, K. D. (2018). Essentials of Medical Pharmacology. 8th ed. New Delhi: Jaypee Brothers.

Medical Microbiology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4332	Medical Microbiology	3	2-1-0	Microbiology

Course Objectives

- To understand the etiological agents responsible for global infectious diseases and explore the biology of bacteria, viruses, and other pathogens associated with infectious diseases in humans.
- To develop diagnostic skills in microbiology, focusing on the practical application of laboratory tests.
- To interpret laboratory findings for the accurate diagnosis and management of infectious diseases.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand different antibiotics from the viewpoint of targets and resistance mechanisms.	PO1 (3), PO5 (3), PO12 (2), PSO1 (3), PSO3 (2)
CO2	Demonstrate the significance of medically important microbes.	PO1 (3), PO7 (2), PO6 (2), PSO1 (3), PSO2 (1) PSO3 (2)
CO3	Analyse the important microbial pathogens, their pathogenesis, diagnosis and prevention.	PO1 (1), PO3 (2), PO4 (1), PO9 (3), PSO1 (3), PSO2 (3) PSO3 (3)
CO4	Evaluate different microbial detection techniques.	PO2 (1), PO3 (3), PO4 (2), PO5 (1), PO7 (2), PSO1 (3)
CO5	Integrate techniques to identify and differentiate between bacteria, viruses, and fungi causing human diseases.	PO1 (1), PO3 (1),PO4 (1), PO5 (3), PO12 (3), PSO1 (3)

Course Contents

Module I

Medical Bacteriology- Anatomy and structure of prokaryotes (Detail structure of Gram positive and Gram negative bacteria, Peptidoglycan synthesis etc). Classification of bacteria based on both cell wall and shape. Nutritional requirement of bacteria, Culture media and its types.

Module II

Biochemical test (IMViC, Catalase, Coagulase etc). Sterilization technique, different staining procedures (AFB, Flagella and Endospore staining etc). Preservation of stock cultures of bacteria.

Module III

Pathogenesis and laboratory diagnosis of medically important Gram Positive and Gram Negative bacteria, Clinical significance of human pathogenic bacteria and their identification.

Module IV

Medical Virology -: Morphology, general properties of viruses, detection of viruses and antigens in clinical specimens, Laboratory and Serological diagnosis of virus infections. Viral vaccines preparation and their immunization schedules. Viruses of importance to bacteria, bacteriophages, their structure, types, typing and their application in bacterial genetics.

Module V

Medical Mycology -: Morphology, general characteristic, taxonomy, classification of fungi, detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. Trichophyton. Epidermophyton and Microsporum. Yeasts of medical importance, Candida, Cryptococcus, detail information with lab diagnosis of human pathogenic Fungus.

Practice

- Preparation of media, and cultivation of bacteria.
- Biochemical tests for identification, Preparation of bacterial smear and staining – Gram's, Acid-fast, Staining of bacterial spore flagella, capsule.
- Isolation, Characterization, and identification of pathogens from various clinical specimens. Study of antibiotic sensitivity of common pathogens.
- Serological diagnosis of viral infections and demonstration of various inoculation routes in fertilized hen egg (Egg Inoculation Method).
- Preparation of culture media used routinely in mycology, staining technique for identification of fungi, isolation, and identification of fungi from clinical specimens.

Recommended Books

- Medical Laboratory Technology by Kanai Lal Mukherjee, Publish Tata McGrawHill.
- An Introduction to Medical Laboratory Technology by FJ Baker; Butterworth.
- Practical Book of Medical Microbiology by Satish Gupta, Publisher JPBrothers.
- Medical Laboratory Manual for Tropical Countries Vol. I and II by Monica Chees brough.
- Textbook of Medical Laboratory Technology by Praful BGodkar.
- Biology of Microorganism by Brock 14th Ed.