Syllabus Book

for

4 Years Undergraduate Programme

B.Tech. 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 Educational Objectives (PEOs)

PEO-01	To design and optimize biotechnology processes using modern tools and methodologies to tackle real-world industry problems.
PEO-02	To pursue entrepreneurial initiatives or higher studies, while adapting to evolving biotechnology, through continuous professional growth.
PEO-03	To promote professional ethics and sustainable biotechnology solutions for societal and environmental benefits.

Programme Specific Outcomes (PSOs)

PSO-1	Graduates will develop hands-on skills related to Biotechnology fields.
PSO-2	Graduates will have competency to develop product using Software like BIOVIA, Biopython, and R for product design, simulation, and analysis.
PSO-3	Graduates will able to qualify NET, GATE and other PSU examinations.

Programme Outcomes (POs)

PO-01	Engineering knowledge: Apply knowledge of mathematics, science, engineering fundamentals, and Biotechnology engineering to the solution of engineering problems
PO-02	Problem analysis: Identify, formulate, review literature and analyse Biotechnology Engineering problems to design, conduct experiments, analyse data and interpret data
PO-03	Design /development of solutions: Design solution for Biotechnology Engineering 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 Engineering
PO-05	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to Biotechnology Engineering activities with an understanding of the limitations
PO-06	The engineer 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 Engineering 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 Engineering 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 Engineering

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 Engineering
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 Engineering
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 Engineering

Academic Regulations for 4 Years Undergraduate Programme
School of Biotechnology
Centurion University of Technology and Management
2024

1. Introduction

This Programme provides flexibility to students to choose a single discipline or a combination of disciplines/ streams as an academic career path. The Programme envisages a competency-based, multi-disciplinary, holistic academic programme with a creative combination of disciplines/ skills/ Domain/ Research of study with multiple entry and exit options.

The curriculum emphasizes a flexible combination of a wide range of courses with a focus on analytical and critical thinking, computational skills, use of cutting-edge technology, innovation, creativity, experiential learning including the development of a competency-based skilling ecosystem and holistic development of students leading to specific career prospects.

The university follows a dynamic curriculum development approach. Hence, it reserves the rights to revise / modify the syllabus, structure, credits etc. as deemed fit.

2. Objective

- To provide basic knowledge and laboratory skills of the subjects.
- To create and apply appropriate techniques, resources, and modern instruments for biochemical estimation, animal tissue culture and plant tissue culture experiments, environment insults measurements, genetics, bioinformatics, cellular, molecular and physiological activities of all living organisms with an understanding of the application and limitations.
- To introduce with the area of research as per the recent outbreaks or demand in the society.
- To train and enhance skills using biological principles and systems to create new products.
- To practice biotechnological research, its importance for society, health, safety, legal and environmental issues and the consequent responsibilities relevant to the biodiversity conservation practice.
- To foster innovation and entrepreneurship skills, enabling students to identify opportunities, drive positive change and contribute to the growth of biotechnology field.
- To prepare students to adapt to evolving technologies and methodologies, emphasizing the importance of continuous learning and professional development.

3. Eligibility

A student who has passed the Higher Secondary (12th grade) or its equivalent examination with subjects - Physics, Biology and Chemistry as core subjects with minimum 50% overall (45% for SC/ST candidates) is eligible to take admission to the 1st year of B.Sc. Biotechnology programme.

4. Programme structure

Basket	Basket Category	Minimum credits to be acquired
I	Foundation Courses in Sciences	17
II	Foundation Courses in Humanities & Management [A: 6 credits (choice), B: 6 credits (Compulsory)]	12
III	Smart Stack	25
IV	Foundation and Core Engineering Courses	58
V	Domain/Skill/Internship/Minor Project/MOOC	48
	Total Credits	**160**

5. Types of courses

5.1 Foundation Courses in Sciences

Foundation Courses in Science are designed to equip students with the fundamental scientific principles necessary for pursuing an engineering degree. These courses typically cover the basics of physics, chemistry, and mathematics, providing a solid grounding in the concepts and problem-solving skills that are essential for more advanced engineering studies.

