THE APOLLO UNIVERSITY

Murukambattu, Chittoor (Dt) 517127, Andhra Pradesh
School of Health Sciences | Department of Biomedical Sciences

B.Sc. BIOTECHNOLOGY

(Honours with Research) – 4-Year Programme

Outcome-Based Education (OBE) Curriculum

Course Structure and Syllabi

Regulations R-2025 | w.e.f. 2026-27 admitted batch

Prepared in the format required for NAAC accreditation and the UGC Credit Framework (CBCS / NEP-aligned)

PART A: PROGRAMME PROFILE

A1. Vision of the School

To be a global leader in health sciences education, research, and innovation, fostering interdisciplinary excellence to advance healthcare, improve patient outcomes, and address global health challenges through cutting-edge knowledge and technology.

A2. Mission of the School

1. To excel in interdisciplinary education, pioneering research, skill development, and technology-driven healthcare solutions.
2. To foster global collaboration, community engagement, and lifelong learning that advance health sciences and improve patient outcomes.

A3. Preamble

The B.Sc. Biotechnology degree (Choice Based Credit System) introduces students to the core and applied aspects of Biotechnology together with interdisciplinary subjects. The curriculum maintains globally competitive standards of knowledge and skill, and develops scientific orientation, spirit of enquiry, problem-solving skills, and the human and professional values that foster rational and critical thinking. The programme opens opportunities from classical to applied biotechnology in healthcare, agriculture, industry, and the environment.

A4. Eligibility and Duration

Item	Provision
Eligibility	Pass in 10+2 or equivalent (State Boards of AP / TN / Kerala, CBSE or equivalent) with Botany / Zoology / Biology as one of the subjects, and at least 35% marks in Part III (aggregate / Part III)
Maximum age at admission	22 years
Duration	3 years (6 semesters) for the B.Sc. degree; 4 years (8 semesters) for B.Sc. (Honours with Research)
Maximum duration to complete	6 years including arrears (as per source document)
Semester length	15 weeks of instruction plus examinations; 3-week induction programme in Semesters I and II

A5. Programme Demand and Career Outlook (from the source document)

The source document records a gap-need analysis based on a mixed-methods study (survey of 500 students and 100 industry professionals, and 20 in-depth interviews).

Gaps identified

- Lack of industry relevance
- Insufficient hands-on training
- Inadequate career guidance
- Limited opportunities for specialisation
- Inadequate infrastructure and resources

Needs identified

- Industry-relevant curriculum
- Hands-on training and practical experience
- Career guidance and job placement support
- Opportunities for specialisation
- State-of-the-art infrastructure and resources

Employers, skills and growth areas

Aspect	Details
Top employers	Pharmaceutical companies, biotechnology companies, research institutions, government agencies, consulting firms
Skills in demand	Molecular biology, genetics, biochemistry, bioprocessing, data analysis and interpretation, communication and teamwork
Growth areas	Gene editing and gene therapy, synthetic biology, personalised medicine, biomanufacturing, bioremediation and biodegradation
Indicative salary (per year, India)	Entry level: INR 4,00,000 to 6,00,000; senior biotechnologist: INR 8,00,000 to 12,00,000; biotechnology manager: INR 12,00,000 to 18,00,000

Note: *The demand statistics in the source (for example, 10 to 15% annual job growth and 1.5 million professionals by 2025) carry a 2025 horizon and an attribution to the US Bureau of Labor Statistics and Grand View Research. Please refresh these figures with current, India-specific data before they are cited in the NAAC Self-Study Report.*

PART B: PROGRAMME OUTCOMES

The source document lists seven Programme Objectives (PO) and five Programme Specific Outcomes (PSO) as per UGC. They are retained with the same numbering and are used for all CO-PO-PSO mapping in this document.

B1. Programme Outcomes (PO)

ID	Programme Outcome	Description
PO1	Interdisciplinary Knowledge Acquisition	Comprehensive understanding of biological sciences, chemical sciences, and engineering principles essential for biotechnology applications
PO2	Practical Skills Development	Hands-on laboratory skills and technical expertise in molecular biology, microbiology, and genetic engineering techniques
PO3	Research and Innovation	Critical thinking and innovation through exposure to contemporary research methodologies
PO4	Ethical and Social Awareness	Understanding of the ethical, legal, and social issues of biotechnological research and applications; responsible scientific practice
PO5	Career Readiness	Preparedness for careers in academia, industry, healthcare, and environmental sectors through skill development and internships
PO6	Lifelong Learning	A mindset of continuous learning and adaptation to new technologies and scientific advancements
PO7	Sustainability and Environmental Awareness	Awareness of sustainable biotechnological practices that address climate change, food security, and conservation

B2. Programme Specific Outcomes (PSO)

ID	Programme Specific Outcome
PSO1	**Experimental Design and Analysis:** design and conduct experiments, analyse and interpret data related to biotechnological processes in healthcare, agriculture, and environmental science
PSO2	**Application of Biotechnological Techniques:** apply molecular biology methods, genetic engineering, and fermentation technology to solve real-world problems
PSO3	**Interdisciplinary Integration:** integrate biological, chemical, and engineering knowledge to develop innovative biotechnological solutions
PSO4	**Critical Thinking and Problem-Solving:** evaluate biotechnological advancements and their implications to address challenges in research and industry
PSO5	**Ethical and Social Responsibility:** appreciate the ethical, legal, and social implications of biotechnology and promote responsible practice

B3. Mapping of Programme Outcomes to the Vision and Mission

Mission statement M1: excellence in interdisciplinary education, research, skill development and technology-driven solutions. Mission statement M2: global collaboration, community engagement and lifelong learning. (Proposed mapping, 3 = high, 2 = medium, 1 = low.)

Mission	PO1	PO2	PO3	PO4	PO5	PO6	PO7
M1	3	3	3	2	3	2	2
M2	2	1	2	3	2	3	3

PART C: CREDIT FRAMEWORK AND OBE RULES

C1. Credit Norms (UGC Credit Framework)

Mode of instruction	Contact hours per week	Credits	Hours per semester (15 weeks)
Lecture (L)	1 hour	1 credit	15
Tutorial (T)	1 hour	1 credit	15
Practical (P)	2 hours	1 credit	30

Applied to this programme:

- A **4-credit theory course (3L + 1T)** has **60 teaching hours**, distributed as **12 hours per unit** across 5 units. Tutorial hours are used for problem solving, case discussion and formative assessment.
- A **3-credit theory course (3L + 0T)** has **45 teaching hours**, distributed as **9 hours per unit** across 5 units (University Core Communicative English follows the source split of 10, 10, 10, 10 and 5 hours).
- A **2-credit laboratory course (4 hours per week)** has **60 practical hours**; a **1.5-credit laboratory course (3 hours per week)** has **45 practical hours**.
- Non-credit components (Soft Skills, Mentoring, Technical Seminar, Library, Physical Activity, Extra-curricular, Co-curricular, Self-Learning) are scheduled as per the semester structure and recorded as Satisfactory / Not Satisfactory.

C2. Credit Summary

Semester	Credits (as per structure)	Remarks
I	22	Induction programme (3 weeks)
II	22	Induction programme (3 weeks); see verification note below
III	26	
IV	26	
V	24	Includes Mini Project
VI (B.Sc. exit)	20	Includes Major Project (16 credits)
Total, B.Sc. (3 years)	**140**	
VI (Honours with Research)	16	Replaces B.Sc. Semester VI
VII and VIII (Honours)	36	Major Project for two semesters
Total, B.Sc. (Honours with Research)	**172**	

Note: *In the source structure, Semester II lists 12 + 3 + 3 + 1.5 + 1.5 = 21 credits but a printed total of 22, with practical periods of 3 + 3 = 6 against a printed total of 8. If both laboratories are intended to be 2 credits and 4 hours per week (as in Semester I), the total of 22 and 36 hours per week is correct. The course sheets follow the printed course table (1.5 credits, 3 hours). Please confirm and correct one of the two before submission.*

C3. Course Categories and Code Convention

Prefix	Meaning
BITT	B.Sc. Biotechnology Theory course
BITL	B.Sc. Biotechnology Laboratory course
BITP	B.Sc. Biotechnology Project

Prefix	Meaning
TAUT	The Apollo University Core / Elective course

C4. Bloom's Taxonomy Levels Used for Course Outcomes

Level	Cognitive domain	Typical verbs
K1	Remember	define, list, state, name
K2	Understand	explain, describe, classify, summarise
K3	Apply	apply, demonstrate, perform, calculate
K4	Analyse	analyse, compare, interpret, differentiate
K5	Evaluate	evaluate, justify, assess, critique
K6	Create	design, develop, formulate, propose

C5. CO-PO-PSO Mapping Scale

Each Course Outcome (CO) is mapped to the seven POs and five PSOs on a 3-point scale. A dash means no correlation. The "Avg." row of each course is the average of the non-zero values in that column, and Appendix A consolidates these averages across all courses.

Value	Meaning
3	Substantial (high) correlation
2	Moderate (medium) correlation
1	Slight (low) correlation
-	No correlation

C6. Assessment and Attainment Framework (proposed, to be ratified by the Board of Studies)

Component	Weightage	Instruments
Continuous Internal Evaluation (CIE)	40%	Two internal tests, assignments, quizzes, tutorial performance, seminar
Semester End Examination (SEE)	60%	Written examination covering all five units
Laboratory courses	50% CIE : 50% SEE	Record, viva, day-to-day performance; end-semester practical examination
CO attainment target	60% of students scoring at least 60% of the marks mapped to the CO	Direct attainment 80% weight (CIE + SEE); indirect attainment 20% weight (course-exit survey)
Attainment levels	Level 3: at least 70% of students meet the target; Level 2: 60 to 69%; Level 1: 50 to 59%	Reviewed every semester; action plan recorded for any CO below Level 2

PART D: SEMESTER-WISE COURSE STRUCTURE

L = Lecture, T = Tutorial, P = Practical (periods per week), C = Credits.

Semester I (3-week induction programme)

Code	Course	L	T	P	C	Hrs/week	Category
BITT1501	Cell Biology and Genetics	3	1	0	4	4	Core
BITT1502	Biochemistry	3	1	0	4	4	Core
BITT1503	Data Science	3	1	0	4	4	Core
TAUT1101	University Core 1: Communicative English	3	0	0	3	3	University Core
TAUT1201	University Elective 1	3	0	0	3	3	University Elective
BITL1501	Data Science Lab	0	0	4	2	4	Laboratory
BITL1502	Biochemistry Lab	0	0	4	2	4	Laboratory
	Non-credit components (Soft Skills, Mentoring, Technical Seminar, Library, Physical Activity, Extra-curricular, Co-curricular, Self-Learning)	0	0	0	0	10	Non-credit
	Total	**15**	**3**	**8**	**22**	**36**	

Semester II (3-week induction programme)

Code	Course	L	T	P	C	Hrs/week	Category
BITT1504	Molecular Biology and Genetic Engineering	3	1	0	4	4	Core
BITT1505	Microbiology	3	1	0	4	4	Core
BITT1506	Bioanalytical Techniques	3	1	0	4	4	Core
TAUT1102	University Core 2: Environmental Studies	3	0	0	3	3	University Core
TAUT1202	University Elective 2	3	0	0	3	3	University Elective
BITL1503	Molecular Biology and Genetic Engineering Lab	0	0	3	1.5	3	Laboratory
BITL1504	Microbiology Lab	0	0	3	1.5	3	Laboratory
	Non-credit components (Soft Skills, Mentoring, Technical Seminar, Library, Physical Activity, Extra-curricular, Co-curricular, Self-Learning)	0	0	0	0	10	Non-credit
	Total	**15**	**3**	**8 (as printed)**	**22 (as printed)**	**36**	

Semester III

Code	Course	L	T	P	C	Hrs/week	Category
BITT2507	Immunology	3	1	0	4	4	Core

Code	Course	L	T	P	C	Hrs/week	Category
BITT2508	Plant Biotechnology	3	1	0	4	4	Core
BITT2509	Enzyme Technology	3	1	0	4	4	Core
BITT2510	Nanobiotechnology	3	1	0	4	4	Core
TAUT2101	University Core 3: Health and Wellness	3	0	0	3	3	University Core
TAUT2201	University Elective 3	3	0	0	3	3	University Elective
BITL2503	Immunology Lab	0	0	4	2	4	Laboratory
BITL2504	Enzyme Technology Lab	0	0	4	2	4	Laboratory
	Non-credit components (Technical Seminar, Library, Physical Activity, Extra-curricular)	0	0	0	0	6	Non-credit
	Total	**18**	**4**	**8**	**26**	**36**	

Semester IV

Code	Course	L	T	P	C	Hrs/week	Category
BITT2511	Animal Cell Culture and Techniques	3	1	0	4	4	Core
BITT2512	Industrial Biotechnology	3	1	0	4	4	Core
BITT2513	Bioinformatics	3	1	0	4	4	Core
BITT2514	Biosafety and Ethics	3	1	0	4	4	Core
BITT2601	Program Elective 1	3	0	0	3	3	Program Elective
BITT2602	Program Elective 2	3	0	0	3	3	Program Elective
BITL2505	Bioinformatics Lab	0	0	4	2	4	Laboratory
BITL2506	Industrial Biotechnology Lab	0	0	4	2	4	Laboratory
	Non-credit components (Technical Seminar, Library, Physical Activity, Extra-curricular)	0	0	0	0	6	Non-credit
	Total	**18**	**4**	**8**	**26**	**36**	

Semester V

Code	Course	L	T	P	C	Hrs/week	Category
BITT3515	Protein Engineering	3	1	0	4	4	Core
BITT3516	Food Biotechnology	3	1	0	4	4	Core
BITT3517	Medical and Pharmaceutical Biotechnology	3	1	0	4	4	Core
BITT3518	Principles of Bioprocess Engineering	3	0	0	3	3	Core
BITT3603	Program Elective 3	3	0	0	3	3	Program Elective
BITT3604	Program Elective 4	3	0	0	3	3	Program Elective
BITP3501	Mini Project	0	0	6	3	6	Project
	Non-credit components (Technical Seminar 3, Library 2, Physical Activity 2, Extra-curricular 2)	0	0	0	0	9	Non-credit
	Total	**18**	**3**	**12**	**24**	**36**	

Semester VI: B.Sc. (3-year exit)

Code	Course	L	T	P	C	Hrs/week	Category
BITT3605	MOOCs Course 1	2	0	0	2	2	MOOC
BITT3606	MOOCs Course 2	2	0	0	2	2	MOOC
BITP3502	Major Project	0	0	32	16	32	Project
	Total	**4**	**0**	**32**	**20**	**36**	

Semester VI: B.Sc. (Honours with Research)

Code	Course	L	T	P	C	Hrs/week	Category
BITT3519	Clinical Biochemistry	3	1	0	4	4	Honours Core
BITT3520	AI in Healthcare	3	1	0	4	4	Honours Core
BITT3521	Neuroscience	3	1	0	4	4	Honours Core
BITT3605	MOOCs Course 1	2	0	0	2	2	MOOC
BITT3606	MOOCs Course 2	2	0	0	2	2	MOOC
	Non-credit components (Technical Seminar 4, Library 4, Physical Activity 3, Extra-curricular 3, Journal Club and Publication Writing 4)	0	0	0	0	18	Non-credit
	Total	**13**	**3**	**0**	**16**	**36**	

Semesters VII and VIII: B.Sc. (Honours with Research)

Code	Course	L	T	P	C	Hrs/week	Category
BITP4502	Major Project (two semesters)	0	0	72	36	72	Research Project
	Total	**0**	**0**	**72**	**36**	**72**	

Program Elective Baskets

Basket	Option A	Option B	Option C
Program Elective 1 (BITT2601)	Stem Cell Biology and Regenerative Medicine	Synthetic Biology and Biological Circuit Design	Biotechnology for Sustainable Development
Program Elective 2 (BITT2602)	Marine Biotechnology and Blue Bioeconomy	Systems Biology and Network Medicine	Computational Biology and Multi-Omics
Program Elective 3 (BITT3603)	Entrepreneurship and Biotechnology Venture Creation	Regulatory Affairs and Intellectual Property in Biotechnology	Cancer Biology and Precision Oncology
Program Elective 4 (BITT3604)	Microbiome Science and Human Health	Clinical Research and Good Clinical Practice (GCP)	Biotechnology Product Development and Commercialization

Note: *Code corrections applied in this document: the source syllabus sheets carry codes BITT2603 (A to C) and BITT2604 (A to C) for Program Electives 3 and 4; they are renumbered here as BITT3603 (A to C) and BITT3604 (A to C) to match the*

Semester V structure. Data Science theory (printed "BITTT1503") is read as BITT1503; Data Science Lab (printed "GMBL1501") as BITL1501; Immunology (printed "BITTT2507") as BITT2507; Principles of Bioprocess Engineering (printed "BITT3517" a second time) as BITT3518; the Industrial Biotechnology Lab sheet (printed under the title "Bioinformatics Lab") as BITL2506.

PART E: COURSE SYLLABI (OBE FORMAT)

Each course sheet follows one format: (1) Title, Code and L-T-P-C; (2) Course Description; (3) Course Objectives; (4) Unit-wise Syllabus with Teaching Hours (or List of Experiments with Hours); (5) Course Outcomes with Bloom's level; (6) CO-PO-PSO Mapping with course average; (7) Text Books and Reference Books. Course sheets follow in semester order.

SEMESTER I

BITT1501: Cell Biology and Genetics

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	I	Core

Course Description

In this course we will examine many different areas of cellular biology including: the synthesis and function of macromolecules such as DNA, RNA, and proteins; control of gene expression; membrane and organelle structure and function; bioenergetics; and cellular communication.

Course Objectives

1. Students will understand the basic principles of different types of Microscopes, and its application.
2. Students will understand the cellular structure and function of all cell organelles.
3. Students will understand the mechanism of cell division, cellular aging and cell death and its regulation
4. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.
5. Students will be equipped with a thorough understanding of the molecular and cellular mechanisms that govern genetic inheritance and cellular functions, and how these principles apply to the study of complex biological systems and diseases.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Microscopy.** History, Principle and Optical Components of microscope: Eye piece, Eye piece tube, Objective lenses, Coarse and Fine Focus knobs, Stage and stage clips, Aperture, Illuminator, Condenser, Focus Knob, Iris Diaphragm. Types of Microscopes: Light microscopes -Simple, Compound and Stereo zoom. Phase Contrast: Fluorescent microscope, Electron microscope- TEM and SEM, Confocal and Optical pathway in different microscopes. Applications of Microscopy: High resolution imaging, immune histochemistry, high-content screening and high throughput imaging. Clinical and Forensic applications.	12
2	**Cell Structure and Function.** Concept of cell: Discovery of cell, cell theory, Cell as a basic unit, Classification of cell types – Virus, Prokaryotes, Eukaryotes, Comparison between plant and animal cells. Plasma membrane: Fluid mosaic model, chemical composition, functions of plasma membrane. Ultrastructure and functions of Cytoplasmic organelles: Mitochondria, Endoplasmic reticulum, Golgi bodies, Lysosomes, and Peroxisomes. Chloroplast, Nucleus: Morphology, nuclear envelope, nucleoplasm, nucleolus.	12
3	**Cell Division and Cell Cycle.** Cell division in Bacteria and Archaea: Process of Binary fission. Cell Cycle Regulation: Cell cycle, Interphase-G1, S, G2 and M phase, Checkpoints. Mitosis: Stages, Mitotic apparatus, Role of cyclins and Cdks. Mitogens and Inhibitors, Significance. Meiosis: Stages, Synaptonemal complex, Crossing over and Chiasma formation, Significance. Cytokinesis in plant and animal cells. Endocycle and Endomitosis. Programmed cell death and its significance. Necrosis	12

Unit	Title and contents	Hours
4	**Introduction to Genetics.** Introduction, Genetical Terminology, Mendel and His Work, Genetic Interaction and Lethal Genes, Quantitative Genetics, Inbreeding, Outbreeding and Hybrid Vigour	12
5	**Linkage, Mapping and Human Genetics.** Linkage, Crossing Over, Genetic and Cytological Mapping of Chromosomes, Multiple Alleles, Fine Structure of Gene, Sex-linked Inheritance, Determination of Sex and Sex Differentiation, Chromosomal Mutations, Gene Mutation, Cytoplasmic or Extra-Nuclear Inheritance, Pedigree Analysis, Human Genetics, Eugenics and Genetic Engineering, Transposable Genetic Elements	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the principles, types and applications of microscopes in biological and clinical research	K2	1
CO2	Describe the structure and function of the cell, the plasma membrane and cell organelles	K2	2
CO3	Explain the stages and regulation of the cell cycle, cell division, and programmed cell death	K2	3
CO4	Apply the principles of Mendelian and quantitative genetics to solve inheritance problems	K3	4
CO5	Analyse linkage, genetic mapping, mutations and pedigrees to interpret inheritance patterns in humans	K4	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	-	1	-	-	1	2	-	-	-
CO2	3	1	-	-	-	1	-	-	1	2	-	-
CO3	3	-	1	-	-	1	-	-	-	1	2	-
CO4	3	1	2	-	-	1	-	2	-	-	2	-
CO5	2	1	2	1	1	-	-	3	-	-	3	1
Avg.	**2.8**	**1.2**	**1.5**	**1.0**	**1.0**	**1.0**	**-**	**2.0**	**1.5**	**1.5**	**2.3**	**1.0**

Text Books

1. Essential Cell Biology, 7th edition (2009), Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts and Walter. Garland Science. ISBN-13:978-0815341291.
2. Molecular Cell Biology, 7th edition (2012), Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon and Scott. W. H. Freeman. ISBN-13: 978-1429234139

Reference Books

1. Cell and Molecular Biology: Concepts and Experiments, 6th edition (2009), Gerald Karp, Wiley. ISBN-978-0470483374.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David Freifelder, 2nd edition (1983), W. H. Freeman and Company.
3. An Introduction to Radiobiology, 2nd edition (1998), A. H. W. Nias, Wiley Blackwell, ISBN- 13: 978- 0471975908.

BITT1502: Biochemistry

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	I	Core

Course Description

This course delves into the chemical processes and substances that occur within living organisms. Students will study the structure and function of biomolecules, metabolic pathways, and the regulation of biochemical processes. Emphasis is placed on understanding the molecular basis of life and the application of biochemistry in health, disease, and biotechnology.

Course Objectives

1. To explain the structure, classification, properties and functions of carbohydrates, amino acids, proteins and lipids.
2. To describe the nature, classification, mechanism and regulation of enzymes and the role of coenzymes.
3. To explain the major pathways of carbohydrate metabolism and their regulation.
4. To describe protein and amino acid metabolism, including nitrogen disposal.
5. To explain lipid and nucleic acid metabolism and associated inborn errors of metabolism, and to provide the chemical foundation for careers in medicine, research and biotechnology.

Note: *Objectives 1 to 4 in the source sheet referred to Microbiology and nursing infection control (carried over from another programme). They have been replaced with objectives that match the Biochemistry syllabus.*

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Biomolecules.** Classification of carbohydrates, properties of mono-, Di-, and Polysaccharides, functions of carbohydrates. Proteins and amino acids, classification of amino acids, peptide bond, different structure and properties of proteins and their functions. Fats/lipids classification, properties, and functions.	12
2	**Enzymes and Co enzymes.** Nature and properties of enzymes, classification of enzymes, mode of action of enzymes, active site, mechanism and action of enzymes, factors affecting enzyme activity, Regulation of enzyme activity, industrial and commercial applications of enzymes. Coenzymes: classification, various types and function, structure of NAD+, NADP+, FAD and FMN.	12
3	**carbohydrates metabolism.** Carbohydrate metabolism- Glycolysis, Gluconeogenesis, Tricarboxylic acid cycle, Electron transport chain, Oxidative phosphorylation, Hexose monophosphate shunt, Glycogen metabolism and its regulation.	12
4	**Proteins and amino acid metabolism.** Protein metabolism- General overview, Protein turnover, Nitrogen balance, Amino acid pool, sources for body amino acid pool, transamination, mechanism of transamination, deamination-oxidative and non-oxidative deamination, ammonia and its toxicity, Urea cycle.	12
5	**Lipid and nucleic acid metabolism.** Lipid metabolism- Mobilization of triglycerides, metabolism of glycerol, biosynthesis, and β- oxidation of saturated fatty acids (palmitic acid), ketone bodies. Nucleic acid metabolism-General overview, Outline of purine and pyrimidine metabolism. Introduction to metabolic inborn error diseases: Gout and Lesch-Nyhan syndrome.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Describe the chemistry, classification and structural organisation of carbohydrates, lipids, amino acids and proteins	K2	1
CO2	Explain the classification, mechanism and regulation of enzyme action and the role of coenzymes	K2	2
CO3	Describe the catabolic and regulatory reactions of carbohydrate metabolism	K2	3
CO4	Explain amino acid and protein catabolism, including the urea cycle and ammonia toxicity	K2	4
CO5	Analyse lipid and nucleic acid metabolism and relate metabolic inborn errors to enzyme defects	K4	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	-	1	-	-	1	2	-	-
CO2	3	2	1	-	1	1	-	1	2	2	-	-
CO3	3	1	1	-	-	1	-	1	-	2	2	-
CO4	3	1	1	-	1	1	-	-	-	2	2	-
CO5	3	1	2	1	2	1	-	1	-	2	3	1
Avg.	**3.0**	**1.2**	**1.2**	**1.0**	**1.3**	**1.0**	**-**	**1.0**	**1.5**	**2.0**	**2.3**	**1.0**

Text Books

1. Lehninger Principles of Biochemistry, 5thedition (2012), David L. Nelson and Michael M. Cox; W. H. Freeman, ISBN-13: 978-0716771081.
2. Principles and Techniques of Practical Biochemistry, 5thedition (2000), Keith Wilson and John Walker; Cambridge University Press, ISBN -13: 978-0521799652..

Reference Books

1. "Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer ISBN: 978-1319114657

BITT1503: Data Science

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	I	Core

Course Description

This course provides a comprehensive introduction to computing, starting from binary representation and progressing to programming, data manipulation, linear algebra, and operating system concepts. It equips students with a deep understanding of the computational underpinnings of data science.

Course Objectives

1. To introduce the history and evolution of computing and the binary, octal and hexadecimal number systems.
2. To explain how numbers, characters and data are represented, stored and manipulated in a computer.
3. To develop proficiency in Python programming fundamentals, including control structures, functions and modules.
4. To develop advanced Python skills: generators, comprehensions, file handling, error handling and algorithm design.
5. To apply linear algebra concepts (vectors, matrices, transformations, eigenvalues) to data science problems in biology.

Note: *The source sheet listed objectives on statistics, machine learning, data mining and visualisation, and learning outcomes on calculus and polynomial roots, none of which appear in the five units. Objectives and outcomes here are aligned to the syllabus as printed. If the Board of Studies wants those topics, a unit on statistics and visualisation should be added.*

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Computing.** Early history of computing; Evolution of computing devices and current trends; Understanding binary representation; Hexadecimal and octal numbering systems; Programming Languages and Hardware Abstraction	12
2	**Data Representation.** Integer and floating-point representation; Character encoding (ASCII and Unicode); Data structures and memory allocation; Data manipulation and storage	12
3	**Programming Fundamentals.** Introduction to Python functions and modules; Programming paradigms (imperative, procedural, object-oriented); Control structures (if statements, loops); Functions, scope, and lifetime of variables	12
4	**Advanced Python Programming.** More advanced Python topics (generators, comprehensions, decorators); File handling and I/O operations; Error handling and debugging techniques; Algorithm design and analysis	12
5	**Linear Algebra for Data Science.** Vectors and matrices; Matrix operations (addition, multiplication); Linear transformations; Eigenvalues and eigenvectors; Applications of linear algebra in data science	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the evolution of computing and convert between binary, octal, decimal and hexadecimal number systems	K2	1
CO2	Describe how integers, floating-point numbers, characters and data structures are represented and stored	K2	2
CO3	Write Python programs using control structures, functions and modules to solve computational problems	K3	3
CO4	Apply advanced Python features, file handling and error handling to process data and design simple algorithms	K3	4
CO5	Apply vector, matrix and eigenvalue concepts to model and interpret biological datasets	K3	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	-	-	-	1	1	-	-	-	2	-	-
CO2	2	-	1	-	-	1	-	-	-	2	1	-
CO3	3	2	1	-	2	1	-	1	2	2	1	-
CO4	3	2	2	-	2	2	-	2	2	2	2	-
CO5	3	1	2	-	1	1	-	2	1	3	3	-
Avg.	**2.6**	**1.7**	**1.5**	**-**	**1.5**	**1.2**	**-**	**1.7**	**1.7**	**2.2**	**1.8**	**-**

Text Books

1. Python Data Science Handbook: Tools and Techniques for Developers, by Jake Vander Plas publishers O'Reilly Media, Inc. November 2016
2. Python for Data Analysis - Data Wrangling with Pandas, NumPy, and IPython by Wes McKinney was published by O'Reilly Media, Inc 2017

Reference Books

1. "Think Python - How to Think Like a Computer Scientist" by Allen B. Downey and was published by O'Reilly Media, Inc. 2012
2. "Learning Python" by Mark Lutz and David Ascher published by O'Reilly Media, Inc. 2003.

TAUT1101: University Core 1: Communicative English

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	I	University Core

Course Description

The creation of the Course is to facilitate Stakeholders in productively using the Language to functional advantage to form meaningful engagements in a social context and influence their professional dynamic.

Course Objectives

1. Improve speaking ability in English both in terms of fluency and comprehensibility. Enlarge vocabulary by maintaining a Vocabulary Journal. Increase reading speed and comprehension of academic articles.
2. Heighten awareness of the correct usage of English grammar in Writing and Speaking.
3. Strengthen ability to write academic papers, essays and summaries using "Mind Mapping'.
4. Develop skills that enable them to communicate effectively in English. To present ideas clearly and logically to achieve a specific purpose and to be appropriate for an intended audience
5. Give Oral Presentations and receive Feedback on their performance.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Vocabulary and Reading.** Special Features of English Vocabulary, Reading With Purpose; Understanding What is Read; Drawing a Conclusion Based on Inferences, Deduction, Reading Between the Lines, Context, Connotation, Higher Order Thinking; How to Explain Specific Information with Clarity; Defining and Giving Reasons; Giving Directions; Professional Vocabulary	10
2	**Basic Grammar.** Subject-Verb Agreement; Verb Tenses; Active-Passive Voice; Direct and Indirect Speech; Question Tags; Degrees of Comparison; Articles; Avoiding Jargon.	10
3	**Writing.** Letter Writing; Report Writing; E-Communication, Drafting and Collating Key Information, Taking Notes from Lectures, Reading Materials, Reporting on Minutes of the Meeting, Precis Writing.	10
4	**Basics of Communication.** Role of Communication, Purpose of Communication, Barriers of Communication, Verbal and Non- Verbal Communication, Communication at the workplace, Human Needs and Communication, Mind Mapping and E-Communication.	10
5	**Presentations.** Self-Introduction, Individual Presentation, Group Discussions, Debates.	5
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Read academic and professional texts for intensive information, paraphrase and summarise them accurately, and use professional vocabulary	K3	1
CO2	Use English grammatical structures correctly in speaking and writing across communicative contexts	K3	2
CO3	Plan, draft, revise and edit letters, reports, notes and precis, and avoid plagiarism by citing sources ethically	K3	3
CO4	Analyse communication processes, barriers and verbal and non-verbal messages, and recognise the effects of diversity and power in communication	K4	4

CO	Statement	Bloom level	Unit
CO5	Deliver professional presentations and take part in group discussions and debates with fluency and confidence	K3	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	-	1	-	3	2	-	-	-	-	-	-
CO2	1	-	-	-	3	2	-	-	-	-	-	-
CO3	1	-	2	3	2	2	-	-	-	-	1	3
CO4	-	-	1	2	2	2	-	-	-	-	2	2
CO5	-	-	1	1	3	2	-	-	-	-	1	1
Avg.	**1.0**	**-**	**1.2**	**2.0**	**2.6**	**2.0**	**-**	**-**	**-**	**-**	**1.3**	**2.0**

Text Books

1. Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech & Jan Svartvik. A Comprehensive Grammar of the English Language. London: Longman, 1989
2. Communicative English for Engineers and Professionals by Nitin Bhatnagar & Mamta Bhatnagar New Delhi: Pearson / Longman

Reference Books

1. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and scientists. Delhi: PHI, 2009
2. A Textbook of English for Engineers and Technologists (combined edition, Vol. 1 & 2); Orient Black Swan 2010.
3. English Communications Skills for Professionals, by Gregory A. Barnes, ISBN13: 978-0844208589, 2nd Edition

Academic Resources

Scholarly journals; newspapers and magazines; professional sources; conference proceedings; government documents; Wren and Martin, High School English Grammar and Composition; Raymond Murphy, English Grammar in Use; Zoeller, Watkins and Lampman, Speaking Effective English.

TAUT1201: University Elective 1

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	I	University Elective

The syllabus for this course is drawn from the University Elective basket and is not part of the Biotechnology source document. The elective sheet issued by the University (in the same OBE format) is to be attached here before submission.

BITL1501: Data Science Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	I	Laboratory

Course Description

This laboratory course introduces undergraduate Biotechnology students to the fundamentals of data science using Python and the Linux operating system. Students will develop practical skills in Linux command-line operations, Python programming, data structures, file handling, and basic data manipulation. The course emphasizes computational thinking, scripting, and problem- solving, laying the foundation for bioinformatics, computational biology, and data-driven biological research.

Course Objectives

1. To train students in Linux command-line operations for file and directory management.
2. To develop Python programming skills using variables, control structures, functions and modules.
3. To teach the use of Python data structures and file handling with exception handling.
4. To enable data manipulation, analysis and visualisation using NumPy, Pandas and Matplotlib.
5. To apply computational skills to introductory problems in biotechnology and bioinformatics.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Installation and configuration of Python (Anaconda/Google Colab) and introduction to the Linux environment	4
2	Practice of basic Linux commands for file and directory management, navigation, and file permissions	6
3	Writing and executing Python programs using variables, data types, arithmetic operations, and user input	6
4	Implementation of conditional statements and looping constructs to solve simple computational problems	6
5	Development of user-defined functions and utilization of Python modules for mathematical and scientific computations	8
6	Manipulation of Python data structures including lists, tuples, dictionaries, and sets	8
7	Reading from and writing to text and CSV files with exception handling using try-except	6
8	Data manipulation using the NumPy library, including array creation and mathematical operations	8
9	Data analysis and visualization using Pandas and Matplotlib (reading datasets, summary statistics, and plotting graphs)	8
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate proficiency in Linux commands and Python programming for computational tasks.	K3
CO2	Develop Python programs using control structures, functions, and data structures to solve biological problems.	K3
CO3	Perform file handling and basic data processing using Python.	K3

CO	Statement	Bloom level
CO4	Analyze and visualize biological datasets using Python libraries such as NumPy, Pandas, and Matplotlib.	K4
CO5	Apply computational and data science skills to solve introductory problems in biotechnology and bioinformatics.	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	-	-	2	1	-	-	2	2	-	-
CO2	2	3	1	-	2	1	-	1	2	2	2	-
CO3	2	3	1	1	2	1	-	1	2	1	1	-
CO4	2	3	2	-	2	1	-	3	2	2	3	-
CO5	3	2	2	1	3	2	-	2	2	3	3	1
Avg.	**2.2**	**2.8**	**1.5**	**1.0**	**2.2**	**1.2**	**-**	**1.8**	**2.0**	**2.0**	**2.2**	**1.0**

Text Books and Laboratory Manuals

1. Eric Matthes. Python Crash Course, 3rd Edition, No Starch Press, 2023.
2. Wes McKinney. Python for Data Analysis, 3rd Edition, O'Reilly Media, 2022.
3. Allen B. Downey. Think Python: How to Think Like a Computer Scientist, 2nd Edition, O'Reilly Media.
4. Evi Nemeth, Garth Snyder, Trent R. Hein & Ben Whaley. UNIX and Linux System Administration Handbook, 5th Edition.
5. Jake VanderPlas. Python Data Science Handbook, O'Reilly Media.

BITL1502: Biochemistry Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	I	Laboratory

Course Description

This laboratory course provides foundational training in biochemical techniques commonly employed in biotechnology laboratories. Students will gain practical experience in the qualitative and quantitative analysis of biomolecules, enzyme assays, chromatography, and isolation of biological macromolecules. The course emphasizes laboratory safety, accurate experimentation, data interpretation, and the biochemical principles underlying biological systems.

Course Objectives

1. To train students in laboratory safety and good laboratory practice in a biochemistry laboratory.
2. To enable qualitative identification of carbohydrates, amino acids, proteins and lipids.
3. To develop skills in quantitative estimation of biomolecules.
4. To study the effect of temperature and pH on enzyme activity and to apply chromatographic separation.
5. To develop the ability to record, analyse and interpret experimental data accurately.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Qualitative analysis of carbohydrates using standard biochemical tests	6
2	Qualitative analysis of amino acids and proteins	6
3	Qualitative analysis of lipids	6
4	Hydrolysis of sucrose and starch and identification of hydrolysis products	6
5	Determination of the saponification value of fats and oils	6
6	Isolation of casein from milk	6
7	Estimation of glucose by Benedict's method	6
8	Estimation of proteins by Lowry's method	6
9	Separation of amino acids and sugars by paper chromatography or thin-layer chromatography (TLC)	6
10	Study of the effect of temperature and pH on enzyme activity	6
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Perform qualitative identification of carbohydrates, proteins, amino acids, and lipids using standard biochemical tests.	K3
CO2	Carry out quantitative estimation of biomolecules using established biochemical methods.	K3
CO3	Investigate the effects of environmental factors such as temperature and pH on enzyme activity.	K4
CO4	Apply chromatographic techniques for the separation and identification of biomolecules.	K3
CO5	Analyze experimental observations, interpret biochemical results, and maintain accurate laboratory records.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	1	-	-	1	3	1	-	-
CO2	3	3	1	-	2	-	-	2	3	1	1	-
CO3	3	3	2	-	1	1	-	3	2	1	2	-
CO4	2	3	1	-	2	-	-	2	3	2	1	-
CO5	2	2	3	2	2	2	-	3	1	1	3	1
Avg.	**2.6**	**2.8**	**1.8**	**2.0**	**1.6**	**1.5**	**-**	**2.2**	**2.4**	**1.2**	**1.8**	**1.0**

Text Books and Laboratory Manuals

1. Plummer, D. T. An Introduction to Practical Biochemistry. McGraw-Hill Education.
2. Jayaraman, J. Laboratory Manual in Biochemistry. New Age International Publishers.
3. Sadasivam, S. & Manickam, A. Biochemical Methods. New Age International Publishers.
4. Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

SEMESTER II

BITT1504: Molecular Biology and Genetic Engineering

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	II	Core

Course Description

This course provides a comprehensive understanding of the molecular basis of life and the principles of genetic engineering. It covers the structure, organization, replication, expression, regulation, and repair of genetic material in prokaryotic and eukaryotic systems. The course also introduces recombinant DNA technology, cloning strategies, vectors, DNA libraries, polymerase chain reaction (PCR), gene transfer techniques, and molecular diagnostic tools. Students will gain theoretical knowledge and practical insights into modern molecular biology techniques and their applications in biotechnology, medicine, agriculture, environmental science, and genetic engineering.