Please refer to Annexure- I for courses offered under this basket.

5.2 Foundation Courses in Humanities & Management [A: 6 credit (choice), B: 6 credit (Compulsory)]

Humanities and management courses within an engineering program are designed to provide engineering students with essential knowledge and skills beyond the technical aspects of their field. These courses aim to develop well-rounded engineers who understand the broader social, cultural, ethical, and managerial contexts in which engineering solutions are applied.

Please refer to Annexure- II for courses offered in under this basket.

5.3 Smart Stack

These courses on Smart Engineering Tools focus on equipping students with the knowledge and skills to utilize advanced software, technologies and methodologies that enhance the efficiency, accuracy, and innovation of engineering processes. These courses emphasize the integration of digital tools, automation, data analysis and emerging technologies into engineering practice.

Please refer to Annexure- III for courses offered under this basket.

5.4 Foundation and Core Engineering Courses

Core engineering courses are the foundational and specialized courses directly related to a student's chosen major discipline. These courses form the core of the academic programme and provide in-depth knowledge and skills in the chosen field of study.

These courses aim to build a strong theoretical and practical foundation in the chosen major discipline. They equip students with the specialized knowledge and expertise required to excel in their field of study and future careers.

Please refer to Annexure- IV for courses offered in major (core) discipline.

5.5 Domain/Skill/Internship/Minor Project/MOOC

Domain Courses: These are courses from a chosen minor discipline, providing students with a secondary area of expertise. There are several domains offered by the university for the academic year 2023-24.

Skill Courses: These courses focus on developing practical skills and competencies that are valuable in various professional contexts. Please refer to Annexure-3 for courses offered under this basket.

Internship or Community Engagement programmes involve students participating in real-world work experiences, either in industry or within the community, during the summer break. These experiences can be credit-bearing and provide practical exposure to their chosen field of study. Summer Internship and Community Engagement experiences bridge the gap between theoretical knowledge and practical application. They offer students an opportunity to apply what they have learned in a real-world context, gain hands-on experience and develop professional networks.

These are in-depth, research-oriented components of the academic programme. Students engage in original research, dissertation writing, or production action learning, depending on the programme's requirements. Research projects are typically carried out under the guidance of faculty members.

These components aim to develop students' research skills, critical thinking abilities and problem-solving capabilities. They encourage students to explore, analyze and contribute to the knowledge base of their major discipline, preparing them for careers in research, academia, or industry leadership roles.

Please refer to Annexure- V for courses offered under this basket.

6. Assessment

6.1 Evaluation for Theory Components

Component	**Theory (Marks)**	**Practice (Marks)**
Marks	**100**	**100**
Mid-Sem Written Examination *Mark Distribution:* ➢ *5 Short Questions x 1 marks = 5 marks* ➢ *2 long questions x 5 marks = 10 marks* ➢ *2 short notes x 2.5 marks = 5 marks*	20	
Presentation (*There will be single individual presentation of which the rubrics are given below*) *Rubric is as under:* ➢ *Content & Creativity = 05* ➢ *Presentation & Discussion = 05*	10	
Assignments (*There will be five individual assignments from which the average will be considered*)	10	
Learning Record ➢ *Based on the parameters indicated in the learning record format*	10	

Continuous Assessment (50%)	50	
End-Sem Examination (*Full marks will be 100 but 50% weightage will be considered*)	50	
Internal (50%)		50
External (50%)		50

6.2 Evaluation of Practice/ Laboratory Components

The evaluation of the practice component will be carried out 50% by concerned faculty and 50% by the external examiner and will be conducted as per the present policy. Details are as under:

Internal

A	Concept	10
B	Planning & Execution/ Practical/ Simulation/ Programming	10
C	Result and Interpretation	10
D	Record/ Report	10
E	Viva	10
Total		**50**

External

A	Execution & Result	20
B	Record of Applied and Action Learning	10
C	Viva	20
Total		**50**

6.3 Evaluation of Project Component

The evaluation of the project component will be completed 50% by concerned faculty and 50% by the external examiner and will be conducted as per the present policy. Following guideline may be referred during evaluation of internal and external components:

Internal

A	Understanding the relevance, scope and dimension of the project	10
B	Methodology	10
C	Quality of Analysis and Results	10
D	Interpretations and Conclusions	10
E	Report	10
Total		**50**

External

A	Understanding the relevance, scope and dimension of the project	10
B	Report	20
C	Viva	20
Total		**50**

6.4 Evaluation of Internship

The evaluation of the internship will be completed 50% by concerned faculty and 50% by the industry guide. Following guideline may be referred during evaluation of internal and external components:

Internal

A	Daily Diary & Log Report	20
B	Periodical (Weekly/Monthly) Report	10
C	Presentation & Viva	20
Total		**50**

External

A	Completion of the task / project assigned	30
B	Feedback of the industry supervisor	20
Total		**50**

6.5 Evaluation of Workshop Component

The evaluation of the workshop component will be completed 100% by concerned faculty as per the present policy. Following guideline may be referred during evaluation:

A	Critical Thinking/ Simulation/ Field work & Report	50
B	Presentation & Viva	50
Total		**50**

7. Pass criteria

A. Theory papers: students must secure a minimum of **30% in individual components** (both continuous assessment & end-semester theory) **along with 40% in aggregate**

B. Theory & practice papers

i. Theory component: minimum of 30% in individual components (both continuous assessment & end-semester theory) along with 40% in aggregate

ii. Practice component: minimum of 50% marks both in internal & external

C. Theory & project type papers

i. Theory component: minimum of 30% in individual components (both continuous assessment & end-semester theory) along with 40% in aggregate

ii. Project component: minimum of 50% marks both in internal & external

D. Theory, practice & project type papers

i. Theory component: minimum of 30% in individual components (both continuous assessment & end-semester theory) along with 40% in aggregate

ii. Practice component: minimum of 50% marks both in internal & external

iii. Project component: minimum of 50% marks both in internal & external

E. Practice & project type papers

i. Practice component: minimum of 50% marks both in internal & external

ii. Project component: minimum of 50% marks both in internal & external

F. Workshop or Internship type papers: 50% in aggregate

8. Grading

CUTM follows “Absolute” grading system / Grade point or marks scheme applicable for different programmes. Under absolute grading system, a Ten Point grading system on base of

10 shall be followed in CUTM. Categorization of these grades and their correlation shall be as under:

Qualification	Grade	Score on 100 Percentage Points	Point
Outstanding	O	90 and above up to 100	10
Excellent	E	80 and above but less than 90	9
Very Good	A	70 and above but less than 80	8
Good	B	60 and above but less than 70	7
Fair	C	50 and above but less than 60	6
Pass	D	40 and above but less than 50	5
Failed	F	Below 40	2
Malpractice	NOT APPLICABLE	NOT APPLICABLE	0
Absent	NOT APPLICABLE	NOT APPLICABLE	0

N.B. Grade C shall be considered as average, Grade D shall be the passing Grade for theory and Grade C shall be the Pass Grade for Practical/ Project/ Workshop mode paper.

9. Attendance

Attendance will be calculated from the date of commencement of classes or date of admission, whichever is later.

a. A student attending at least 75% of the total number of classes held shall be allowed to sit for the concerned Semester Examinations subject to fulfilment of other conditions laid down in the regulation.
b. A student attending at least 60% but less than 75% of the total number of classes held shall be allowed to sit for the concerned Semester Examinations subject to the payment of prescribed fees and fulfilment of other conditions laid down in the regulations.
c. A student attending less than 60% of the total number of classes held shall not be allowed to sit for the concerned Semester Examinations and he /she has to take admission to the same Semester in the very next year for attending the classes and appearing at the said Semester Examination.