Course Objectives

1. To understand the structure, organization, and function of genetic material in prokaryotic and eukaryotic organisms.
2. To explain the molecular mechanisms of DNA replication, transcription, translation, and regulation of gene expression.
3. To understand bacterial genetics, mutations, DNA damage, and DNA repair mechanisms.
4. To introduce the principles, tools, and techniques of recombinant DNA technology and genetic engineering.
5. To develop knowledge of cloning vectors, DNA libraries, PCR, gene transfer methods, and their applications in biotechnology, medicine, agriculture, and research.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Chemical Basis of Heredity and Genome Organization.** Introduction to Molecular Biology and Genetic Engineering; Experimental proof of DNA and RNA as genetic material; Structure and functions of DNA and RNA; Watson and Crick model of DNA; A, B and Z forms of DNA; Ribozymes and catalytic RNA; Organization of prokaryotic genome (chromosome and plasmids); Organization of eukaryotic genome (chromatin, nucleosomes and chromosomes); Gene and gene expression.	12
2	**DNA Replication, Transcription and Translation.** DNA replication in prokaryotes and eukaryotes; Enzymes and proteins involved in DNA replication; Mechanism of transcription—initiation, elongation and termination; RNA polymerases, promoters and transcription factors; Post-transcriptional modifications—5′ capping, polyadenylation and mRNA splicing; Transcriptional inhibitors; Genetic code and Wobble hypothesis; Mechanism of translation in prokaryotes and eukaryotes; Post-translational modifications; Regulation of gene expression—Operon concept, Lac operon and Tryptophan operon.	12
3	**Recombinant DNA Technology and Cloning Vectors.** Principles and requirements of recombinant DNA technology; Isolation and purification of DNA; Restriction endonucleases, DNA ligases, DNA polymerases, reverse transcriptase and nucleases; Restriction–modification systems; Cohesive and blunt ends; Cloning vectors—Plasmids, Bacteriophages, Cosmids, BACs and YACs; Expression vectors; Promoters (lac, tac, T7 and λPL); Mammalian vectors (SV40); Plant vectors (Ti and Ri plasmids); Site-directed mutagenesis.	12

Unit	Title and contents	Hours
4	**Gene Cloning and Molecular Techniques.** Gene cloning strategies; Construction of genomic and cDNA libraries; cDNA synthesis; DNA hybridization and DNA probes; Southern, Northern and Western blotting; Gene transfer methods— Transformation, Transduction, Transfection, Electroporation, Microinjection, Particle bombardment and Liposome-mediated gene transfer; Screening and selection of recombinant clones; PCR— Principle, components, primer design and Taq DNA polymerase; Types of PCR—Multiplex PCR, Inverse PCR and Real-Time PCR; RFLP, RAPD and AFLP.	12
5	**Bacterial Genetics, and Applications of Genetic Engineering.** Bacterial recombination—Conjugation (F+, F−, Hfr and F′ strains), Transformation and Griffith's experiment, Generalized and Specialized Transduction, Bacterial Transposons; DNA repair mechanisms—Mismatch repair, Photoreactivation, Base excision repair, Nucleotide excision repair and SOS repair; Beneficial and harmful effects of mutations; Applications of genetic engineering in medicine, agriculture, industry, environmental biotechnology, forensic science and gene therapy.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the structure, organization, replication, expression, regulation, and repair of genetic material in prokaryotic and eukaryotic organisms.	K2
CO2	Describe the molecular mechanisms of gene expression and bacterial genetic recombination, and their significance in cellular processes.	K2
CO3	Demonstrate an understanding of recombinant DNA technology, cloning vectors, DNA libraries, PCR, and other molecular biology techniques.	K2
CO4	Apply molecular biology and genetic engineering principles to solve problems in biotechnology, medicine, agriculture, environmental science, and genetic research.	K3
CO5	Perform and interpret fundamental molecular biology techniques, including DNA isolation, cloning, PCR, blotting, and gene transfer methods used in research and diagnostics.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	1	1	-	2	2	1	-	-
CO2	3	3	1	-	1	1	-	3	2	1	1	-
CO3	3	3	2	-	1	1	-	3	3	1	2	-
CO4	3	2	2	-	2	1	-	2	3	2	2	-
CO5	3	2	3	1	2	2	-	3	3	2	3	2
Avg.	**3.0**	**2.4**	**2.0**	**1.0**	**1.4**	**1.2**	**-**	**2.6**	**2.6**	**1.4**	**2.0**	**2.0**

Text Books

1. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C. &Gelbart, W. M.(2000) An Introduction to Genetic Analysis (7th Ed.), Freeman, New York.
2. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E., Silver, L. M. & Veres, R. C. (2000) Genetics: From Genes to Genomes,Tata McGraw Hill, New Delhi.
3. Brown, T. A. (2021). Gene Cloning and DNA Analysis: An Introduction (8th Ed.). Wiley- Blackwell.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). Molecular Biology of the Gene (7th Ed.). Pearson.

Reference Books

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). Molecular Biology of the Cell (7th Ed.). Garland Science.
2. Lodish, J. H & Baltimore, D. (1990).Molecular Cell Biology (2nd Ed.), Scientific American Books, New York.
3. Watson, J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. & Weiner, A. M. (1987). Molecular Biology of the Gene (4th Ed.), Benjamin Cummins, Menlo Park.
4. Primrose, S. B., & Twyman, R. M. (2020). Principles of Gene Manipulation and Genomics (8th Ed.). Wiley-Blackwell.
5. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). Molecular Biotechnology: Principles and Applications of Recombinant DNA (5th Ed.). ASM Press. .

BITT1505: Microbiology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	II	Core

Course Description

This course introduces students to the fundamental principles of microbiology, emphasizing the diversity, structure, physiology, genetics, and classification of microorganisms. It covers bacteria, viruses, fungi, and parasites of medical and biotechnological importance, along with host-microbe interactions, antimicrobial resistance, and the beneficial role of microorganisms in human health, industry, and the environment. The course also highlights laboratory biosafety and modern diagnostic approaches in microbiology.

Course Objectives

1. Understand the diversity, structure, classification, physiology, and growth characteristics of microorganisms.
2. Explain the pathogenic mechanisms of medically important bacteria, fungi, viruses, and parasites.
3. Describe host-microbe interactions, immune responses, antimicrobial agents, and mechanisms of drug resistance.
4. Understand laboratory biosafety, sterilization, microbial diagnostics, and infection control practices.
5. Appreciate the beneficial roles of microorganisms in human health, biotechnology, agriculture, and environmental sustainability.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Microbiology and Microbial Diversity.** History, scope, and branches of microbiology; classification and characteristics of prokaryotic and eukaryotic microorganisms; bacterial cell structure and morphology; introduction to fungi, viruses, viroids, prions, and parasites; microbial nutrition, culture media, bacterial growth curve, aerobic and anaerobic cultivation; sterilization, disinfection, aseptic techniques, biosafety levels, and biomedical waste management.	12
2	**Bacteriology and Bacterial Diseases.** Structure and functions of bacterial cell components; bacterial genetics, plasmids, endospores, and bacterial classification; microbial metabolism and growth factors; pathogenic bacteria and mechanisms of virulence; bacterial diseases including tuberculosis, diphtheria, cholera, typhoid, food poisoning, urinary tract infections, gonorrhea, and syphilis; laboratory diagnosis and prevention.	12
3	**Medical Mycology and Parasitology.** Classification and characteristics of medically important fungi; superficial, cutaneous, subcutaneous, systemic, and opportunistic mycoses; life cycle and pathogenicity of Candida albicans and Aspergillus species; antifungal agents; medically important protozoa and helminths including Plasmodium, Entamoeba histolytica, Taenia solium, Ascaris lumbricoides, and Fasciola hepatica; laboratory diagnosis, prevention, and control.	12
4	**Virology and Emerging Infectious Diseases.** General characteristics, structure, classification, cultivation, and replication of viruses; lytic and lysogenic cycles of bacteriophages; viroids and prions; medically important RNA and DNA viruses including influenza virus, poliovirus, rabies virus, hepatitis viruses, human papillomavirus (HPV), adenovirus, HIV, SARS-CoV-2, and rotavirus; emerging and re-emerging viral diseases; nosocomial infections and infection control.	12
5	**Antimicrobial Agents, Microbiome, and Clinical Microbiology.** Principles of antimicrobial chemotherapy; classes and mechanisms of antibiotics; antimicrobial susceptibility testing; multidrug resistance and antimicrobial stewardship; normal human microbiota and its role in health and disease; gut microbiome and probiotics; microbial diagnostics, molecular detection techniques (PCR and ELISA), vaccines, and applications of microbiology in biotechnology and public health.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the structure, classification, physiology, and diversity of microorganisms.	K2
CO2	Describe the etiology, pathogenesis, diagnosis, prevention, and control of major bacterial, fungal, viral, and parasitic diseases.	K2
CO3	Apply principles of sterilization, disinfection, biosafety, and microbial identification in laboratory and clinical settings.	K3
CO4	Evaluate antimicrobial agents, mechanisms of antimicrobial resistance, and strategies for infection control.	K5
CO5	Explain the significance of the human microbiome, microbial diagnostics, and the applications of microbiology in biotechnology, medicine, and public health.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	-	1	2	-	-
CO2	3	1	1	-	2	1	-	-	1	2	1	-
CO3	3	2	1	-	3	1	-	1	1	2	2	-
CO4	3	2	2	1	3	1	-	1	2	2	3	1
CO5	3	2	2	2	3	2	-	1	2	2	3	2
Avg.	**3.0**	**1.6**	**1.5**	**1.5**	**2.4**	**1.2**	**-**	**1.0**	**1.4**	**2.0**	**2.2**	**1.5**

Text Books

1. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson.
2. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology. 11th Edition. McGraw-Hill.

Reference Books

1. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson.
2. Forbes, B. A., Sahm, D. F., & Weissfeld, A. S. Bailey & Scott's Diagnostic Microbiology. 15th Edition. Elsevier.
3. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. Medical Microbiology. 10th Edition. Elsevier.

BITT1506: Bioanalytical Techniques

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	II	Core

Course Description

This course introduces the principles and applications of modern bioanalytical techniques widely used in biological, biomedical, pharmaceutical, and biotechnological research. It covers the theoretical foundations and instrumentation of separation techniques, spectroscopy, mass spectrometry, electrochemical methods, and biosensors. The course emphasizes the selection, operation, and applications of analytical techniques for the qualitative and quantitative analysis of biological molecules.

Course Objectives

1. Understand the principles and instrumentation of major bioanalytical techniques used in biological sciences.
2. Explain the applications of spectroscopic, chromatographic, electrophoretic, and mass spectrometric methods in biomolecular analysis.
3. Develop knowledge of sample preparation, analytical method selection, and data interpretation.
4. Understand the applications of biosensors, microarrays, and electrochemical techniques in biotechnology and healthcare.
5. Appreciate quality assurance, laboratory safety, and the role of bioanalytical techniques in research, diagnostics, and industry.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Sample Preparation and Separation Techniques.** Principles and applications of centrifugation; differential, density gradient, and ultracentrifugation; principles of electrophoresis; agarose gel electrophoresis, polyacrylamide gel electrophoresis (PAGE), SDS-PAGE, isoelectric focusing, two-dimensional gel electrophoresis (2D-PAGE), capillary electrophoresis, pulse-field gel electrophoresis; introduction to radioisotopes and their applications in biological research.	12
2	**Chromatographic and Spectroscopic Techniques.** Principles and applications of chromatography; paper, thin-layer, ion-exchange, gel filtration, affinity, gas chromatography (GC), high-performance liquid chromatography (HPLC); principles, instrumentation, and applications of UV-Visible spectroscopy; infrared (IR) spectroscopy; Raman spectroscopy; turbidimetry and nephelometry.	12
3	**Fluorescence and Mass Spectrometry.** Principles of fluorescence spectroscopy; fluorescence immunoassays, molecular beacons, and DNA sequencing; principles and instrumentation of mass spectrometry; ionization techniques (EI, ESI, MALDI); mass analyzers (quadrupole, TOF, magnetic sector); applications in peptide sequencing, protein identification, metabolomics, and proteomics.	12
4	**Nuclear Magnetic Resonance and Advanced Analytical Techniques.** Principles of Nuclear Magnetic Resonance (NMR) spectroscopy; chemical shift, spin-spin coupling, and structural elucidation; Fourier Transform NMR (FT-NMR), two-dimensional NMR (2D-NMR); Electron Spin Resonance (ESR) spectroscopy; introduction to Magnetic Resonance Imaging (MRI) and Magnetic Resonance Spectroscopy (MRS) and their biomedical applications.	12
5	**Electrochemical Methods, Biosensors, and Emerging Technologies.** Principles and applications of potentiometry and Clark's oxygen electrode; biosensors—electrochemical, optical, piezoelectric, and enzyme-based biosensors with emphasis on glucose biosensors; principles and applications of DNA and protein microarrays; introduction to lab-on-a-chip technologies, biosensing platforms, quality assurance, and applications of bioanalytical techniques in diagnostics, biotechnology, pharmaceuticals, and biomedical research.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles, instrumentation, and applications of major bioanalytical techniques used in biotechnology.	K2
CO2	Select appropriate chromatographic, electrophoretic, spectroscopic, and mass spectrometric techniques for biomolecular analysis.	K3
CO3	Interpret analytical data generated from modern bioanalytical instruments.	K4
CO4	Describe the principles and applications of biosensors, electrochemical methods, and microarray technologies.	K2
CO5	Apply bioanalytical concepts in research, clinical diagnostics, pharmaceutical analysis, and quality assurance.	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	1	1	-	2	2	1	-	-
CO2	3	3	1	-	1	1	-	3	2	1	1	-
CO3	3	3	2	-	1	1	-	3	3	1	2	-
CO4	3	2	2	-	2	1	-	2	3	2	2	-
CO5	3	2	3	1	2	2	-	3	3	2	3	2
Avg.	**3.0**	**2.4**	**2.0**	**1.0**	**1.4**	**1.2**	**-**	**2.6**	**2.6**	**1.4**	**2.0**	**2.0**

Text Books

1. Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. 8th Edition. Cambridge University Press.
2. Upadhyay, A., Upadhyay, K., & Nath, N. Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House.

Reference Books

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. Principles of Instrumental Analysis. 7th Edition. Cengage Learning.
2. Lottspeich, F. & Engels, J. W. Bioanalytics: Analytical Methods and Concepts in Biochemistry and Molecular Biology. Wiley-VCH.
3. Voet, D., Voet, J. G., & Pratt, C. W. Fundamentals of Biochemistry: Life at the Molecular Level. Wiley.

TAUT1102: University Core 2: Environmental Studies

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	II	University Core

Course Description

This course provides an interdisciplinary understanding of the interactions between humans and the environment, emphasizing ecological principles, natural resource conservation, biodiversity, environmental pollution, sustainable development, and environmental governance. It equips students with the knowledge and skills required to address contemporary environmental challenges and promotes responsible environmental stewardship for sustainable living.

Course Objectives

1. Understand the fundamental concepts of ecology, environmental science, and sustainable development.
2. Explain the importance of natural resources, biodiversity, and ecosystem services in maintaining ecological balance.
3. Analyze the causes and impacts of environmental pollution, climate change, and other global environmental challenges.
4. Develop awareness of environmental laws, policies, ethics, and sustainable resource management practices.
5. Promote environmental responsibility and adopt sustainable practices in personal, professional, and societal contexts.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Environmental Studies and Natural Resources.** Definition, scope, and importance of environmental studies; multidisciplinary nature of environmental science; public awareness and environmental education; natural resources— renewable and non-renewable resources; forest, water, mineral, food, energy, and land resources; resource depletion and conservation; sustainable utilization of natural resources; equitable resource distribution and sustainable lifestyles.	9
2	**Ecosystems and Ecology.** Concept, structure, and functions of ecosystems; biotic and abiotic components; producers, consumers, and decomposers; energy flow and ecological pyramids; food chains and food webs; ecological succession; forest, grassland, desert, freshwater, estuarine, and marine ecosystems; ecosystem services and ecological balance.	9
3	**Biodiversity and Environmental Pollution.** Levels of biodiversity—genetic, species, and ecosystem diversity; biodiversity hotspots; biogeographical regions of India; importance and conservation of biodiversity; threats to biodiversity; causes, effects, prevention, and control of air, water, soil, noise, thermal, marine, and radioactive pollution; solid waste management; disaster management including floods, earthquakes, cyclones, and landslides.	9
4	**Social Issues, Climate Change, and Environmental Management.** Sustainable development; urban environmental issues; water conservation, rainwater harvesting, and watershed management; environmental ethics; climate change, global warming, ozone layer depletion, acid rain, and carbon footprint; renewable energy resources; environmental impact assessment; environmental legislation including the Environment Protection Act, Water Act, Air Act, Wildlife Protection Act, and Forest Conservation Act; environmental governance and public participation.	9
5	**Human Population, Health, and Environmental Conservation.** Population growth and environmental impacts; human health and environmental quality; sanitation and public health; environmental hazards; environmental education and value systems; role of information technology in environmental management; consumer awareness and sustainable consumption; green technologies; national and global initiatives for environmental conservation; case studies on sustainable development and environmental protection.	9

Unit	Title and contents	Hours
	Total	45

Field Work (practical component)

1. Visit to a local ecosystem (forest, river, wetland, hill, or grassland) to document environmental resources.
2. Field visit to an urban, rural, industrial, or agricultural area to study environmental pollution.
3. Identification and documentation of common plants, insects, birds, and local biodiversity.
4. Study of ecosystem structure, biodiversity, and environmental conservation practices in the local community.
5. Preparation and presentation of a field report based on observations and environmental analysis.

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of ecology, natural resource management, and ecosystem functioning.	K2
CO2	Assess the importance of biodiversity conservation and sustainable utilization of natural resources.	K5
CO3	Analyze the causes, impacts, and control measures of various forms of environmental pollution and climate change.	K4
CO4	Interpret environmental policies, legislation, and sustainable development strategies for environmental protection.	K4
CO5	Demonstrate environmental responsibility through informed decision-making and sustainable practices in everyday life.	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	-	-	-	1	3	-	-	2	-	-
CO2	3	1	-	-	1	1	3	-	1	1	1	-
CO3	3	1	1	1	1	1	3	1	1	1	2	1
CO4	3	1	1	2	1	2	3	2	1	1	2	2
CO5	2	1	1	3	1	2	3	2	1	2	2	3
Avg.	**2.6**	**1.0**	**1.0**	**2.0**	**1.0**	**1.4**	**3.0**	**1.7**	**1.0**	**1.4**	**1.8**	**2.0**

Text Books

1. Bharucha, E. Textbook of Environmental Studies for Undergraduate Courses. Universities Press (UGC).
2. Cunningham, W. P. & Cunningham, M. A. Principles of Environmental Science: Inquiry and Applications. McGraw-Hill Education.

Reference Books

1. Singh, J. S., Singh, S. P., & Gupta, S. R. Ecology, Environmental Science and Conservation. S. Chand Publishing.
2. Odum, E. P. & Barrett, G. W. Fundamentals of Ecology. Cengage Learning.
3. Raven, P. H., Berg, L. R., & Hassenzahl, D. M. Environment. Wiley.

TAUT1202: University Elective 2

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	II	University Elective

The syllabus for this course is drawn from the University Elective basket and is not part of the Biotechnology source document. The elective sheet issued by the University (in the same OBE format) is to be attached here before submission.

BITL1503: Molecular Biology and Genetic Engineering Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	3	1.5	45	II	Laboratory

Course Description

This laboratory course provides hands-on training in fundamental molecular biology and genetic engineering techniques used in modern biotechnology. Students will develop practical skills in nucleic acid isolation, quantification, electrophoresis, restriction enzyme analysis, PCR, and recombinant DNA technology. The course emphasizes laboratory safety, good laboratory practices, accurate data interpretation, and the applications of molecular techniques in biological research.

Course Objectives

1. To train students in laboratory safety, good laboratory practice and preparation of reagents and buffers.
2. To enable isolation, quantification and quality assessment of genomic DNA.
3. To develop skills in agarose gel electrophoresis, restriction digestion and PCR.
4. To explain the principles of bacterial transformation and recombinant DNA technology.
5. To interpret molecular biology data and use basic bioinformatics tools for sequence analysis and primer design.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Preparation of laboratory reagents, buffers, and sterilization techniques (Autoclaving and aseptic handling)	5
2	Isolation of genomic DNA from plant or bacterial samples and qualitative analysis	5
3	Quantification and purity assessment of DNA using UV spectrophotometry (A260/A280) or NanoDrop (demonstration)	5
4	Separation of DNA by Agarose Gel Electrophoresis and interpretation of DNA banding patterns	5
5	Restriction digestion of DNA using restriction endonucleases and analysis of restriction fragments by agarose gel electrophoresis	5
6	Polymerase Chain Reaction (PCR) – Preparation of PCR reaction mixture and demonstration of DNA amplification	5
7	Analysis of PCR products using agarose gel electrophoresis	5
8	Bacterial transformation using plasmid DNA (demonstration or simulation) and selection of transformants on antibiotic-containing medium	5
9	Demonstration/Virtual experiment on recombinant DNA technology – Cloning strategy, plasmid vector map analysis, restriction mapping, and screening of recombinant clones	5
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate laboratory safety practices and prepare reagents and buffers required for molecular biology experiments.	K3
CO2	Isolate, quantify, and analyze genomic DNA using standard molecular biology techniques.	K4

CO	Statement	Bloom level
CO3	Perform agarose gel electrophoresis, restriction digestion, and PCR for DNA analysis.	K3
CO4	Explain the principles and applications of recombinant DNA technology and bacterial transformation.	K2
CO5	Interpret molecular biology experimental results and utilize basic bioinformatics tools for sequence analysis and primer design.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	1	-	-	1	3	1	-	-
CO2	3	3	1	-	2	-	-	2	3	1	1	-
CO3	3	3	2	-	1	1	-	3	2	1	2	-
CO4	2	3	1	-	2	-	-	2	3	2	1	-
CO5	2	2	3	2	2	2	-	3	1	1	3	1
Avg.	**2.6**	**2.8**	**1.8**	**2.0**	**1.6**	**1.5**	**-**	**2.2**	**2.4**	**1.2**	**1.8**	**1.0**

Text Books and Laboratory Manuals

1. Green, M. R., & Sambrook, J. Molecular Cloning: A Laboratory Manual. 4th Edition. Cold Spring Harbor Laboratory Press.
2. Brown, T. A. Gene Cloning and DNA Analysis: An Introduction. 8th Edition. Wiley- Blackwell.
3. Primrose, S. B., & Twyman, R. M. Principles of Gene Manipulation and Genomics. 8th Edition. Wiley-Blackwell.
4. Wilson, K., & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. 8th Edition. Cambridge University Press.
5. Glick, B. R., Pasternak, J. J., & Patten, C. L. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.

BITL1504: Microbiology Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	3	1.5	45	II	Laboratory

Course Description

This laboratory course provides practical training in fundamental microbiological techniques used in research, clinical, industrial, and environmental laboratories. Students will develop skills in microscopy, aseptic techniques, sterilization, microbial cultivation, growth analysis, and antimicrobial susceptibility testing. The course emphasizes good laboratory practices, biosafety, accurate observation, and interpretation of microbiological data.

Course Objectives

1. To train students in microbiological laboratory safety, aseptic technique and equipment handling.
2. To enable preparation and sterilisation of culture media and glassware.
3. To develop skills in isolation, staining and identification of bacteria.
4. To analyse bacterial growth and the effect of environmental factors on growth.
5. To perform antimicrobial susceptibility testing and interpret microbiological data.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Microscopy and Staining Techniques 2 To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory	5
2	Preparation of culture media for bacterial cultivation	5
3	Sterilization of medium using Autoclave and assessment for sterility	5
4	Sterilization of glassware using Hot Air Oven and assessment for sterility	5
5	Isolation of pure cultures of bacteria by streaking method	5
6	Study and plot the growth curve of E. coli by turbidometric and standard plate count methods	4
7	Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data	4
8	Effect of temperature, pH, salt, carbon and nitrogen sources on growth of E.coli	4
9	Antibiotic Susceptibility Testing by Kirby–Bauer Disc Diffusion Method	4
10	Demonstration of the thermal death time and decimal reduction time of E. coli	4
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate microbiological laboratory safety, aseptic techniques, and proper handling of laboratory equipment.	K3
CO2	Prepare, sterilize, and evaluate culture media and laboratory materials for microbial cultivation.	K5
CO3	Isolate, stain, and identify bacterial cultures using standard microbiological techniques.	K3
CO4	Analyze bacterial growth characteristics and evaluate the influence of environmental factors on microbial growth.	K5

CO	Statement	Bloom level
CO5	Perform antimicrobial susceptibility testing and interpret microbiological experimental data.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	1	-	-	1	3	1	-	-
CO2	3	3	1	-	2	-	-	2	3	1	1	-
CO3	3	3	2	-	1	1	-	3	2	1	2	-
CO4	2	3	1	-	2	-	-	2	3	2	1	-
CO5	2	2	3	2	2	2	-	3	1	1	3	1
Avg.	**2.6**	**2.8**	**1.8**	**2.0**	**1.6**	**1.5**	**-**	**2.2**	**2.4**	**1.2**	**1.8**	**1.0**

Text Books and Laboratory Manuals

1. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers.
3. Harley, J. P., & Prescott, L. M. Laboratory Exercises in Microbiology. McGraw-Hill Education.
4. Forbes, B. A., Sahm, D. F., & Weissfeld, A. S. Bailey & Scott's Diagnostic Microbiology. Elsevier.
5. Benson, H. J. Microbiological Applications: Laboratory Manual in General Microbiology. McGraw-Hill Education.

SEMESTER III

BITT2507: Immunology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	III	Core

Course Description

This course delves into the study of the immune system, its components, functions, and interactions with pathogens and diseased cells. Students will explore the molecular and cellular basis of immune responses, immune regulation, immunodeficiencies, and immunotherapy. Practical aspects include laboratory techniques for studying immune cells and molecules, with an emphasis on understanding how immunobiology impacts health and disease.

Course Objectives

1. Understand the fundamental principles of immunology, including the structure and function of immune cells, tissues, and molecules.
2. Analyze the mechanisms of immune responses to pathogens, allergens, and cancerous cells.
3. Evaluate the roles of genetics, environment, and immunological memory in shaping immune responses.
4. Explore the applications of immunobiology in vaccine development, immunotherapy, and personalized medicine.
5. Critically assess current research and emerging trends in immunobiology and their implications for healthcare.

Note: *The source learning outcomes referred to laboratory work (flow cytometry, ELISA), communication and teamwork, none of which are taught in the five theory units (the practical component is in BITL2503). Course Outcomes here are rewritten to match the units.*

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Overview of Immunity.** Overview of the immune system, Historical perspective on immunology, Components of the immune system (innate and adaptive), Barrier Immunity, Antigens and antibodies, Haptens.	12
2	**Innate Immunity & Adaptive Immunity.** Immune cells and their functions, Phagocytosis and macrophages, Complement system, Natural killer (NK) cells, Inflammation and its role in innate immunity, B-cells and T-cells, Immune response types, Antibody structure and function, Major Histocompatibility Complex (MHC) and antigen presentation	12
3	**Adaptive Immunity.** B cells and antibody-mediated immunity, B cell development and activation, T cells and cell-mediated immunity, T cell development and activation, Types of T cells (CD4+ and CD8+), Cytotoxic T cells and helper T cells.	12
4	**The recognition of antigen and Immune regulation.** Humoral Immune response, Cell mediated immune response, Antigen Recognition by B-cell and T- cell Receptors, The Generation of Lymphocyte Antigen Receptors, Antigen Presentation to T Lymphocytes, development of mature lymphocyte receptor, Lymphocyte Receptor Signaling	12
5	**The Immune System in Health and Disease.** Immunodeficiency disorders, Autoimmunity and autoimmune diseases, Allergies and hypersensitivity reactions, Vaccination and immunization, Failures of Host Défense Mechanisms, Allergy and Allergic Diseases, Transplantation immunology - Manipulation of the Immune Response, Infectious diseases and immunology, Emerging trends in immunology research	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the components of the innate and adaptive immune systems, antigens, antibodies and haptens	K2	1
CO2	Describe the functions of immune cells, the complement system, inflammation and the MHC in antigen presentation	K2	2
CO3	Explain B cell and T cell development, activation and effector functions in humoral and cell-mediated immunity	K2	3
CO4	Analyse antigen recognition, lymphocyte receptor generation and signalling in immune regulation	K4	4
CO5	Apply immunological principles to immunodeficiency, autoimmunity, allergy, vaccination and transplantation	K3	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	-	1	2	-	-
CO2	3	1	1	-	2	1	-	-	1	2	1	-
CO3	3	2	1	-	3	1	-	1	1	2	2	-
CO4	3	2	2	1	3	1	-	1	2	2	3	1
CO5	3	2	2	2	3	2	-	1	2	2	3	2
Avg.	**3.0**	**1.6**	**1.5**	**1.5**	**2.4**	**1.2**	**-**	**1.0**	**1.4**	**2.0**	**2.2**	**1.5**

Text Books

1. "Kuby Immunology" by Judy Owen, Jenni Punt, and Sharon Stranford
2. "Immunobiology" by Charles Janeway, Paul Travers, Mark Walport, and Mark Shlomchik
3. "Basic Immunology: Functions and Disorders of the Immune System" by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai

BITT2508: Plant Biotechnology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	III	Core

Course Description

This course introduces the principles and applications of plant biotechnology with emphasis on plant tissue culture, genetic transformation, molecular breeding, and crop improvement. It covers the techniques used for in vitro propagation, conservation of plant genetic resources, production of transgenic plants, genome editing, and the application of biotechnology in sustainable agriculture, food security, and environmental conservation.

Course Objectives

1. Understand the principles of plant tissue culture and in vitro plant regeneration.
2. Explain the molecular and genetic approaches used for crop improvement and plant transformation.
3. Describe the applications of plant biotechnology in agriculture, horticulture, and conservation biology.
4. Understand the role of molecular markers, genome editing, and transgenic technologies in modern plant breeding.
5. Appreciate the biosafety, bioethics, and regulatory aspects associated with genetically modified crops.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamentals of Plant Biotechnology.** Introduction to plant biotechnology; history and scope; plant cell totipotency; laboratory organization and aseptic techniques; culture media and plant growth regulators; types of plant tissue culture; callus culture, cell suspension culture, organ culture, and meristem culture; factors affecting in vitro culture.	12
2	**Plant Tissue Culture and Micropropagation.** Micropropagation and its stages; shoot tip, axillary bud, and nodal culture; somatic embryogenesis; synthetic seeds; embryo culture; anther and pollen culture for haploid production; protoplast isolation, culture, fusion, and somatic hybridization; applications of plant tissue culture in crop improvement and germplasm conservation.	12
3	**Plant Genetic Engineering and Molecular Breeding.** Gene transfer methods in plants; Agrobacterium tumefaciens-mediated transformation; direct gene transfer techniques including particle bombardment and electroporation; selectable and reporter genes; development of transgenic plants; molecular markers (RFLP, RAPD, AFLP, SSR, SNP); marker-assisted selection; genome editing using CRISPR-Cas technology.	12
4	**Applications of Plant Biotechnology.** Development of insect-resistant, herbicide-tolerant, disease-resistant, and stress-tolerant crops; biofortification; edible vaccines; production of secondary metabolites; molecular farming; plant- based biopharmaceuticals; conservation of endangered plant species; cryopreservation and germplasm storage.	12
5	**Biosafety, Intellectual Property Rights, and Future Perspectives.** Biosafety guidelines for genetically modified plants; environmental and food safety assessment; bioethics in plant biotechnology; intellectual property rights and plant breeder's rights; regulatory framework for genetically modified crops; future trends including genome editing, synthetic biology, precision agriculture, and climate-resilient crop development.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles and techniques of plant tissue culture and in vitro plant regeneration.	K2

CO	Statement	Bloom level
CO2	Describe methods of plant genetic transformation and molecular breeding for crop improvement.	K2
CO3	Evaluate the applications of plant biotechnology in agriculture, horticulture, and conservation.	K5
CO4	Interpret the role of molecular markers and genome editing technologies in modern plant breeding.	K4
CO5	Discuss biosafety, ethical, legal, and regulatory aspects related to plant biotechnology.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	1	1	2	-	-
CO2	3	1	1	-	2	1	-	1	2	2	1	-
CO3	3	2	1	-	2	1	-	2	2	2	2	-
CO4	3	2	1	1	3	1	-	2	2	2	3	1
CO5	2	2	1	2	3	1	1	2	1	3	3	2
Avg.	**2.8**	**1.6**	**1.0**	**1.5**	**2.2**	**1.0**	**1.0**	**1.6**	**1.6**	**2.2**	**2.2**	**1.5**

Text Books

1. Slater, A., Scott, N. W., & Fowler, M. R. Plant Biotechnology: The Genetic Manipulation of Plants. 2nd Edition. Oxford University Press.
2. Bhojwani, S. S., & Razdan, M. K. Plant Tissue Culture: Theory and Practice. Elsevier.

Reference Books

1. Chawla, H. S. Introduction to Plant Biotechnology. 3rd Edition. CRC Press.
2. Smith, R. H. Plant Tissue Culture: Techniques and Experiments. 3rd Edition. Academic Press.
3. Altman, A., & Hasegawa, P. M. Plant Biotechnology and Agriculture: Prospects for the 21st Century. Academic Press.

BITT2509: Enzyme Technology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	III	Core

Course Description

This course provides a comprehensive understanding of enzymes, their structure, classification, kinetics, mechanisms of action, production, purification, immobilization, and industrial applications. Students will explore enzyme assay techniques, factors affecting enzyme activity, enzyme engineering, and the role of enzymes in biotechnology, medicine, food processing, agriculture, environmental biotechnology, and pharmaceutical industries. The course integrates theoretical concepts with practical applications, preparing students for careers in biotechnology, industrial microbiology, and life sciences.

Course Objectives

1. To understand the structure, classification, properties, and catalytic mechanisms of enzymes.
2. To explain enzyme kinetics, inhibition, regulation, and factors influencing enzyme activity.
3. To understand the production, extraction, purification, and characterization of enzymes.
4. To introduce enzyme immobilization techniques and enzyme engineering for industrial applications.
5. To explore the applications of enzymes in biotechnology, medicine, food, agriculture, environmental science, and pharmaceutical industries.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Enzymes and Enzyme Kinetics.** Introduction to enzymes; Historical background; Nomenclature and classification of enzymes (EC classification); Structure and properties of enzymes; Active site; Lock-and-key and induced-fit theories; Cofactors, coenzymes and prosthetic groups; Isoenzymes and ribozymes; Enzyme specificity; Factors affecting enzyme activity (temperature, pH, substrate concentration, enzyme concentration); Michaelis–Menten kinetics; Lineweaver–Burk plot; Enzyme inhibition—competitive, non-competitive, uncompetitive and irreversible inhibition.	12
2	**Enzyme Production, Extraction and Purification.** Sources of enzymes—Plant, animal and microbial; Microbial production of industrial enzymes; Fermentation methods—Submerged and solid-state fermentation; Extraction of intracellular and extracellular enzymes; Enzyme purification techniques—Precipitation, dialysis, ultrafiltration, centrifugation, chromatography (ion-exchange, gel filtration and affinity chromatography); Electrophoresis; Enzyme assays; Specific activity; Purity and characterization of enzymes.	12
3	**Enzyme Immobilization and Enzyme Engineering.** Principles of enzyme immobilization; Advantages and limitations of immobilized enzymes; Methods of immobilization—Adsorption, covalent binding, entrapment, encapsulation and cross-linking; Immobilized enzyme reactors; Enzyme engineering—Protein engineering and directed evolution (overview); Site-directed mutagenesis (basic concept); Biosensors and enzyme-based diagnostics.	12
4	**Industrial Applications of Enzymes.** Industrial enzymes and their production; Applications in food and dairy industries; Brewing and baking industries; Detergent enzymes; Textile and leather industries; Paper and pulp industries; Pharmaceutical and fine chemical industries; Agricultural applications; Environmental biotechnology—Bioremediation and waste management; Clinical and diagnostic applications of enzymes.	12
5	**Recent Advances and Applications of Enzyme Technology.** Enzymes in molecular biology—DNA polymerases, restriction enzymes, ligases and reverse transcriptase; Therapeutic enzymes; Enzymes in nanobiotechnology; Enzyme-based biosensors; Immobilized enzymes in bioprocessing; Green chemistry and biocatalysis; Enzyme applications in personalized medicine; Recent advances in enzyme technology and future prospects.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the classification, structure, properties, kinetics, and catalytic mechanisms of enzymes.	K2
CO2	Evaluate the factors affecting enzyme activity and interpret enzyme kinetic data.	K5
CO3	Describe methods for enzyme production, extraction, purification, characterization, and immobilization.	K2
CO4	Apply enzyme technology principles in biotechnology, food processing, pharmaceuticals, agriculture, environmental management, and diagnostics.	K3
CO5	Demonstrate knowledge of modern enzyme engineering approaches and recent advances in industrial enzyme technology.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	1	1	-	2	2	1	-	-
CO2	3	3	1	-	1	1	-	3	2	1	1	-
CO3	3	3	2	-	1	1	-	3	3	1	2	-
CO4	3	2	2	-	2	1	-	2	3	2	2	-
CO5	3	2	3	1	2	2	-	3	3	2	3	2
Avg.	**3.0**	**2.4**	**2.0**	**1.0**	**1.4**	**1.2**	**-**	**2.6**	**2.6**	**1.4**	**2.0**	**2.0**

Text Books

1. Rastogi, S. C. (2020). Biochemistry (4th Ed.). McGraw Hill Education.
2. Dixon, M., & Webb, E. C. (1979). Enzymes (3rd Ed.). Academic Press.

Reference Books

1. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th Ed.). W. H. Freeman.
2. Chaplin, M. F., & Bucke, C. (1990). Enzyme Technology. Cambridge University Press.
3. Bisswanger, H. (2019). Enzyme Kinetics: Principles and Methods (3rd Ed.). Wiley-VCH.
4. Palmer, T., & Bonner, P. L. (2007). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (2nd Ed.). Woodhead Publishing.

BITT2510: Nanobiotechnology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	III	Core

Course Description

This course introduces the fundamental principles of nanotechnology and its applications in biological systems. It provides an understanding of nanomaterials, their synthesis, characterization, functionalization, and interactions with biological molecules and cells. The course emphasizes the applications of nanobiotechnology in medicine, drug delivery, diagnostics, biosensors, agriculture, environmental biotechnology, and tissue engineering. Students will gain knowledge of the interdisciplinary nature of nanobiotechnology and its emerging role in healthcare and biotechnology industries. The syllabus is designed specifically for undergraduate students and is aligned with current nanobiotechnology curricula.

Course Objectives

1. To understand the fundamental concepts, principles, and scope of nanobiotechnology.
2. To explain the properties, synthesis, and characterization of nanomaterials used in biological systems.
3. To understand the interactions between nanomaterials and biological molecules, cells, and tissues.
4. To introduce nanobiotechnology applications in medicine, agriculture, environmental science, and diagnostics.
5. To familiarize students with recent advances, ethical issues, and future prospects in nanobiotechnology.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Nanobiotechnology.** Introduction to nanotechnology and nanobiotechnology; Historical development; Scope and interdisciplinary nature; Nanoscale and size-dependent properties; Classification of nanomaterials (0D, 1D, 2D and 3D); Physical, chemical and biological properties of nanomaterials; Natural and synthetic nanomaterials; Applications of nanobiotechnology in life sciences	12
2	**Synthesis and Characterization of Nanomaterials.** Top-down and bottom-up approaches; Physical methods of nanoparticle synthesis; Chemical methods; Biological (green) synthesis of nanoparticles using plants and microorganisms; Functionalization of nanoparticles; Characterization techniques—UV-Visible spectroscopy, Dynamic Light Scattering (DLS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), X-ray Diffraction (XRD).	12
3	**Nanomaterials in Biological Systems.** Carbon nanotubes; Quantum dots; Gold and silver nanoparticles; Liposomes; Dendrimers; Polymeric nanoparticles; Nanocomposites; Nanomaterial–cell interactions; Cellular uptake of nanoparticles; Biocompatibility; Toxicity and biosafety of nanomaterials; Nano biomaterials for tissue engineering.	12
4	**Applications of Nanobiotechnology.** Nanomedicine; Targeted drug delivery systems; Nanoparticles in cancer diagnosis and therapy; Nano biosensors; Nano-based diagnostic tools; DNA and protein nanotechnology; Agricultural applications; Food nanotechnology; Environmental applications including water purification, biosensing and bioremediation.	12
5	**Recent Advances and Future Perspectives.** Nano vaccines; Gene delivery using nanoparticles; Nanozymes; Smart nanomaterials; Nanorobotics (overview); Personalized medicine; Regulatory aspects and biosafety; Ethical and environmental concerns; Commercial applications; Future prospects of nanobiotechnology.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the basic concepts, classification, and properties of nanomaterials used in biotechnology.	K2
CO2	Describe various methods of synthesis, functionalization, and characterization of nanomaterials.	K2
CO3	Understand the interactions between nanomaterials and biological systems, including their biocompatibility and toxicity.	K2
CO4	Apply the principles of nanobiotechnology to medicine, diagnostics, agriculture, food technology, and environmental biotechnology.	K3
CO5	Evaluate recent developments, ethical issues, and future applications of nanobiotechnology in research and industry.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	1	1	2	-	-
CO2	3	1	1	-	2	1	-	1	2	2	1	-
CO3	3	2	1	-	2	1	-	2	2	2	2	-
CO4	3	2	1	1	3	1	-	2	2	2	3	1
CO5	2	2	1	2	3	1	1	2	1	3	3	2
Avg.	**2.8**	**1.6**	**1.0**	**1.5**	**2.2**	**1.0**	**1.0**	**1.6**	**1.6**	**2.2**	**2.2**	**1.5**

Text Books

1. Niemeyer, C. M., & Mirkin, C. A. (2011). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH.
2. Goodsell, D. S. (2004). Bionanotechnology: Lessons from Nature. Wiley-Liss.