Details of the Choice-based Credit System (CBCS) Structure

Basket IV Core Courses				
Sl. No.	**Course Code**	**Course Title**	**Credits**	**Type T+P+PJ**
1.	CUTM4350	Fermentation Biotechnology	4	3-1-0
2.	CUTM4117	Microbial Biotechnology	4	3-1-0
3.	CUTM4351	Genetic Engineering	4	3-1-0
4.	CUTM2363	Plant Tissue Culture Engineering	4	3-1-0
5.	CUTM4118	Biosafety Engineering	3	3-0-0
6.	CUTM4115	Cell Biology	4	3-1-0
7.	CUTM4116	Molecular Biology	4	3-1-0
8.	CUTM4119	Biochemistry	4	3-1-0
9.	CUTM4352	Immunology	4	3-1-0
10.	CUTM4120	Animal Biotechnology	4	3-1-0
11.	CUTM4355	Cancer Biology	4	3-1-0
12.	CUTM2367	Introduction to Biotechnology	3	3-0-0
13.	CUTM4121	Bioanalytical Techniques	4	3-1-0
14.	CUTM4122	Introduction to Bioinformatics	4	3-1-0
15.	CUTM4354	Introduction to R programming	4	2-1-1
16.		**Total Credits**	**58**	**-**

Basket V Domain/Skill/MOOC/Minor Project/Internship/ Electives				
Sl. No.	**Course Code**	**Course Title**	**Credits**	**Type T+P+PJ**
Electives				
1.	CUTM2375	Nanobiotechnology	3	2-0-1
2.	CUTM2376	Biomaterials	3	2-0-1
Domains				
1.		Genetics and Genomics	29	
2.		Organic Farming	29	
3.		Food processing	29	
5.		Nutraceuticals	29	
Skills				
Internship/Minor Project				
			Total Credits	**48**

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 contents

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).

Biosafety Engineering

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4118	Biosafety Engineering	3	3-0-0	Nil

Course Objectives

- To emphasize on IPR issues and patents in biotechnology.
- To introduce the biosafety regulations and ethical concepts in biotechnology.
- To understand the concept of GMOs and usage guidelines.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To memorize the concepts of intellectual property rights, history and their significance.	PO1 (3), PO6 (2), PO12 (2), PSO1 (2), PSO2 (2) PSO3 (3)
CO2	To discuss and distinguish the types of patents and the protocol of patent filing, licensing, infringement, scope, litigation.	PO1 (3), PO4 (2), PO6 (2), PSO1 (3), PSO2 (1) PSO3 (3)
CO3	To interpret the various bioethical issues of Biotechnology.	PO1 (1), PO2 (1), PO3 (2), PO4 (1), PO8 (3), PSO1 (3), PSO3 (3)
CO4	To identify different types of the biosafety levels and health hazards concerning biotechnology.	PO2 (1), PO3 (3), PO4 (2), PO5 (1), PO6 (2), PSO1 (2)
CO5	To outline the biosafety guideline, the pros and cons of GMOs and relevant national regulations and international agreements.	PO1 (1), PO3 (1),PO4 (1), PO5 (3), PO6 (3), PO9 (2), PO10 (2), PO11 (2) PSO1 (2), PSO3 (3)

Course Contents

Module I

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.

Module II

Historical perspectives and need for the introduction of Intellectual Property Right Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications. History of GATT & TRIPS Agreement; Madrid Agreement; Hague

Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.

Module III

Fundamentals of patents, copyrights, geographical indications, Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection. National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting–disclosure/non-disclosure; financial assistance for patenting-introduction to existing schemes, Patent licensing and agreement Patent infringement- meaning, scope, litigation.

Module IV

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals.

Module V

Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including; Cartegana Protocol. Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons.