Reference Books

1. Bhushan, B. (2017). Springer Handbook of Nanotechnology (4th Ed.). Springer.
2. Kumar, C. S. S. R. (Ed.). (2006). Nanotechnologies for the Life Sciences. Wiley-VCH.
3. Salata, O. V. (Ed.). (2007). Applications of Nanotechnology in Biology and Medicine. Humana Press.
4. Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2020). Biomaterials Science: An Introduction to Materials in Medicine (4th Ed.). Academic Press.
5. Rai, M., & Duran, N. (Eds.). (2011). Metal Nanoparticles in Microbiology. Springer.

TAUT2101: University Core 3: Health and Wellness

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	III	University Core

Course Description

This course helps students learn about human health: how current health knowledge helps future generations become stronger and healthier.

Course Objectives

1. To help students understand the importance of a healthy lifestyle.
2. To familiarise students with physical and mental health.
3. To create awareness of lifestyle-related diseases.
4. To create awareness of metabolic diseases.
5. To introduce functional foods and their role in health.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Health, Wellness and Genetics.** Define and differentiate health and wellness, Importance of health and wellness, Basic concepts of genetics, including genes, DNA, chromosomes, and inheritance patterns. Genetic factors affecting macronutrient (carbohydrates, proteins, and fats) digestion. Genetic variations associated with micronutrient (vitamins and minerals) digestion; malnutrition, under nutrition and over nutrition	9
2	**Human Body Systems.** Brief overview of Body systems – Skeletal system, Muscular system, Circulatory System, Lymphatic system, Cardiovascular system, Respiratory system, Nervous system (Central nervous system, Peripheral nervous system, Somatic and Autonomic nervous systems), Digestive system, Urinary system, Endocrine system, Reproductive system, Integumentary system	9
3	**Lifestyle, Mental Health and Vital Signs.** Sedentary lifestyle and its risk of disease, Lifestyle Disease and its Management, Factors affecting mental health - Stress, anxiety, and depression, Identification of suicidal tendencies, Substance abuse (Drugs, Cigarette, Alcohol), de-addiction, counselling and rehabilitation. Four Vital signs- Pulse rate, Respiratory rate, Blood pressure, Body temperature, other measurements-Body mass index, Waist- Hip Ratio, Basal Metabolic Rate	9
4	**Lifestyle and Metabolic Diseases.** Risk factors and Pathology of the following Diseases and their Management – Diabetes, Hypertension, Coronary Heart Disease, Obesity, Osteoporosis, Osteoarthritis, Rheumatoid arthritis, Cancers (Blood, Breast, Brain, Lung, Liver and Kidney), Polycystic ovarian syndrome (PCOS), Pain (including Low Back pain)	9
5	**Functional Foods and Yoga.** Introduction to Functional Foods; Nutrients and Bioactive Compounds in Functional Foods; Functional Foods for Cardiovascular Health, Weight Management, Immune Function, Cognitive Health, Chronic Disease Prevention; Yoga and its importance in Health and Wellness	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Differentiate health and wellness and explain the role of genetics and nutrition in wellbeing	K2	1

CO	Statement	Bloom level	Unit
CO2	Describe the organisation and functions of the major human body systems relevant to health	K2	2
CO3	Evaluate lifestyle, mental health and substance use risks and apply basic vital-sign monitoring and preventive practices	K5	3
CO4	Explain the risk factors, pathology and management of major lifestyle and metabolic diseases	K2	4
CO5	Explain the role of functional foods and yoga in weight management and disease prevention	K2	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	-	1	2	-	-
CO2	3	1	1	-	2	1	-	-	1	2	1	-
CO3	3	2	1	-	3	1	-	1	1	2	2	-
CO4	3	2	2	1	3	1	-	1	2	2	3	1
CO5	3	2	2	2	3	2	-	1	2	2	3	2
Avg.	**3.0**	**1.6**	**1.5**	**1.5**	**2.4**	**1.2**	**-**	**1.0**	**1.4**	**2.0**	**2.2**	**1.5**

Text Books

1. Physical Activity and Health by Claude Bouchard, Steven N. Blair, William L. Haskell.
2. Mental Health Workbook by Emily Attached & Marzia Fernandez, 2021.
3. Mental Health Workbook for Women: Exercises to Transform Negative Thoughts and Improve WellBeing by Nashay Lorick, 2022

Reference Books

1. Lifestyle Diseases: Lifestyle Disease Management, by C. Nyambichu & Jeff Lumiri, 2018.
2. Physical Activity and Mental Health by Angela Clow & Sarah Edmunds, 2013.

TAUT2201: University Elective 3

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	III	University Elective

The syllabus for this course is drawn from the University Elective basket and is not part of the Biotechnology source document. The elective sheet issued by the University (in the same OBE format) is to be attached here before submission.

BITL2503: Immunology Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	III	Laboratory

Course Description

This laboratory course provides practical training in fundamental immunological and serological techniques used in clinical diagnostics and biomedical research. Students will develop skills in blood grouping, hematological analysis, antigen-antibody reactions, immunodiffusion, and immunoassays. The course emphasizes laboratory safety, specimen handling, biosafety practices, quality control, and interpretation of immunological test results.

Course Objectives

1. To train students in laboratory safety, biosafety and handling of biological specimens.
2. To develop skills in basic haematological techniques, including blood grouping and blood cell analysis.
3. To enable serological assays based on antigen-antibody interactions for disease diagnosis.
4. To explain the principles of immunodiffusion, ELISA and other immunodiagnostic techniques.
5. To interpret laboratory results and apply quality control in a clinical immunology laboratory.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Laboratory safety practices, preparation of reagents, and handling of biological specimens	5
2	Identification of Blood cells	5
3	Total count of Blood cells	5
4	ABO and Rh blood grouping by slide and tube methods	5
5	Widal test for the serological diagnosis of typhoid fever	5
6	VDRL (Venereal Disease Research Laboratory) test (demonstration) for syphilis screening	5
7	Latex agglutination test for detection of Rheumatoid Factor (RF) or C-Reactive Protein (CRP)	5
8	Ouchterlony Double Immunodiffusion (DID) for antigen-antibody precipitation	5
9	Single Radial Immunodiffusion (SRID) for quantitative estimation of immunoglobulins (demonstration)	5
10	Enzyme-Linked Immunosorbent Assay (ELISA) (demonstration) for detection of antigen or antibody	5
11	Preparation and staining of peripheral blood smear and differential leukocyte count (DLC)	5
12	Isolation of peripheral blood mononuclear cells (PBMCs) by density gradient centrifugation (demonstration) or Complement fixation test (demonstration), depending on laboratory facilities	5
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate laboratory safety, biosafety practices, and proper handling of biological specimens.	K3
CO2	Perform basic hematological and immunological techniques, including blood grouping and blood cell analysis.	K3

CO	Statement	Bloom level
CO3	Carry out serological assays based on antigen-antibody interactions for disease diagnosis.	K3
CO4	Explain the principles and applications of immunodiffusion, ELISA, and other immunological diagnostic techniques.	K2
CO5	Interpret laboratory results and apply quality control measures in clinical immunology laboratories.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	1	-	-	1	3	1	-	-
CO2	3	3	1	-	2	-	-	2	3	1	1	-
CO3	3	3	2	-	1	1	-	3	2	1	2	-
CO4	2	3	1	-	2	-	-	2	3	2	1	-
CO5	2	2	3	2	2	2	-	3	1	1	3	1
Avg.	**2.6**	**2.8**	**1.8**	**2.0**	**1.6**	**1.5**	**-**	**2.2**	**2.4**	**1.2**	**1.8**	**1.0**

Text Books and Laboratory Manuals

1. Turgeon, M. L. Immunology and Serology in Laboratory Medicine. 7th Edition. Elsevier.
2. Cheesbrough, M. District Laboratory Practice in Tropical Countries, Part 2. Cambridge University Press.
3. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. Roitt's Essential Immunology. 14th Edition. Wiley-Blackwell.
4. Goldsby, R. A., Kindt, T. J., Osborne, B. A., & Kuby, J. Kuby Immunology. W.H. Freeman.
5. Abbas, A. K., Lichtman, A. H., & Pillai, S. Basic Immunology: Functions and Disorders of the Immune System. Elsevier.

BITL2504: Enzyme Technology Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	III	Laboratory

Course Description

This laboratory course provides practical training in enzyme technology, focusing on the isolation, characterization, purification, and analysis of enzymes. Students will perform enzyme assays, investigate factors influencing enzyme activity, and learn basic protein separation techniques used in biochemical and biotechnological laboratories. The course emphasizes laboratory safety, experimental accuracy, and interpretation of enzyme kinetics and analytical data.

Course Objectives

1. To prepare laboratory reagents and buffers and perform enzyme assays under good laboratory practice.
2. To evaluate enzyme activity by qualitative and quantitative methods.
3. To investigate the effect of environmental factors on enzyme activity and stability.
4. To perform basic enzyme purification and protein separation techniques.
5. To analyse enzyme kinetics and interpret experimental data.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Laboratory safety, preparation of buffers, and calibration of calibration of laboratory instruments	6
2	Preparation of phosphate, acetate, and Tris buffers of different pH	6
3	Qualitative detection of amylase activity by starch hydrolysis	6
4	Quantitative estimation of amylase activity using the DNS method	6
5	Assay of catalase activity using hydrogen peroxide decomposition	6
6	Assay of urease activity by ammonia estimation	5
7	Assay of alkaline phosphatase activity	5
8	Determination of optimum pH for enzyme activity	5
9	Dialysis for enzyme purification	5
10	Serum electrophoresis by SDS PAGE	5
11	Western Blotting	5
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Prepare laboratory reagents and buffers and perform enzyme assays following good laboratory practices.	K3
CO2	Evaluate enzyme activity using qualitative and quantitative biochemical methods.	K5
CO3	Investigate the effects of environmental factors on enzyme activity and stability.	K4
CO4	Perform basic enzyme purification and protein separation techniques used in biotechnology laboratories.	K3

CO	Statement	Bloom level
CO5	Analyze enzyme kinetics and interpret experimental data for biochemical and industrial applications.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	1	-	-	1	3	1	-	-
CO2	3	3	1	-	2	-	-	2	3	1	1	-
CO3	3	3	2	-	1	1	-	3	2	1	2	-
CO4	2	3	1	-	2	-	-	2	3	2	1	-
CO5	2	2	3	2	2	2	-	3	1	1	3	1
Avg.	**2.6**	**2.8**	**1.8**	**2.0**	**1.6**	**1.5**	**-**	**2.2**	**2.4**	**1.2**	**1.8**	**1.0**

Text Books and Laboratory Manuals

1. Price, N. C., & Stevens, L. Fundamentals of Enzymology. Oxford University Press.
2. Satyanarayana, U., & Chakrapani, U. Biochemistry. Elsevier.
3. Dixon, M., & Webb, E. C. Enzymes. Academic Press.
4. Bisswanger, H. Enzyme Kinetics: Principles and Methods. Wiley-Blackwell.
5. Wilson, K., & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

SEMESTER IV

BITT2511: Animal Cell Culture and Techniques

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	IV	Core

Course Description

This course provides a comprehensive overview of techniques for cultivating and manipulating animal cells in vitro. Students will learn principles and practices of cell culture, including media preparation, cell line establishment, maintenance, and characterization. Emphasis is placed on applications in biotechnology, drug development, and cell biology and medical research.

Course Objectives

1. Understand the principles of animal cell culture, including cell biology, growth kinetics, and culture environments.
2. Develop proficiency in sterile technique, media formulation, and maintaining cell viability and purity.
3. Learn techniques for cell line establishment, cryopreservation, and cell-based assays.
4. Explore the application of cell culture techniques in biopharmaceutical production and regenerative medicine.
5. Evaluate ethical considerations and regulatory guidelines in animal cell culture research and applications.

Note: *The source sheet listed only three outcomes, none matching the units. Five Course Outcomes aligned to the five units are given here.*

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Foundations of Animal Cell Culture.** History of Development of Cell Culture, Natural Surroundings of Animal Cell, Metabolic Capabilities of Animal Cell, Simulating Natural Conditions for Growing Animal Cells	12
2	**Media, Culture Systems and Cell Lines.** Serum and Serum Free Media, Cell Culture System, Secondary Culture: Transformed Animal cell, commonly used Cell Lines and their Uses	12
3	**Growth Kinetics, Gene Expression and Transfection.** Growth Kinetics of Cells in Culture, Gene Expression and Application of Animal Cell Culture for Its Studies, Organ Culture, Transfection	12
4	**Cell Fusion, Hybridoma and Differentiation.** Cell Fusion, Selectable Marker and Antibiotic Resistance, Hybridoma and Monoclonal Antibodies, Transplantation of Cultured Cell, Differentiation of Cells	12
5	**Transgenic Animals, Cell Death and Embryo Transfer.** Transgenesis and Transgenic Animals, Apoptosis, Necrosis, Senescence and Quiescence, Embryo Transfer Technology	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the history, natural surroundings and metabolic capabilities of animal cells and the principles of simulating them in vitro	K2	1

CO	Statement	Bloom level	Unit
CO2	Prepare and compare serum and serum-free media and culture systems, and identify commonly used cell lines	K3	2
CO3	Analyse growth kinetics of cultured cells and describe organ culture, gene expression studies and transfection	K4	3
CO4	Explain cell fusion, selectable markers, hybridoma technology, transplantation and differentiation of cultured cells	K2	4
CO5	Evaluate the applications and ethical aspects of transgenic animals, apoptosis, senescence and embryo transfer technology	K5	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	1	1	-	2	2	1	-	-
CO2	3	3	1	-	1	1	-	3	2	1	1	-
CO3	3	3	2	-	1	1	-	3	3	1	2	-
CO4	3	2	2	-	2	1	-	2	3	2	2	-
CO5	3	2	3	1	2	2	-	3	3	2	3	2
Avg.	**3.0**	**2.4**	**2.0**	**1.0**	**1.4**	**1.2**	**-**	**2.6**	**2.6**	**1.4**	**2.0**	**2.0**

Text Books

1. Principles of Animal Cell Culture - Students Compendium, Basant Kumar Sinha and Rinesh Kumar M., International Book Distributing Co., First Edition, 2008
2. Freshney's Culture of Animal Cells A Manual of Basic Technique and Specialized Applications, Eighth Edition, Amanda Capes-Davis and R. Ian Freshney, Robert J. Geraghty and Raymond W. Nims, Wiley Blackwell, 2016
3. Introduction to Cell and Tissue Culture: Theory and Technique by Jennie P. Mather and Penelope E. Roberts

Reference Books

1. Tissue Culture Techniques: An Introduction by Paul F.A. Madson
2. Animal Cell Culture and Technology by Michael Butler and Kim Lee

BITT2512: Industrial Biotechnology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	IV	Core

Course Description

This course introduces the principles and applications of industrial biotechnology, emphasizing the use of microorganisms, enzymes, and bioprocesses for the large-scale production of commercially valuable products. Students will learn the fundamentals of fermentation technology, upstream and downstream processing, bioreactor design, industrial production of biopharmaceuticals, biofuels, food products, and environmental biotechnology. The course also covers quality control, biosafety, regulatory aspects, and emerging trends in industrial biotechnology.

Course Objectives

1. Understand the principles of industrial microbiology and fermentation technology.
2. Explain the design and operation of bioreactors and the various stages of upstream and downstream processing.
3. Describe the industrial production of microbial metabolites, enzymes, pharmaceuticals, and recombinant products.
4. Understand quality assurance, biosafety, and regulatory requirements in bioprocess industries.
5. Appreciate recent advances and applications of industrial biotechnology in healthcare, agriculture, food, energy, and environmental sustainability.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Industrial Biotechnology and Microbial Processes.** Introduction to industrial biotechnology; history and scope; characteristics of industrial microorganisms; microbial strain selection, improvement, preservation, and maintenance; microbial growth kinetics; industrially important bacteria, fungi, yeasts, and algae; screening of industrially useful microorganisms; principles of fermentation technology and industrial fermentation processes.	12
2	**Fermentation Technology and Bioreactors.** Components of fermentation media; sterilization of media and equipment; inoculum development; types of fermentation processes (batch, fed-batch, and continuous); principles and design of bioreactors; aeration and agitation; process monitoring and control (temperature, pH, dissolved oxygen); scale-up of fermentation processes.	12
3	**Downstream Processing and Industrial Products.** Principles of downstream processing; cell harvesting, filtration, centrifugation, extraction, precipitation, chromatography, and drying techniques; production of primary metabolites (organic acids, amino acids, alcohols), secondary metabolites (antibiotics, pigments), industrial enzymes, vitamins, probiotics, and recombinant proteins; quality control of industrial products.	12
4	**Applications of Industrial Biotechnology.** Industrial production of vaccines, monoclonal antibodies, recombinant therapeutics, biofertilizers, biopesticides, biofuels, single-cell protein, fermented foods, and beverages; applications in agriculture, food processing, pharmaceuticals, environmental biotechnology, waste management, and bioremediation.	12
5	**Biosafety, Regulations, and Emerging Trends.** Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP), biosafety and biosecurity; intellectual property rights (IPR) and patents in biotechnology; regulatory guidelines for biopharmaceutical production; quality assurance and validation; circular bioeconomy, synthetic biology, precision fermentation, industrial enzymes, biorefineries, and future trends in industrial biotechnology.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of industrial microbiology, microbial growth, and fermentation technology.	K2
CO2	Describe the operation of bioreactors and the processes involved in upstream and downstream bioprocessing.	K2
CO3	Analyze the production processes of industrially important biomolecules, enzymes, pharmaceuticals, and biofuels.	K4
CO4	Evaluate quality assurance practices, biosafety measures, and regulatory requirements in biotechnology industries.	K5
CO5	Apply industrial biotechnology concepts to healthcare, agriculture, environmental management, and sustainable industrial development.	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	1	1	2	-	-
CO2	3	1	1	-	2	1	-	1	2	2	1	-
CO3	3	2	1	-	2	1	-	2	2	2	2	-
CO4	3	2	1	1	3	1	-	2	2	2	3	1
CO5	2	2	1	2	3	1	1	2	1	3	3	2
Avg.	**2.8**	**1.6**	**1.0**	**1.5**	**2.2**	**1.0**	**1.0**	**1.6**	**1.6**	**2.2**	**2.2**	**1.5**

Text Books

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. 3rd Edition. Elsevier.
2. Crueger, W., & Crueger, A. Biotechnology: A Textbook of Industrial Microbiology. 3rd Edition. Panima Publishing.

Reference Books

1. Doran, P. M. Bioprocess Engineering Principles. 2nd Edition. Academic Press.
2. Shuler, M. L., Kargi, F., & DeLisa, M. P. Bioprocess Engineering: Basic Concepts. 3rd Edition. Pearson.
3. Ratledge, C., & Kristiansen, B. Basic Biotechnology. 3rd Edition. Cambridge University Press.

BITT2513: Bioinformatics

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	IV	Core

Course Description

This course introduces the fundamental concepts, tools, and applications of bioinformatics in modern biological research. It covers biological databases, sequence analysis, genome annotation, structural bioinformatics, phylogenetics, and computational approaches for analyzing genomic and proteomic data. Students will gain an understanding of how bioinformatics supports biotechnology, medicine, agriculture, and drug discovery through computational analysis of biological information.

Course Objectives

1. Understand the principles, scope, and applications of bioinformatics in biological sciences.
2. Develop proficiency in accessing and utilizing biological databases and computational tools.
3. Apply sequence analysis, alignment, and phylogenetic methods to study genes and proteins.
4. Understand protein structure prediction, molecular visualization, and functional annotation techniques.
5. Appreciate the applications of bioinformatics in genomics, proteomics, personalized medicine, agriculture, and biotechnology.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Bioinformatics and Biological Databases.** Introduction, scope, and applications of bioinformatics; biological data and information resources; sequence, structure, and literature databases; primary, secondary, and composite databases; NCBI, EMBL-EBI, DDBJ, UniProt, PDB, GenBank, Ensembl, KEGG, and PubMed; database retrieval, data formats (FASTA, GenBank), and biological data management.	12
2	**Sequence Analysis and Comparative Genomics.** Pairwise and multiple sequence alignment; sequence similarity and homology; scoring matrices (PAM and BLOSUM); BLAST and FASTA algorithms; multiple sequence alignment using Clustal Omega and MUSCLE; phylogenetic analysis and tree construction; comparative genomics and genome annotation.	12
3	**Structural Bioinformatics.** Levels of protein structure; protein structure databases; molecular visualization using PyMOL and UCSF Chimera; protein structure prediction; homology modeling; protein structure validation; molecular docking principles; introduction to molecular dynamics simulations; applications in drug discovery and protein engineering.	12
4	**Functional Genomics and Omics Technologies.** Genome sequencing technologies; next-generation sequencing (NGS); transcriptomics, proteomics, metabolomics, and metabolomic databases; gene expression analysis; Gene Ontology (GO); pathway databases (KEGG and Reactome); systems biology; introduction to network biology and biological data integration.	12
5	**Applications of Bioinformatics.** Applications in personalized medicine, pharmacogenomics, precision medicine, agriculture, microbial genomics, vaccine design, drug discovery, biomarker identification, synthetic biology, artificial intelligence in bioinformatics, cloud computing, ethical issues, data security, and future trends in computational biology.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles, scope, and applications of bioinformatics in biological research.	K2
CO2	Retrieve, analyze, and interpret biological information using major biological databases and bioinformatics tools.	K4
CO3	Perform sequence alignment, phylogenetic analysis, and functional annotation of genes and proteins.	K3
CO4	Describe the principles of structural bioinformatics, molecular visualization, and computational approaches used in drug discovery.	K2
CO5	Evaluate the applications of bioinformatics in genomics, proteomics, healthcare, agriculture, and biotechnology.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	-	1	1	-	-	1	2	2	-
CO2	3	2	1	-	1	1	-	1	2	3	2	-
CO3	3	2	2	-	2	1	-	2	3	3	3	-
CO4	3	2	2	1	2	1	-	2	3	3	3	1
CO5	2	2	3	2	3	1	-	2	2	3	3	1
Avg.	**2.8**	**1.8**	**1.8**	**1.5**	**1.8**	**1.0**	**-**	**1.8**	**2.2**	**2.8**	**2.6**	**1.0**

Text Books

1. Rastogi, S. C., Mendiratta, N., & Rastogi, P. Bioinformatics: Methods and Applications. 4th Edition. PHI Learning.
2. Mount, D. W. Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press.

Reference Books

1. Pevsner, J. Bioinformatics and Functional Genomics. 4th Edition. Wiley-Blackwell.
2. Lesk, A. M. Introduction to Bioinformatics. 6th Edition. Oxford University Press.
3. Baxevanis, A. D., & Bader, G. D. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 4th Edition. Wiley.

BITT2514: Biosafety and Ethics

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	IV	Core

Course Description

This course introduces the fundamental principles of biosafety and bioethics in biological sciences, biotechnology, biomedical research, and healthcare. It covers laboratory biosafety practices, biosafety regulations, risk assessment, waste management, and safe handling of biological materials. The course also explores ethical principles in biological research, genetic engineering, stem cell research, clinical trials, animal experimentation, intellectual property rights, and regulatory frameworks. Students will develop an understanding of responsible scientific conduct and ethical decision-making in research and biotechnology.

Course Objectives

1. To understand the principles and importance of biosafety in biological laboratories and research.
2. To explain biosafety guidelines, laboratory risk assessment, and biological waste management practices.
3. To understand the ethical principles governing biological and biomedical research.
4. To familiarize students with national and international biosafety regulations and ethical guidelines.
5. To develop awareness of responsible conduct in research, intellectual property rights, and emerging ethical issues in biotechnology.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Biosafety.** Introduction to biosafety; Concepts and importance of biosafety; Laboratory hazards biological, chemical, physical and mechanical hazards; Risk groups of microorganisms (RG1–RG4); Biosafety Levels (BSL-1 to BSL-4) and their characteristics; Laboratory design and safety equipment; Personal Protective Equipment (PPE); Good Laboratory Practices (GLP); Biosafety symbols and signage.	12
2	**Biosafety Practices and Waste Management.** Laboratory risk assessment; Safe handling, transport and storage of biological materials; Sterilization and disinfection methods; Decontamination procedures; Biomedical waste management; Segregation, collection and disposal of biological waste; Spill management; Emergency response procedures; Occupational health and laboratory-acquired infections.	12
3	**Introduction to Bioethics.** Definition, principles and scope of bioethics; History and evolution of bioethics; Ethical principles Autonomy, Beneficence, Non-maleficence and Justice; Informed consent; Confidentiality and privacy; Research misconduct fabrication, falsification and plagiarism; Responsible conduct of scientific research.	12
4	**Ethical Issues in Biotechnology and Biomedical Research.** Ethical issues in recombinant DNA technology; Genetic testing and genetic counseling; Human genome research; Stem cell research; Gene editing (CRISPR-Cas9) and gene therapy (overview); Animal ethics and CPCSEA guidelines; Clinical trials and Institutional Ethics Committees (IEC); Biosafety regulations for genetically modified organisms (GMOs).	12
5	**Biosafety Regulations, Intellectual Property Rights and Emerging Issues.** National and international biosafety guidelines; Institutional Biosafety Committee (IBSC); Recombinant DNA safety guidelines; Cartagena Protocol on Biosafety; Intellectual Property Rights (IPR) Patents, copyrights, trademarks and geographical indications (overview); Biosafety in agriculture, food, healthcare and industry; Dual-use research; Emerging ethical issues in biotechnology, artificial intelligence in healthcare and future perspectives.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of biosafety, laboratory safety practices, and biological risk assessment.	K2
CO2	Apply appropriate biosafety measures, waste management procedures, and standard laboratory practices for handling biological materials.	K3
CO3	Demonstrate an understanding of ethical principles, responsible conduct of research, and professional integrity in life sciences.	K2
CO4	Evaluate ethical and biosafety issues related to genetic engineering, stem cell research, clinical trials, and genetically modified organisms.	K5
CO5	Interpret national and international biosafety regulations, intellectual property rights, and regulatory frameworks governing biological research and biotechnology.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	2	1	-	-	-	-	-	1
CO2	3	1	1	-	3	1	-	-	1	-	1	1
CO3	2	1	1	3	3	1	-	-	-	2	1	3
CO4	2	1	2	3	3	1	-	-	-	3	2	5
CO5	2	1	2	3	3	2	-	-	-	3	3	5
Avg.	**2.4**	**1.0**	**1.5**	**3.0**	**2.8**	**1.2**	**-**	**-**	**1.0**	**2.7**	**1.8**	**3.0**

Text Books

1. Sateesh, M. K. (2010). Bioethics and Biosafety. I.K. International Publishing House.
2. Fleming, D. O., & Hunt, D. L. (2006). Biological Safety: Principles and Practices (4th Ed.). ASM Press.

Reference Books

1. World Health Organization (WHO). Laboratory Biosafety Manual (4th Ed.).
2. National Academy of Sciences. On Being a Scientist: A Guide to Responsible Conduct in Research (3rd Ed.).
3. Indian Council of Medical Research (ICMR). National Ethical Guidelines for Biomedical and Health Research Involving Human Participants (Latest Edition).
4. Department of Biotechnology (DBT), Government of India. Recombinant DNA Safety Guidelines.
5. Prescott, L. M., Harley, J. P., & Klein, D. A. Microbiology. McGraw-Hill.

BITT2601(A): Stem Cell Biology and Regenerative Medicine

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	IV	Program Elective

Course Description

This course introduces the principles of stem cell biology and regenerative medicine, emphasizing stem cell types, differentiation, tissue engineering, cell-based therapies, and their applications in disease treatment and regenerative healthcare. The course also discusses ethical, regulatory, and translational aspects of stem cell research.

Course Objectives

1. Understand the biology and classification of stem cells.
2. Explain stem cell differentiation and tissue regeneration.
3. Describe tissue engineering and regenerative medicine strategies.
4. Understand clinical applications of stem cell therapies.
5. Appreciate ethical and regulatory issues in regenerative medicine.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamentals of Stem Cell Biology.** Stem cell concept; embryonic, adult, induced pluripotent (iPSCs), and mesenchymal stem cells; stem cell niche; self-renewal and differentiation; stem cell markers.	9
2	**Stem Cell Culture and Differentiation.** Stem cell isolation; culture techniques; differentiation pathways; growth factors; organoids; gene editing in stem cells; quality assessment.	9
3	**Tissue Engineering and Regenerative Medicine.** Biomaterials; scaffolds; bioprinting; tissue engineering principles; regenerative therapies; wound healing; cartilage and bone regeneration.	9
4	**Clinical Applications.** Stem cell therapy for neurological disorders, cardiovascular diseases, diabetes, musculoskeletal disorders, cancer, and ophthalmology; regenerative medicine in personalized healthcare.	9
5	**Ethics and Future Perspectives.** Ethical issues; regulatory guidelines; clinical trials; GMP for stem cell products; emerging advances including organoids, gene therapy, and regenerative biomaterials.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain stem cell biology and differentiation mechanisms.	K2
CO2	Describe stem cell culture and tissue engineering techniques.	K2
CO3	Interpret regenerative medicine approaches for disease treatment.	K4
CO4	Evaluate clinical applications of stem cell therapies.	K5
CO5	Discuss ethical and regulatory aspects of regenerative medicine.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	-	1	2	-	-
CO2	3	1	1	-	2	1	-	-	1	2	1	-
CO3	3	2	1	-	3	1	-	1	1	2	2	-
CO4	3	2	2	1	3	1	-	1	2	2	3	1
CO5	3	2	2	2	3	2	-	1	2	2	3	2
Avg.	**3.0**	**1.6**	**1.5**	**1.5**	**2.4**	**1.2**	**-**	**1.0**	**1.4**	**2.0**	**2.2**	**1.5**

Text Books

1. Lanza's Principles of Tissue Engineering.
2. Essentials of Stem Cell Biology – Lanza et al.

Reference Books

1. Stem Cells: Scientific Facts and Fiction – Christine Mummery.
2. Principles of Regenerative Medicine – Atala et al.
3. Molecular Biology of the Cell – Alberts et al.

BITT2601(B): Synthetic Biology and Biological Circuit Design

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	IV	Program Elective

Course Description

This course introduces synthetic biology as an interdisciplinary field integrating biology, engineering, and computational sciences to design and construct novel biological systems and genetic circuits for healthcare, agriculture, industry, and environmental applications.

Course Objectives

1. Understand the principles of synthetic biology.
2. Explain biological circuit design and genetic engineering.
3. Describe genome editing technologies.
4. Explore industrial and biomedical applications.
5. Understand biosafety and ethical considerations.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Synthetic Biology.** History; engineering principles; biological parts, devices, and systems; BioBricks; standardization; chassis organisms.	9
2	**Genetic Circuit Design.** Gene regulation; promoters; repressors; oscillators; toggle switches; quorum sensing; CRISPR- based regulation.	9
3	**Genome Engineering.** CRISPR-Cas systems; TALENs; zinc finger nucleases; genome editing strategies; DNA assembly methods; metabolic engineering.	9
4	**Applications.** Synthetic biology in healthcare, vaccine development, industrial biotechnology, agriculture, biosensors, environmental remediation, and biofuels.	9
5	**Ethics and Emerging Technologies.** Biosecurity; biosafety; intellectual property; synthetic genomes; AI-assisted biological design; future perspectives.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain synthetic biology principles.	K2
CO2	Describe biological circuit design strategies.	K6
CO3	Apply genome engineering concepts.	K3
CO4	Evaluate synthetic biology applications.	K5
CO5	Discuss ethical and regulatory issues.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	1	1	-	2	2	1	-	-
CO2	3	3	1	-	1	1	-	3	2	1	1	-
CO3	3	3	2	-	1	1	-	3	3	1	2	-

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO4	3	2	2	-	2	1	-	2	3	2	2	-
CO5	3	2	3	1	2	2	-	3	3	2	3	2
Avg.	**3.0**	**2.4**	**2.0**	**1.0**	**1.4**	**1.2**	**-**	**2.6**	**2.6**	**1.4**	**2.0**	**2.0**

Text Books

1. Synthetic Biology – Fu et al.
2. Synthetic Biology: A Primer – Paul Freemont.

Reference Books

1. Molecular Biotechnology – Glick et al.
2. Gene Cloning and DNA Analysis – Brown.
3. Principles of Gene Manipulation – Primrose & Twyman.

BITT2601(C): Biotechnology for Sustainable Development

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	IV	Program Elective

Course Description

This course explores the role of biotechnology in achieving sustainable development through environmentally friendly technologies, renewable biological resources, and circular bioeconomy approaches. It emphasizes the application of biotechnology in agriculture, environmental conservation, industrial production, renewable energy, waste management, and climate change mitigation. The course also highlights national and global sustainability initiatives and the contribution of biotechnology towards achieving the Sustainable Development Goals (SDGs).

Course Objectives

1. Understand the principles of sustainable development and the role of biotechnology in environmental conservation.
2. Explain the applications of biotechnology in agriculture, waste management, and renewable energy.
3. Describe green technologies and circular bioeconomy approaches for sustainable industrial development.
4. Understand the role of biotechnology in addressing climate change, food security, and environmental protection.
5. Appreciate emerging biotechnological innovations supporting global sustainability.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Biotechnology and Sustainable Development.** Concept and principles of sustainable development; United Nations Sustainable Development Goals (SDGs); environmental sustainability; circular bioeconomy; green biotechnology; sustainable utilization of biological resources; biodiversity conservation; ecosystem restoration; climate resilience; role of biotechnology in achieving sustainable development.	9
2	**Environmental Biotechnology.** Microbial ecology and environmental microbiology; bioremediation of contaminated soil and water; phytoremediation; mycoremediation; wastewater treatment; solid waste management; composting; biomining and bioleaching; biosensors for environmental monitoring; microbial degradation of xenobiotics; environmental risk assessment.	9
3	**Agricultural Biotechnology.** Plant biotechnology for sustainable agriculture; biofertilizers; biopesticides; plant growth- promoting microorganisms; integrated pest management; stress-tolerant and climate-resilient crops; molecular breeding; precision agriculture; sustainable soil health management; conservation agriculture; applications of biotechnology in food security.	9
4	**Industrial and Energy Biotechnology.** Industrial fermentation; enzyme technology; biorefineries; production of bioethanol, biodiesel, biogas, and biohydrogen; biodegradable plastics; microbial production of value-added products; carbon capture and utilization; industrial waste valorization; green manufacturing; life cycle assessment of bioprocesses.	9
5	**Emerging Trends and Future Perspectives.** Blue bioeconomy; synthetic biology for sustainability; AI and digital technologies in environmental biotechnology; carbon-neutral technologies; sustainable biotechnology policies; biosafety and bioethics; international environmental agreements; entrepreneurship in green biotechnology; future prospects of sustainable biotechnology.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of sustainable development and the contribution of biotechnology to environmental conservation.	K2
CO2	Describe biotechnological approaches for environmental remediation and waste management.	K2
CO3	Evaluate sustainable agricultural and industrial biotechnology practices.	K5
CO4	Assess renewable energy technologies and bioeconomy-based industrial processes.	K5
CO5	Discuss emerging biotechnological innovations and policies for sustainable development.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	-	-	-	1	3	-	-	2	-	-
CO2	3	1	-	-	1	1	3	-	1	1	1	-
CO3	3	1	1	1	1	1	3	1	1	1	2	1
CO4	3	1	1	2	1	2	3	2	1	1	2	2
CO5	2	1	1	3	1	2	3	2	1	2	2	3
Avg.	**2.6**	**1.0**	**1.0**	**2.0**	**1.0**	**1.4**	**3.0**	**1.7**	**1.0**	**1.4**	**1.8**	**2.0**

Text Books

1. Singh, J. S., Singh, S. P., & Gupta, S. R. Ecology, Environmental Science and Conservation. S. Chand Publishing.
2. Rittmann, B. E., & McCarty, P. L. Environmental Biotechnology: Principles and Applications. McGraw-Hill.

Reference Books

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. Elsevier.
2. Soetaert, W., & Vandamme, E. J. Industrial Biotechnology: Sustainable Growth and Economic Success. Wiley.
3. OECD. Biotechnology for Sustainable Development. OECD Publications. Program Elective 2 (BITT2602)

BITT2602(A): Marine Biotechnology and Blue Bioeconomy

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	IV	Program Elective

Course Description

This course introduces the principles and applications of marine biotechnology with emphasis on marine biodiversity, marine microorganisms, bioactive compounds, aquaculture, marine genomics, renewable marine resources, and the blue bioeconomy. The course explores sustainable utilization of marine biological resources for pharmaceuticals, food, bioenergy, environmental conservation, and industrial biotechnology.

Course Objectives

1. Understand marine biodiversity and marine biological resources.
2. Explain the applications of marine organisms in biotechnology and pharmaceuticals.
3. Describe marine biotechnology applications in aquaculture and environmental sustainability.
4. Understand blue bioeconomy concepts and sustainable marine resource utilization.
5. Appreciate emerging technologies in marine biotechnology.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Marine Biodiversity and Marine Resources.** Marine ecosystems; marine biodiversity; marine microorganisms; algae, seaweeds, cyanobacteria, fungi and marine invertebrates; marine genetic resources; extremophiles; marine microbial ecology; marine biotechnology databases; conservation of marine biodiversity.	9
2	**Marine Natural Products and Bioproducts.** Marine bioactive compounds; marine enzymes; pigments; polysaccharides; omega-3 fatty acids; marine nutraceuticals; marine pharmaceuticals; antimicrobial, antiviral and anticancer compounds; marine biomaterials; marine bioprospecting.	9
3	**Aquaculture and Algal Biotechnology.** Principles of aquaculture; fish health management; genetic improvement of aquaculture species; algal biotechnology; microalgae cultivation; macroalgae; algal biofuels; algal bioproducts; seaweed biotechnology; sustainable aquaculture.	9
4	**Marine Biotechnology for Sustainable Development.** Marine bioremediation; wastewater treatment; marine biosensors; marine biotechnology in food processing; marine bioenergy; marine biomining; blue carbon ecosystems; climate change adaptation; marine conservation strategies; circular blue economy.	9
5	**Emerging Trends in Marine Biotechnology.** Marine genomics and metagenomics; marine synthetic biology; AI applications in marine biotechnology; marine microbiome; deep-sea biotechnology; marine biotechnology regulations; intellectual property; entrepreneurship; future prospects of the blue bioeconomy.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain marine biodiversity and marine biological resources.	K2
CO2	Describe marine bioactive compounds and their industrial applications.	K2
CO3	Evaluate biotechnology applications in aquaculture and marine resource management.	K5
CO4	Assess the role of marine biotechnology in sustainable blue bioeconomy.	K5

CO	Statement	Bloom level
CO5	Discuss emerging technologies and future opportunities in marine biotechnology.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	1	1	2	-	-
CO2	3	1	1	-	2	1	-	1	2	2	1	-
CO3	3	2	1	-	2	1	-	2	2	2	2	-
CO4	3	2	1	1	3	1	-	2	2	2	3	1
CO5	2	2	1	2	3	1	1	2	1	3	3	2
Avg.	**2.8**	**1.6**	**1.0**	**1.5**	**2.2**	**1.0**	**1.0**	**1.6**	**1.6**	**2.2**	**2.2**	**1.5**

Text Books

1. Kim, S. K. Marine Biotechnology. Springer.
2. Fingerman, M., & Nagabhushanam, R. Recent Advances in Marine Biotechnology. CRC Press.