Text Books

1. Deepa GoelShomini Parashar, IPR, Biosafety and Bioethics, Pearson Education India

2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd

Reference Books

1. H.S Chawla,Introduction to Plant Biotechnology oxford and IBH publishing, third edition

2. Neeraj Pandey and Khushdeep Dharni,"Intellectual Property Rights" ; 1 edition PHI Learning

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. Medium sterilization, design of batch sterilization processes. Calculation of the Del factor during heating and cooling; Calculation of the holding time at constant temperature. Sterilization of media by membrane filters. Design of continuous sterilization processes: Sterilization of fermenter, Sterilization of feeds, Sterilization of liquid wastes. Air sterilization: Various types of sterilization equipments.

Module II

Development of inoculum for industrial fermentations; Kinetics of microbial growth and

death; Environmental factors affecting growth kinetics, heat generation by microbial growth, kinetics of substrate utilization, Yield and maintenance coefficients, kinetics of product formation; 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).

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.

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 contents

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.

Plant Tissue Culture Engineering

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM2363	Plant Tissue Culture Engineering	4	3-1-0	Cell Biology

Course Objectives

- To understand the basics of plant tissue culture and micropropagation.
- To understand the different techniques in plant tissue culture and its applications.
- To practice the micropropagation of important crop species through tissue culture.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To learn the principles and techniques of plant tissue culture and explain the cellular and molecular basis of plant tissue culture.	PO1 (3), PO2 (3), PO3 (1), PO4 (2), PO5(2), PSO1 (3), PSO2 (1) PSO3 (2)
CO2	To discuss the ethical issues and environmental impacts associated with plant tissue culture and genetic engineering and develop an understanding of the regulations and safety standards in plant biotechnology.	PO1 (3), PO2 (3), PO3 (3), PO5 (3), PO9 (2), PO10 (2), PO11 (2), PSO1 (3), PSO3 (2)
CO3	To identify and troubleshoot common issues in plant tissue culture, such as contamination and vitrification and develop problem-solving skills specific to the challenges faced in tissue culture.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO9 (2), PO10 (2), PO11 (2), PSO1 (3), PSO2 (1) PSO3 (2)
CO4	To interpret the aseptic techniques and understand the protocols for establishing and maintaining in vitro cultures and perform key laboratory procedures such as media preparation, sterilization, and micropropagation.	PO1 (3), PO2 (2), PO3 (2), PO5 (3), PO6 (1), PSO1 (3), PSO3 (3)
CO5	To develop the methods for plant regeneration including somatic embryogenesis and organogenesis and execute micropropagation techniques to produce clones of plants.	PO1 (3), PO2 (2), PO3 (2), PO4 (3), PO5 (3), PO8 (2), PO9 (2), PO10 (2), PO11 (2), PSO1 (3), PSO2 (1) PSO3 (2)

Course Contents

Module I

Brief history of plant tissue culture, Scope of plant tissue culture, Laboratory instructions and maintenance of sterilization, composition of media, nutrient and hormone requirement, mode of action of auxin and cytokinin. Plant tissue culture plasticity and totipotency

Module II

Criteria of explant selection, factor affecting the culture of cells. Cell, Callus & Suspension cultures. Somatic Embryogenesis and Hybridization. Haploid Production through Anther and ovule culture; Embryo culture.

Module III

Somaclonal variation; In vitro mutation methods; Micro propagation somatic hybrid and cybrid, Plant regeneration. Germ plasm conservation, Sources of plant secondary metabolite. Production of secondary metabolites.

Module IV

Gene constructs, Vectors for the production of transgenic plants, Introduction- Agrobacterium mediated gene transfer –Ti-plasmid-process of T-DNA transfer and integration, transformation in plant, Direct and indirect gene transfer methods. Binary vectors- basic features of vectors-optimization-clean gene technology.

Module V

Molecular farming, Factors affecting molecular farming, GM crops- current status concerns about GM crops-regulations on GM crops and products.

Practice

1. Laboratory structure, instrumentation, and sterilization techniques in plant tissue culture.
2. Preparation of MS media.
3. Explant preparation, inoculation and initiation of tissue culture.
4. Preparation of media for callus culture.
5. Callus culture and organogenesis.
6. Organ (Anther, ovule, ovary, etc.) culture.