Reference Books

1. Munn, C. B. Marine Microbiology: Ecology and Applications. Garland Science.
2. Bux, F., & Chisti, Y. Algae Biotechnology: Products and Processes. Springer.
3. Kim, S. K. Handbook of Marine Biotechnology. Springer.

BITT2602(B): Systems Biology and Network Medicine

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	IV	Program Elective

Course Description

This course introduces systems biology as an integrative approach to understanding complex biological systems through the analysis of genes, proteins, metabolites, and cellular networks. It emphasizes computational modeling, biological network analysis, and the application of systems biology in disease mechanisms, biomarker discovery, drug development, and precision medicine.

Course Objectives

1. Understand the principles and concepts of systems biology and biological networks.
2. Explain the integration of multi-level biological data for studying complex biological systems.
3. Describe computational approaches for network construction, visualization, and analysis.
4. Understand the applications of systems biology in disease modeling, drug discovery, and precision medicine.
5. Appreciate emerging technologies in network medicine and computational healthcare.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Systems Biology.** Introduction and scope of systems biology; reductionist and systems approaches; organization of biological systems; biological complexity; omics technologies; integration of genomics, transcriptomics, proteomics, metabolomics, and microbiome data; biological databases; systems- level analysis; overview of computational biology and bioinformatics.	9
2	**Biological Networks and Pathway Analysis.** Gene regulatory networks; protein-protein interaction networks; metabolic networks; signaling pathways; transcriptional regulatory networks; network topology; network motifs; pathway databases including KEGG, Reactome, and BioCyc; network visualization using Cytoscape; functional enrichment and pathway analysis.	9
3	**Computational Modeling of Biological Systems.** Mathematical models in biology; deterministic and stochastic models; kinetic modeling; systems dynamics; Boolean networks; flux balance analysis; introduction to machine learning in systems biology; simulation of biological systems; model validation and interpretation.	9
4	**Network Medicine and Precision Healthcare.** Disease networks; molecular mechanisms of complex diseases; biomarker discovery; disease gene prioritization; network pharmacology; drug-target interaction networks; drug repurposing; personalized medicine; systems pharmacology; applications in cancer, metabolic disorders, cardiovascular diseases, and infectious diseases.	9
5	**Emerging Trends in Systems Biology.** Single-cell omics; spatial transcriptomics; digital twins in healthcare; artificial intelligence and deep learning in systems biology; cloud computing for biological data analysis; systems immunology; microbiome systems biology; ethical issues in computational biology; future prospects of systems medicine.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of systems biology and biological network organization.	K2

CO	Statement	Bloom level
CO2	Construct and interpret biological networks using computational approaches.	K4
CO3	Apply computational modeling techniques to study biological systems.	K3
CO4	Evaluate the applications of systems biology in disease diagnosis, drug discovery, and precision medicine.	K5
CO5	Discuss emerging technologies including AI, single-cell biology, and digital health in systems medicine.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	-	1	1	-	-	1	2	2	-
CO2	3	2	1	-	1	1	-	1	2	3	2	-
CO3	3	2	2	-	2	1	-	2	3	3	3	-
CO4	3	2	2	1	2	1	-	2	3	3	3	1
CO5	2	2	3	2	3	1	-	2	2	3	3	1
Avg.	**2.8**	**1.8**	**1.8**	**1.5**	**1.8**	**1.0**	**-**	**1.8**	**2.2**	**2.8**	**2.6**	**1.0**

Text Books

1. Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., Lehrach, H., & Herwig, R. Systems Biology: A Textbook. 3rd Edition. Wiley-VCH.
2. Barabási, A.-L., Gulbahce, N., & Loscalzo, J. Network Medicine: A Network-based Approach to Human Disease. Nature Reviews Genetics.

Reference Books

1. Alon, U. An Introduction to Systems Biology: Design Principles of Biological Circuits. CRC Press.
2. Pevsner, J. Bioinformatics and Functional Genomics. Wiley-Blackwell.
3. Lesk, A. M. Introduction to Genomics. Oxford University Press.

BITT2602(C): Computational Biology and Multi-Omics

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	IV	Program Elective

Course Description

This course introduces computational biology and the integration of multi-omics technologies for understanding biological systems. It covers biological databases, sequence analysis, genomics, transcriptomics, proteomics, metabolomics, microbiomics, epigenomics, and computational approaches for multi-omics data integration. The course highlights applications in biomarker discovery, precision medicine, drug discovery, and systems biology.

Course Objectives

1. Understand the principles of computational biology and bioinformatics.
2. Explain the generation and analysis of genomics, transcriptomics, proteomics, and metabolomics data.
3. Describe computational tools and workflows used in multi-omics research.
4. Understand applications of multi-omics integration in disease biology and precision medicine.
5. Appreciate recent advances in artificial intelligence and big data analytics in life sciences.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Foundations of Computational Biology.** Introduction to computational biology; biological databases; NCBI, EMBL-EBI, DDBJ, UniProt, PDB, GEO; sequence formats; sequence alignment; BLAST; multiple sequence alignment; phylogenetic analysis; biological data management; introduction to high-performance computing and cloud computing.	9
2	**Genomics and Transcriptomics.** Genome organization; genome sequencing technologies; next-generation sequencing (NGS); genome assembly; genome annotation; RNA sequencing; differential gene expression analysis; functional genomics; transcriptome databases; applications in disease diagnosis and precision medicine.	9
3	**Proteomics, Metabolomics, and Other Omics.** Protein identification and characterization; mass spectrometry-based proteomics; protein interaction analysis; metabolomics technologies; lipidomics; glycomics; microbiome analysis; epigenomics; integrated omics approaches; biological pathway analysis.	9
4	**Multi-Omics Data Integration.** Strategies for multi-omics integration; data preprocessing; statistical analysis; machine learning approaches; network-based analysis; systems biology approaches; biomarker discovery; personalized medicine; computational workflows; visualization and interpretation of integrated biological datasets.	9
5	**Applications and Emerging Technologies.** Artificial intelligence in computational biology; deep learning for biological data analysis; protein structure prediction; AlphaFold and AI-assisted structural biology; drug discovery and virtual screening; precision medicine; digital health; ethical and legal issues in biological data management; future perspectives in computational biotechnology.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of computational biology and biological databases.	K2

CO	Statement	Bloom level
CO2	Describe genomics, transcriptomics, proteomics, metabolomics, and other omics technologies.	K2
CO3	Apply computational tools for sequence analysis and multi-omics data interpretation.	K3
CO4	Evaluate the role of multi-omics integration in systems biology, biomarker discovery, and precision medicine.	K5
CO5	Discuss the applications of AI, big data analytics, and emerging computational technologies in biotechnology.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	-	1	1	-	-	1	2	2	-
CO2	3	2	1	-	1	1	-	1	2	3	2	-
CO3	3	2	2	-	2	1	-	2	3	3	3	-
CO4	3	2	2	1	2	1	-	2	3	3	3	1
CO5	2	2	3	2	3	1	-	2	2	3	3	1
Avg.	**2.8**	**1.8**	**1.8**	**1.5**	**1.8**	**1.0**	**-**	**1.8**	**2.2**	**2.8**	**2.6**	**1.0**

Text Books

1. Pevsner, J. Bioinformatics and Functional Genomics. 3rd Edition. Wiley-Blackwell.
2. Mount, D. W. Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press.

Reference Books

1. Lesk, A. M. Introduction to Genomics. 3rd Edition. Oxford University Press.
2. Klipp, E., et al. Systems Biology: A Textbook. 3rd Edition. Wiley-VCH.
3. Xiong, J. Essential Bioinformatics. Cambridge University Press. Program Elective -3 (BITT3603)

BITL2505: Bioinformatics Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	IV	Laboratory

Course Description

This laboratory course introduces students to the fundamental computational tools and databases used in genomics and proteomics. Students gain hands-on experience in biological sequence retrieval, sequence alignment, protein structure analysis, gene expression studies, and functional genomics using widely adopted bioinformatics resources. The course emphasizes data interpretation and the application of computational approaches in modern biological and biomedical research.

Course Objectives

1. To retrieve nucleotide and protein data from public biological databases.
2. To perform sequence alignment and phylogenetic analysis with standard tools.
3. To predict, visualise and validate protein three-dimensional structures.
4. To analyse gene expression datasets and interpret functional genomic information.
5. To apply bioinformatics tools to toxicity prediction and pathway analysis.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Retrieval of nucleotide and protein sequences using NCBI databases (GenBank, Gene, and BLAST)	6
2	Protein sequence and structural information retrieval using UniProt and Protein Data Bank (PDB)	6
3	Pairwise sequence alignment using BLAST and sequence comparison tools	6
4	Multiple sequence alignment and phylogenetic analysis using Clustal Omega or ClustalW	6
5	Analysis of protein three-dimensional structures using PyMOL or UCSF Chimera	6
6	Protein structure prediction by homology modeling using SWISS-MODEL	6
7	Validation of predicted protein structures using Ramachandran plot analysis and structure validation tools	6
8	Differential gene expression analysis using GEO2R and interpretation of gene expression profiles	6
9	In silico toxicity prediction of chemical compounds using ProTox-3.0 and basic ADMET analysis	6
10	Functional enrichment and pathway analysis using Gene Ontology (GO), KEGG, and metabolomic data interpretation through MetaboAnalyst	6
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Retrieve and analyze genomic and proteomic data from public biological databases.	K4
CO2	Perform sequence alignment and phylogenetic analysis using standard bioinformatics tools.	K3
CO3	Predict, visualize, and validate protein three-dimensional structures using computational methods.	K2

CO	Statement	Bloom level
CO4	Analyze gene expression datasets and interpret functional genomic information.	K4
CO5	Apply bioinformatics tools for toxicity prediction, pathway analysis, and biological data interpretation.	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	-	-	2	1	-	-	2	2	-	-
CO2	2	3	1	-	2	1	-	1	2	2	2	-
CO3	2	3	1	1	2	1	-	1	2	1	1	-
CO4	2	3	2	-	2	1	-	3	2	2	3	-
CO5	3	2	2	1	3	2	-	2	2	3	3	1
Avg.	**2.2**	**2.8**	**1.5**	**1.0**	**2.2**	**1.2**	**-**	**1.8**	**2.0**	**2.0**	**2.2**	**1.0**

Text Books and Laboratory Manuals

1. Mount, D. W. Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press.
2. Lesk, A. M. Introduction to Bioinformatics. 6th Edition. Oxford University Press.
3. Pevsner, J. Bioinformatics and Functional Genomics. 4th Edition. Wiley-Blackwell.
4. Rastogi, S. C., Mendiratta, N., & Rastogi, P. Bioinformatics: Methods and Applications. 4th Edition. PHI Learning.
5. Baxevanis, A. D., & Bader, G. D. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 4th Edition. Wiley.

BITL2506: Industrial Biotechnology Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	IV	Laboratory

Course Description

This laboratory course provides practical exposure to the fundamental techniques employed in industrial biotechnology and bioprocessing. Students gain hands-on experience in microbial fermentation, media preparation, enzyme production, biomass estimation, downstream processing, and quality assessment of bioproducts. The course emphasizes aseptic techniques, process optimization, bioprocess monitoring, and industrial applications of microorganisms in biotechnology.

Course Objectives

1. To practise aseptic technique, media preparation and handling of industrial microbial cultures.
2. To perform microbial fermentation for industrially important metabolites and enzymes.
3. To evaluate the effect of environmental and nutritional factors on growth and product yield.
4. To apply downstream processing techniques for recovery and purification of bioproducts.
5. To interpret fermentation data and understand quality control practices.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Preparation and sterilization of fermentation media and maintenance of aseptic conditions for industrial bioprocesses	6
2	Isolation, maintenance, and preservation of industrially important microorganisms	6
3	Preparation of microbial inoculum and optimization of inoculum size for fermentation	6
4	Batch fermentation for ethanol production using Saccharomyces cerevisiae	6
5	Production and estimation of microbial enzymes (amylase or protease) under submerged fermentation	6
6	Estimation of microbial biomass by dry cell weight and optical density (OD) measurement	6
7	Effect of pH, temperature, carbon source, and nitrogen source on microbial growth and metabolite production	6
8	Downstream processing techniques: filtration, centrifugation, and product recovery (demonstration)	6
9	Determination of fermentation products such as ethanol or organic acids using suitable analytical methods	6
10	Quality control of fermentation products and demonstration of bioreactor operation and process monitoring	6
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate aseptic techniques, media preparation, and microbial culture handling for industrial biotechnology applications.	K3
CO2	Perform microbial fermentation for the production of industrially important metabolites and enzymes.	K3

CO	Statement	Bloom level
CO3	Evaluate the influence of environmental and nutritional factors on microbial growth and product yield.	K5
CO4	Apply downstream processing techniques for the recovery and purification of bioproducts.	K3
CO5	Interpret fermentation data and understand quality control practices used in industrial bioprocesses.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	1	-	-	1	3	1	-	-
CO2	3	3	1	-	2	-	-	2	3	1	1	-
CO3	3	3	2	-	1	1	-	3	2	1	2	-
CO4	2	3	1	-	2	-	-	2	3	2	1	-
CO5	2	2	3	2	2	2	-	3	1	1	3	1
Avg.	**2.6**	**2.8**	**1.8**	**2.0**	**1.6**	**1.5**	**-**	**2.2**	**2.4**	**1.2**	**1.8**	**1.0**

Text Books and Laboratory Manuals

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. 3rd Edition. Elsevier.
2. Doran, P. M. Bioprocess Engineering Principles. 2nd Edition. Academic Press.
3. Crueger, W., & Crueger, A. Biotechnology: A Textbook of Industrial Microbiology. Panima Publishing.
4. Shuler, M. L., & Kargi, F. Bioprocess Engineering: Basic Concepts. 3rd Edition. Pearson.
5. Casida, L. E. Industrial Microbiology. New Age International Publishers.

SEMESTER V

BITT3515: Protein Engineering

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	V	Core

Course Description

This course introduces the principles and applications of protein engineering with emphasis on protein structure, function, design, and modification. Students will learn approaches for engineering proteins through rational design and directed evolution, computational tools for protein analysis, recombinant protein production, and applications in medicine, agriculture, and industrial biotechnology.

Course Objectives

1. Understand the structural organization and functional properties of proteins.
2. Explain various approaches used in protein engineering and molecular design.
3. Understand recombinant protein production and purification techniques.
4. Apply computational tools for protein analysis and engineering.
5. Appreciate the industrial, medical, and agricultural applications of engineered proteins.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamentals of Protein Structure and Function.** Amino acids and peptide bonds; primary, secondary, tertiary, and quaternary structures of proteins; protein folding and stability; molecular chaperones; protein domains and motifs; protein-protein interactions; enzyme structure and catalytic mechanisms; relationship between protein structure and biological function; protein databases including UniProt and Protein Data Bank (PDB).	12
2	**Principles and Strategies of Protein Engineering.** Concept and scope of protein engineering; rational protein design; directed evolution; site-directed mutagenesis; random mutagenesis; domain swapping; recombinant DNA technology for protein engineering; expression systems in Escherichia coli, yeast, insect, and mammalian cells; factors influencing recombinant protein expression.	12
3	**Computational Approaches in Protein Engineering.** Sequence alignment and homology analysis; protein structure prediction; homology modelling; molecular docking; molecular dynamics simulations; protein stability prediction; protein–ligand interactions; introduction to artificial intelligence and machine learning applications in protein engineering; bioinformatics resources for protein analysis.	12
4	**Protein Purification and Characterization.** Protein extraction; purification using precipitation, dialysis, chromatography, and electrophoresis; affinity purification; spectroscopic methods for protein analysis; enzyme assays; determination of protein concentration; structural characterization using X-ray crystallography, NMR spectroscopy, and Cryo-electron microscopy (overview); quality assessment of recombinant proteins.	12
5	**Applications of Protein Engineering.** Engineering industrial enzymes; therapeutic proteins and monoclonal antibodies; protein engineering in vaccine development; biosensors and diagnostic proteins; agricultural biotechnology; synthetic biology and metabolic engineering; protein therapeutics; personalized medicine; current advances and future prospects in protein engineering.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the structural organization and functional properties of proteins.	K2
CO2	Describe the principles and methodologies employed in protein engineering.	K2
CO3	Apply computational tools for protein structure prediction and engineering.	K3
CO4	Interpret protein purification and characterization techniques used in biotechnology.	K4
CO5	Evaluate the applications of engineered proteins in medicine, industry, agriculture, and research.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	1	1	2	-	-
CO2	3	1	1	-	2	1	-	1	2	2	1	-
CO3	3	2	1	-	2	1	-	2	2	2	2	-
CO4	3	2	1	1	3	1	-	2	2	2	3	1
CO5	2	2	1	2	3	1	1	2	1	3	3	2
Avg.	**2.8**	**1.6**	**1.0**	**1.5**	**2.2**	**1.0**	**1.0**	**1.6**	**1.6**	**2.2**	**2.2**	**1.5**

Text Books

1. Lutz, S., & Bornscheuer, U. Protein Engineering Handbook. Wiley-VCH.
2. Branden, C., & Tooze, J. Introduction to Protein Structure. Garland Science.

Reference Books

1. Creighton, T. E. Proteins: Structures and Molecular Properties. W.H. Freeman.
2. Voet, D., Voet, J. G., & Pratt, C. W. Fundamentals of Biochemistry. Wiley.
3. Alberts, B., et al. Molecular Biology of the Cell. Garland Science.

BITT3516: Food Biotechnology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	V	Core

Course Description

This course provides an understanding of the application of biotechnology in food production, processing, preservation, quality assurance, and safety. It covers microbial fermentation, food enzymes, probiotics, genetically modified foods, functional foods, food quality management, and emerging biotechnological innovations that contribute to sustainable food production and human nutrition.

Course Objectives

1. Understand the role of microorganisms and biotechnology in food production and processing.
2. Explain the principles of food fermentation, preservation, and quality control.
3. Describe the applications of enzymes and genetically modified organisms in the food industry.
4. Understand food safety regulations and quality management systems.
5. Appreciate recent advances in food biotechnology and sustainable food production.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Food Biotechnology.** Scope and importance of food biotechnology; composition and nutritional value of foods; microorganisms associated with foods; beneficial and spoilage microorganisms; food contamination; foodborne diseases; principles of food preservation; physical, chemical, and biological methods of food preservation; biotechnology in food production.	12
2	**Food Fermentation and Industrial Applications.** Microbial cultures used in food fermentation; starter cultures; fermentation of dairy products, cereals, vegetables, meat, and beverages; production of fermented foods; probiotics, prebiotics, and synbiotics; industrial production of food enzymes; microbial production of organic acids, vitamins, amino acids, and food additives.	12
3	**Food Processing, Quality Control, and Safety.** Food processing techniques; food packaging technologies; quality assurance and quality control; Good Manufacturing Practices (GMP); Hazard Analysis and Critical Control Points (HACCP); food quality evaluation; food spoilage and foodborne pathogens; biosensors in food quality assessment; food safety regulations and standards.	12
4	**Modern Applications of Food Biotechnology.** Genetically modified foods; transgenic crops for improved nutrition; biofortification; nutraceuticals and functional foods; enzyme technology in food processing; single-cell protein; edible vaccines; nanotechnology in food systems; applications of biotechnology in food waste management.	12
5	**Emerging Trends in Food Biotechnology.** Sustainable food biotechnology; precision fermentation; alternative proteins; cultured meat; microbiome and nutrition; personalized nutrition; food biotechnology and climate resilience; FSSAI and Codex Alimentarius guidelines; ethical, environmental, and regulatory issues in food biotechnology.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles and applications of food biotechnology.	K2
CO2	Describe microbial fermentation and enzyme technology in food processing.	K2
CO3	Apply quality assurance and food safety principles in food industries.	K3

CO	Statement	Bloom level
CO4	Evaluate the role of genetically modified and functional foods in human health.	K5
CO5	Discuss emerging biotechnological innovations for sustainable food production.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	1	1	2	-	-
CO2	3	1	1	-	2	1	-	1	2	2	1	-
CO3	3	2	1	-	2	1	-	2	2	2	2	-
CO4	3	2	1	1	3	1	-	2	2	2	3	1
CO5	2	2	1	2	3	1	1	2	1	3	3	2
Avg.	**2.8**	**1.6**	**1.0**	**1.5**	**2.2**	**1.0**	**1.0**	**1.6**	**1.6**	**2.2**	**2.2**	**1.5**

Text Books

1. Byong H. Lee. Fundamentals of Food Biotechnology. Wiley-Blackwell.
2. Ray, B., & Bhunia, A. Fundamental Food Microbiology. CRC Press.