Text Books

1. Bhojwani, Sant Saran, Dantu, Prem Kumar, Plant tissue culture: An introductory text, Springer publication, 3rd Edition.

2. Slater.A., Nigel W.S, Flower. R.Mark , Plant Biotechnology: The Genetic Manipulation of Plants, 2009, Oxford University Press.

Reference Books

1. H.S Chawla, Introduction to Plant Biotechnology oxford and ibh publishing, third edition.
2. Robert H.Smith, Plant tissue culture techniques and experiments, third edition, Academic Press.

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 Contents

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
CUTM4352	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.

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.

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.

Introduction to Biotechnology

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM2367	Introduction to Biotechnology	3	3-0-0	Nil

Course Objectives

- To introduce students to the foundational concepts, principles, and scope of biotechnology, emphasizing its interdisciplinary nature and applications in various sectors such as healthcare, agriculture, and industry.,
- To familiarize students with key biotechnological techniques and tools, including genetic engineering, cell culture, and bioinformatics, and their role in addressing scientific and societal challenges.
- To enable students to explore the real-world applications of biotechnology and understand the ethical, legal, and social implications of biotechnological advancements.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Fundamental and contextual knowledge of structural classifications and biological function.	PO1(3), PO2(2), PO4(1), PO5(1), PSO1(2), PSO3(2)
CO2	Identification and structural information of biomolecules and biomolecular interactions.	PO1(3), PO2(2), PO4(1), PO5(1), PSO1(2), PSO3(2)
CO3	Understanding of contextual knowledge on biological significance of differences in DNA and RNA and Overview of cloning and gene expression.	PO1(3), PO2(3), PSO1(2), PSO3(2)
CO4	Discussion of the theoretical concept of cellular components, theoretical understanding of cell division, and flow cytometry, immune system and differentiation of T cells and B cells.	PO1(3), PO2(2), PSO1(2), PSO3(2)
CO5	Employ the theoretical information in Industrial production in steps involved in Drug Discovery and development process.	PO1(3), PO2(3), PO6(2), PSO1(2), PSO3(2)

Course Contents

Module I

Introduction, History and scope of biotechnology, Component of the cell, structure and biochemical functions, DNA replication, transcription, and translation.

Module II

Overview on Biomolecules, Carbohydrates, Lipids, Proteins, Nucleic acids, Structure and classification of enzymes.

Module III

Nucleic acids as genetic material, structure and physiochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA, Overview of cloning Purification and separation of Nucleic acids-cutting and joining DNA and vectors, analysis of gene expression, applications.

Module IV

Eukaryotic and Prokaryotic cells, Cell cycle-Mitosis and Meiosis, Cell fractionation and flow cytometry, Cells of immune system, Development, maturation, activation and differentiation of T cells and B cells, Phagocytosis process

Module V

Industrial production, Drug Discovery and development, GMO, Bioremediation.

Text Books

1. Lehninger A.L., Nelson D.L. and M.M. Principles of Biochemistry.CBS publishers and distributers.
2. Murray R.K., Granner D.K., Mayes P.A and Rodwell V.W.Harpers Biochemistry. Appleton and Lange, Stanford, Conneticut.

Reference Books

1. Lodish,Harvey et al., "Molecular Cell Biology", 6th Edition.W.H Freeman,2008.
2. Alberts,Bruce, "Molecular Biology of Cell",5th Edition, Garland Science,2008.
3. Satyanarayana,U. "Biotechnology" Books & Allied(P) Ltd.,2005.

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.

Introduction to Bioinformatics

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4122	Introduction to Bioinformatics	4	3-1-0	Nil

Course Objectives

- To introduce students to the fundamental principles, concepts, and scope of bioinformatics, including its role in modern biological research and data analysis.
- To train students in using bioinformatics tools, software, and databases for the analysis of biological sequences, structures, and functional data.
- To enable students to apply bioinformatics approaches to solve real-world biological problems in areas such as genomics, proteomics, and systems biology.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Fundamental information on biological database, Data retrieval and analysis.	PO1 (3), PO2 (3), PO4 (2), PSO1 (3), PSO2 (1) PSO3 (2)
CO2	Understanding the concept of Sequence alignment and its application in genome research practice.	PO1(3), PO4 (3), PSO1(3), PSO2(3), PSO3(2)
CO3	Interpretation of protein structure prediction, analysis and visualization by computational technique.	PO2 (3), PO4 (3), PSO1(3), PSO3(2)
CO4	To examine and classify the system biology in health and diseases pathway analysis.	PO1(3), PO4 (2), PSO1(2), PSO3(2)
CO5	Design and visualize the small molecules by Computer-aided drug design process and its application in drug discovery practice.	PO1(3), PO2 (2), PO3 (2), PO4 (3), PSO1(3), PSO2 (3), PSO3(2)

Course Contents

Module I

Introduction to biological database, primary and secondary database nucleotide and protein sequence databases, nucleic acid & protein structure databases, pathway databases, specialized sequence and information resources; NCBI resources; EXPASY Resources; EBI resources, literature databases.

Module II

Sequence alignment; pair wise and multiple sequence alignment, basic local alignment search tool (BLAST) and its types, Genome analysis and sequencing, Mapping of Human Genome, Human Genome project, Future of Genome Research, its application and opportunities.

Module III

Introduction to protein data bank (PDB), chemical structure database; PUBCHEM, Drug Bank; protein structure prediction (primary, secondary, tertiary), homology modeling, chemical bonding, binding sites, structural energy minimization and molecular interaction, structure visualization.

Module IV

Introduction to system biology and its application in health and diseases, pathway databases like KEGG, EMP, STRING, MetaCyc; Gene ontology.

Module V

Steps of drug design, target binding site prediction, virtual screening strategies for lead identification, structure-based drug design, ADMET prediction for drug molecules.

Practice

1) Biological Data Mining (Functional data retrieval)
2) Sequence alignment (Global and Local sequence alignment)
3) Structural data retrieval and visualization
4) Diseases pathway analysis
5) Molecular Docking and ADMET prediction

References Books

1. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Thailand: Cold Spring Harbor Laboratory Press.

2. Xiong, J. (2006). Essential bioinformatics. Spain: Cambridge University Press.

3. Liljas, A., Liljas, L., Lindblom, G., Nissen, P., Kjeldgaard, M., Ash, M. (2016). Textb ook of Structural Biology (Second Edition). Singapore: World Scientific Publishing Company.

Introduction to R programming

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM4354	Introduction to R programming	4	2-1-1	Nil

Course Objectives

- To understand the concept of R programming.
- To use R for data analysis and interpretation.
- To use R for bioinformatics prediction.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Introduction to the concepts R.	PO1 (3), PO6 (3), PO12 (2), PSO1 (3)
CO2	Knowledge on basic graphics in R	PO1 (3), PO4 (2), PO6 (2), PSO1 (3), PSO2 (1)
CO3	Understanding of data analysis and interpretation using R.	PO1 (1), PO2 (1), PO3 (2), PO4 (1), PO8 (3), PSO1 (2)
CO4	Usage of selected packages in R	PO2 (1), PO3 (3), PO4 (2), PO5 (1), PO6 (2), PSO1 (3), PSO2 (1) PSO3 (2)
CO5	Apply R to selected Bioinformatics problems	PO1 (1), PO3 (1),PO4 (1), PO5 (3), PO6 (3), PO9 (2), PO12 (3), PSO1 (3)

Course Contents

Module I

Getting Started with R: download and installation, introduction to components of R. Working with data in R: input from keyboard, import file-.xlx, .xlsx, .txt, .csv, etc.

Module II

Creating vectors, performing arithmetic operations, adding elements to a vector, creating a matrix, matrix operations, extracting elements from a matrix, creating data frame, extracting elements from a data frame, Dealing with missing data.

Module III

Programming in R: understanding the flow, operators-comparison and logical, looping, for loop, while loop, repeat loop, if loop. Creating your own function in R and export data from R to another format like .xlx, .xlsx, .csv, .txt. Statistical analysis in R: descriptive statistics, creating tables and graphs, correlation and regression, performing t-tests, ANOVA.

Module IV

Applications of R in Computational Biology and Bioinformatics: Case studies of bioinformatics and computational biology problems using the packages from Bioconductor: Sequence alignment using Needleman Wunch and Smith Waterman algorithms; Phylogenetic tree construction; Computational gene finding by identifying ORFs; Generating biological sequence using Hidden Markov Model.

Practice

1. To prepare of Bar graph, Box Plot and Pie chart for the given data.
2. To conduct a hypothesis test in R.
3. To perform ANOVA in R.
4. To obtain the linear regression using R.
5. Data mining in the R studio and data interpretation on given data.
6. Construction of phylogenetic tree using R.
7. Identification of ORFs using R Scripts.

Recommended Books

1. Larry Pace (2012), Beginning R: An Introduction to Statistical Programming, A press.

2. S.R. Deshmukh and S. Purohit. (2007) Microarray Data: Statistical Data Analysis using R, Alpha Science International

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.

Biomaterials

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM2376	Biomaterials	3	2-0-1	Biochemistry

Course Objectives

- To understand the concept of biologically derived materials or materials compatible with biology.
- To produce polyphenol resins by the enzyme soybean peroxidase.
- To evaluate of the properties of biopolymers to make good biomaterials.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To develop knowledge on structure of macromolecules such as carbohydrates, proteins and lipids.	PO1 (3), PO6 (3), PO12 (2), PSO1 (3), PSO2 (2) PSO3 (2)
CO2	To demonstrate the organization and biological functions of macromolecules.	PO1 (3), PO5 (2), PO9 (2), PSO1 (3), PSO2 (3) PSO3 (2)
CO3	To make use of knowledge on carbohydrate metabolism.	PO1 (1), PO3 (2), PO4 (1), PO8 (3), PSO1 (3), PSO3 (2)
CO4	To understand the structure activity relationship of proteins and mechanism of enzyme action.	PO2 (1), PO3 (3), PO4 (2), PO5 (1), PO10 (3), PSO1 (3), PSO2 (3) PSO3 (3)
CO5	To identify the structural organization of membranes and ion channels.	PO1 (1), PO3 (1), PO4 (1), PO5 (3), PO11 (2), PO12 (3), PSO1 (3), PSO2 (1) PSO3 (2)

Course Contents

Module I

Definition of biomaterials – biologically derived materials or materials compatible with connective tissues): Structure production and its use. Fibroin (protein in silk): Production and its use. Production of these proteins by conventional cloning methods.

Module II

Modified carbohydrates actin gas lubricants for biomedical applications; Polydextrose made from bacteria; Carbohydrates modified from enzymes; artificial wood.

Module III

Synthesis from a simple biological monomer (eghyaluronate polymers); Dextrans (used in chromatographycolumns); Rubberllike materials produced by bacteria and fungi (Polyhydroxybutyrate PHB), Polycaprolactone (PCL); Production of a copolymer of

PHBPHV(polyhydrovaleric acid), sold as Biopol by fermentation on Alcaligeneseutrophus; Biodegradable polymers

Module IV

Production of polyphenol resins by the enzyme soybean peroxidase; Evaluation of the properties of biopolymers to make good biomaterials; Tensile strength (both elasticity and breaking strength); Hydration, visco – elastic properties; viscosity.

Recommended Books

1. Ratledge C and Kristiansen B, Basic Biotechnology, Cambridge University Press, 2nd Edition, 2001.
2. Doi Y, Microbial Polyesters, VCH Weinheim, 1990.