Reference Books

1. Fellows, P. J. Food Processing Technology: Principles and Practice. Woodhead Publishing.
2. Adams, M. R., & Moss, M. Food Microbiology. Royal Society of Chemistry.
3. Frazier, W. C., & Westhoff, D. C. Food Microbiology. McGraw-Hill.

BITT3517: Medical and Pharmaceutical Biotechnology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	V	Core

Course Description

This course explores the application of biotechnology in medicine and pharmaceutical sciences. It covers recombinant therapeutics, vaccines, molecular diagnostics, drug discovery, pharmacogenomics, gene therapy, regenerative medicine, and regulatory aspects involved in the development and commercialization of biopharmaceutical products.

Course Objectives

1. Understand the principles and applications of medical and pharmaceutical biotechnology.
2. Explain the development and production of biopharmaceuticals and vaccines.
3. Describe molecular diagnostic techniques and modern drug discovery approaches.
4. Understand advanced therapeutic strategies including gene and stem cell therapies.
5. Appreciate regulatory, ethical, and quality aspects of pharmaceutical biotechnology.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Medical Biotechnology.** Scope and importance of medical biotechnology; recombinant DNA technology in healthcare; therapeutic proteins; recombinant insulin, growth hormone, interferons, erythropoietin, and blood clotting factors; monoclonal antibodies; biosimilars; introduction to personalized medicine.	12
2	**Vaccines and Molecular Diagnostics.** Conventional and recombinant vaccines; DNA, RNA, and vector-based vaccines; vaccine production and quality control; molecular diagnostics; PCR, RT-PCR, real-time PCR, ELISA, DNA sequencing, biosensors; biomarkers for disease diagnosis; companion diagnostics.	12
3	**Drug Discovery and Biopharmaceutical Production.** Drug discovery pipeline; target identification and validation; lead optimization; pharmacogenomics; biologics and biosimilars; microbial and mammalian expression systems; downstream processing of biopharmaceuticals; quality assurance in pharmaceutical biotechnology.	12
4	**Advanced Therapeutics.** Gene therapy; stem cell therapy; regenerative medicine; tissue engineering; CRISPR-Cas genome editing; RNA therapeutics; nanomedicine; antibody-drug conjugates; precision medicine and future therapeutic strategies.	12
5	**Regulatory Affairs and Emerging Trends.** Good Manufacturing Practices (GMP); Good Laboratory Practices (GLP); Good Clinical Practices (GCP); clinical trial phases; regulatory agencies (CDSCO, FDA, EMA); biosafety and bioethics; intellectual property rights; emerging trends in pharmaceutical biotechnology and precision healthcare.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles and applications of medical and pharmaceutical biotechnology.	K2
CO2	Describe recombinant therapeutics, vaccines, and molecular diagnostic technologies.	K2
CO3	Explain the stages involved in drug discovery and biopharmaceutical production.	K2

CO	Statement	Bloom level
CO4	Evaluate modern therapeutic approaches including gene therapy, regenerative medicine, and genome editing.	K5
CO5	Discuss regulatory, ethical, and quality assurance aspects of pharmaceutical biotechnology.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	-	1	2	-	-
CO2	3	1	1	-	2	1	-	-	1	2	1	-
CO3	3	2	1	-	3	1	-	1	1	2	2	-
CO4	3	2	2	1	3	1	-	1	2	2	3	1
CO5	3	2	2	2	3	2	-	1	2	2	3	2
Avg.	**3.0**	**1.6**	**1.5**	**1.5**	**2.4**	**1.2**	**-**	**1.0**	**1.4**	**2.0**	**2.2**	**1.5**

Text Books

1. Walsh, G. Biopharmaceuticals: Biochemistry and Biotechnology. Wiley.
2. Crommelin, D., Sindelar, R., & Meibohm, B. Pharmaceutical Biotechnology. Springer.

Reference Books

1. Glick, B. R., Pasternak, J. J., & Patten, C. L. Molecular Biotechnology. ASM Press.
2. Brown, T. A. Gene Cloning and DNA Analysis. Wiley-Blackwell.
3. Kayser, O., & Müller, R. H. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications. Wiley.

BITT3518: Principles of Bioprocess Engineering

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Core

Course Description

This course introduces the engineering principles involved in the production of biotechnological products using microbial, plant, and animal cell systems. It covers microbial growth kinetics, bioreactor design, upstream and downstream processing, process monitoring, scale-up, and industrial applications of bioprocess engineering in pharmaceuticals, food, agriculture, and environmental biotechnology.

Course Objectives

1. Understand the principles of bioprocess engineering and industrial fermentation.
2. Explain microbial growth kinetics and the design of bioreactors.
3. Describe upstream and downstream processing involved in bioproduct manufacturing.
4. Understand process monitoring, control, and scale-up strategies.
5. Appreciate industrial applications of bioprocess engineering and emerging biomanufacturing technologies.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Bioprocess Engineering.** Scope and importance of bioprocess engineering; industrial microorganisms; microbial growth kinetics; batch, fed-batch, and continuous cultures; media formulation; sterilization of media and equipment; inoculum development; factors affecting microbial growth; industrial fermentation processes.	9
2	**Bioreactors and Fermentation Technology.** Types of bioreactors; stirred-tank, airlift, packed-bed, fluidized-bed, and photobioreactors; aeration and agitation; oxygen transfer; mixing; foam control; sensors and instrumentation; monitoring fermentation parameters; bioreactor operation and maintenance.	9
3	**Upstream Processing.** Selection and improvement of industrial microorganisms; strain development; inoculum preparation; optimization of fermentation parameters; media optimization; bioprocess monitoring; statistical optimization techniques; introduction to Process Analytical Technology (PAT).	9
4	**Downstream Processing.** Recovery of fermentation products; filtration; centrifugation; cell disruption; extraction; precipitation; membrane separation; chromatography; drying; formulation; quality control and product stabilization; process economics.	9
5	**Industrial Applications and Emerging Trends.** Production of antibiotics, enzymes, organic acids, amino acids, vaccines, recombinant proteins, biofertilizers, biopesticides, biofuels, and biopolymers; scale-up principles; bioprocess validation; industrial automation; Industry 4.0 in bioprocessing; sustainability and green bioprocess engineering.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of microbial growth and industrial fermentation.	K2
CO2	Describe the design, operation, and applications of different bioreactors.	K6
CO3	Apply upstream and downstream processing concepts for bioproduct manufacturing.	K3

CO	Statement	Bloom level
CO4	Interpret process monitoring, optimization, and scale-up strategies in industrial biotechnology.	K4
CO5	Evaluate the applications of bioprocess engineering in pharmaceuticals, food, agriculture, environmental biotechnology, and emerging biomanufacturing technologies.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	1	1	2	-	-
CO2	3	1	1	-	2	1	-	1	2	2	1	-
CO3	3	2	1	-	2	1	-	2	2	2	2	-
CO4	3	2	1	1	3	1	-	2	2	2	3	1
CO5	2	2	1	2	3	1	1	2	1	3	3	2
Avg.	**2.8**	**1.6**	**1.0**	**1.5**	**2.2**	**1.0**	**1.0**	**1.6**	**1.6**	**2.2**	**2.2**	**1.5**

Text Books

1. Doran, P. M. Bioprocess Engineering Principles. 2nd Edition. Academic Press.
2. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. 3rd Edition. Elsevier.

Reference Books

1. Shuler, M. L., Kargi, F., & DeLisa, M. P. Bioprocess Engineering: Basic Concepts. 3rd Edition. Pearson.
2. Bailey, J. E., & Ollis, D. F. Biochemical Engineering Fundamentals. McGraw-Hill.
3. Crueger, W., & Crueger, A. Biotechnology: A Textbook of Industrial Microbiology. Panima Publishing.

BITT3603(A): Entrepreneurship and Biotechnology Venture Creation

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Program Elective

Course Description

This course introduces the principles of entrepreneurship and innovation in biotechnology, focusing on transforming scientific discoveries into commercially viable products and services. It covers ideation, business planning, startup ecosystems, funding mechanisms, technology transfer, regulatory pathways, commercialization strategies, and entrepreneurial leadership in the biotechnology sector.

Course Objectives

1. Understand the principles of entrepreneurship and innovation in biotechnology.
2. Explain the process of transforming scientific ideas into biotechnology ventures.
3. Develop knowledge of business planning, funding, and commercialization strategies.
4. Understand technology transfer, incubation, and startup ecosystems.
5. Appreciate ethical, legal, and regulatory aspects of biotechnology entrepreneurship.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamentals of Biotechnology Entrepreneurship.** Entrepreneurship and innovation; characteristics of entrepreneurs; biotechnology startup ecosystem; ideation and opportunity identification; biotechnology value chain; entrepreneurship development process; design thinking; innovation management; business models in biotechnology; successful biotechnology ventures.	9
2	**Venture Planning and Business Development.** Business plan development; market analysis; customer discovery; product development cycle; feasibility analysis; business model canvas; marketing strategies; financial planning; budgeting; revenue models; risk assessment; project management.	9
3	**Technology Transfer and Commercialization.** Technology readiness levels; technology transfer process; incubation and accelerators; biotechnology parks; university-industry collaboration; licensing; commercialization of research; product validation; scale-up strategies; quality management; industrial partnerships.	9
4	**Funding, Regulations, and Intellectual Property.** Sources of funding; venture capital; angel investors; government funding schemes (BIRAC, DBT, Startup India); grants and crowdfunding; patent basics; intellectual property management; biosafety regulations; regulatory approval pathways; ethics in biotechnology entrepreneurship.	9
5	**Emerging Trends and Entrepreneurship Ecosystem.** Digital biotechnology; AI-enabled biotechnology startups; synthetic biology enterprises; personalized healthcare ventures; bioeconomy and sustainable biotechnology; entrepreneurship in agriculture, healthcare, industrial and environmental biotechnology; leadership; startup case studies; future prospects.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of biotechnology entrepreneurship and innovation.	K2
CO2	Develop business plans and commercialization strategies for biotechnology products.	K3
CO3	Evaluate funding mechanisms, technology transfer, and startup ecosystems.	K5

CO	Statement	Bloom level
CO4	Apply intellectual property and regulatory concepts in biotechnology ventures.	K3
CO5	Analyze emerging entrepreneurial opportunities in the biotechnology sector.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	-	-	3	2	-	-	-	1	-	1
CO2	2	1	1	-	3	3	-	-	-	1	1	1
CO3	2	1	2	-	3	3	1	-	1	1	1	2
CO4	2	1	2	1	3	3	1	-	1	1	2	2
CO5	2	1	2	2	3	3	2	-	1	1	2	3
Avg.	**2.0**	**1.0**	**1.8**	**1.5**	**3.0**	**2.8**	**1.3**	**-**	**1.0**	**1.0**	**1.5**	**1.8**

Text Books

1. Desai, V. Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House.
2. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. Entrepreneurship. McGraw-Hill.

Reference Books

1. Allen, K. R. Launching New Ventures. Cengage Learning.
2. OECD. Commercialising Public Research: New Trends and Strategies.
3. BIRAC & Startup India publications on Biotechnology Entrepreneurship.

BITT3603(B): Regulatory Affairs and Intellectual Property in Biotechnology

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Program Elective

Course Description

This course introduces the regulatory framework governing biotechnology products and the protection of intellectual property. It covers regulatory requirements for pharmaceuticals, biologics, medical devices, genetically modified organisms, biosafety, patents, trademarks, copyrights, and international agreements relevant to biotechnology innovation.

Course Objectives

1. Understand regulatory systems governing biotechnology products.
2. Explain the principles of intellectual property rights in biotechnology.
3. Describe biosafety, bioethics, and quality management requirements.
4. Understand national and international regulatory agencies and approval processes.
5. Appreciate the importance of regulatory compliance and intellectual property management.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Regulatory Affairs.** Introduction to regulatory affairs; importance in biotechnology; product life cycle; regulatory framework; quality management systems; Good Laboratory Practices (GLP); Good Manufacturing Practices (GMP); Good Clinical Practices (GCP); documentation; quality assurance.	9
2	**Regulatory Approval Processes.** Regulatory pathways for pharmaceuticals, biologics, vaccines, biosimilars, diagnostics, and medical devices; preclinical studies; clinical trial phases; regulatory submissions; post-marketing surveillance; pharmacovigilance; biosafety guidelines; environmental risk assessment.	9
3	**Intellectual Property Rights.** Introduction to intellectual property; patents; copyrights; trademarks; industrial designs; geographical indications; trade secrets; patent drafting; patent search; patent filing procedures; patent databases; technology licensing.	9
4	**National and International Regulatory Frameworks.** Regulatory agencies including CDSCO, DBT, GEAC, ICMR, FDA, EMA, WHO, and OECD; TRIPS Agreement; Patent Cooperation Treaty (PCT); Convention on Biological Diversity (CBD); Nagoya Protocol; biosafety regulations; ethical issues in biotechnology.	9
5	**Emerging Trends and Case Studies.** Regulatory challenges for gene therapy, cell therapy, genome editing, AI-enabled medical devices, digital health, personalized medicine, and synthetic biology; regulatory intelligence; quality audits; entrepreneurship and intellectual property management; case studies in biotechnology regulation.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain regulatory frameworks governing biotechnology products.	K2
CO2	Describe regulatory approval processes for pharmaceuticals and biologics.	K2
CO3	Apply intellectual property concepts to biotechnology innovations.	K3
CO4	Evaluate biosafety, bioethics, and quality management systems.	K5

CO	Statement	Bloom level
CO5	Discuss emerging regulatory challenges and global biotechnology policies.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	2	1	-	-	-	-	-	1
CO2	3	1	1	-	3	1	-	-	1	-	1	1
CO3	2	1	1	3	3	1	-	-	-	2	1	3
CO4	2	1	2	3	3	1	-	-	-	3	2	5
CO5	2	1	2	3	3	2	-	-	-	3	3	5
Avg.	**2.4**	**1.0**	**1.5**	**3.0**	**2.8**	**1.2**	**-**	**-**	**1.0**	**2.7**	**1.8**	**3.0**

Text Books

1. Guarino, R. A. New Drug Approval Process. CRC Press.
2. N.K. Acharya. Textbook on Intellectual Property Rights. Asia Law House.

Reference Books

1. Bouchoux, D. E. Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets. Cengage Learning.
2. World Intellectual Property Organization (WIPO). Understanding Intellectual Property.
3. ICH Guidelines and CDSCO Guidance Documents.

BITT3603(C): Cancer Biology and Precision Oncology

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Program Elective

Course Description

This course provides an overview of the molecular and cellular basis of cancer, emphasizing tumor biology, carcinogenesis, cancer genomics, molecular diagnostics, targeted therapies, immunotherapy, and precision oncology. It also introduces emerging technologies used in cancer diagnosis, prognosis, and personalized treatment.

Course Objectives

1. Understand the molecular basis and hallmarks of cancer.
2. Explain the mechanisms of carcinogenesis, tumor progression, and metastasis.
3. Describe cancer genomics, biomarkers, and molecular diagnostic techniques.
4. Understand targeted therapies, immunotherapy, and precision oncology approaches.
5. Appreciate recent advances in cancer research and personalized cancer management.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamentals of Cancer Biology.** Introduction to cancer; characteristics of normal and cancer cells; hallmarks of cancer; oncogenes; tumor suppressor genes; cell cycle regulation; apoptosis; DNA damage and repair; genomic instability; carcinogenesis; environmental and genetic risk factors.	9
2	**Tumor Progression and Cancer Genomics.** Tumor microenvironment; angiogenesis; invasion and metastasis; cancer stem cells; epithelial- mesenchymal transition (EMT); cancer genomics; driver and passenger mutations; epigenetic alterations; cancer biomarkers; The Cancer Genome Atlas (TCGA); liquid biopsy.	9
3	**Molecular Diagnostics and Therapeutics.** Cancer screening; histopathology; immunohistochemistry; PCR-based diagnostics; next-generation sequencing; companion diagnostics; targeted therapies; small-molecule inhibitors; monoclonal antibodies; antibody-drug conjugates; resistance mechanisms.	9
4	**Precision Oncology and Immunotherapy.** Precision medicine in oncology; pharmacogenomics; immune checkpoints; CAR-T cell therapy; cancer vaccines; cytokine therapy; adoptive cell therapy; nanomedicine; artificial intelligence in oncology; clinical decision support systems.	9
5	**Emerging Trends and Future Perspectives.** Multi-omics in cancer research; single-cell sequencing; spatial transcriptomics; organoids in cancer research; computational oncology; AI-assisted drug discovery; personalized treatment strategies; cancer prevention; ethics in genomic medicine; future prospects of precision oncology.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the molecular mechanisms involved in cancer initiation and progression.	K2
CO2	Describe cancer genomics, biomarkers, and molecular diagnostic approaches.	K2
CO3	Evaluate targeted therapies and immunotherapeutic strategies for cancer treatment.	K5
CO4	Interpret the principles of precision oncology and personalized cancer management.	K4

CO	Statement	Bloom level
CO5	Discuss emerging technologies and future directions in cancer biology and precision oncology.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	-	1	2	-	-
CO2	3	1	1	-	2	1	-	-	1	2	1	-
CO3	3	2	1	-	3	1	-	1	1	2	2	-
CO4	3	2	2	1	3	1	-	1	2	2	3	1
CO5	3	2	2	2	3	2	-	1	2	2	3	2
Avg.	**3.0**	**1.6**	**1.5**	**1.5**	**2.4**	**1.2**	**-**	**1.0**	**1.4**	**2.0**	**2.2**	**1.5**

Text Books

1. Weinberg, R. A. The Biology of Cancer. 3rd Edition. Garland Science.
2. Pecorino, L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Oxford University Press.

Reference Books

1. Kleinsmith, L. J. Principles of Cancer Biology. Pearson.
2. DeVita, V. T., Hellman, S., & Rosenberg, S. A. Cancer: Principles & Practice of Oncology. Wolters Kluwer.
3. Alberts, B., et al. Molecular Biology of the Cell. Garland Science. Program Elective -4 (BITT3604)

BITT3604(A): Microbiome Science and Human Health

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Program Elective

Course Description

This course introduces the structure, diversity, and functions of the human microbiome and its role in health and disease. It covers microbial communities associated with different body sites, microbiome analysis techniques, host-microbiome interactions, dysbiosis, microbiome-based therapeutics, and emerging applications in precision medicine and personalized healthcare.

Course Objectives

1. Understand the composition and diversity of the human microbiome.
2. Explain host-microbiome interactions in maintaining human health.
3. Describe microbiome analysis techniques and bioinformatics approaches.
4. Understand the role of the microbiome in human diseases and therapeutics.
5. Appreciate emerging applications of microbiome research in precision medicine.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Human Microbiome.** Introduction to microbiome science; history and scope; human microbiota and microbiome; microbial diversity; microbiome of the gastrointestinal tract, skin, oral cavity, respiratory tract, and urogenital tract; factors influencing microbiome composition; microbiome development across the lifespan.	9
2	**Host–Microbiome Interactions.** Host immune system and microbiome; gut-brain axis; gut-liver axis; microbial metabolism; probiotics, prebiotics, synbiotics, and postbiotics; nutrition and microbiome; microbiome and immune regulation; microbiome homeostasis and dysbiosis.	9
3	**Microbiome Analysis and Multi-Omics.** Sample collection and processing; metagenomics; 16S rRNA sequencing; shotgun metagenomics; metatranscriptomics; metaproteomics; metabolomics; microbiome databases; bioinformatics tools; microbial community analysis and interpretation.	9
4	**Microbiome in Human Diseases.** Microbiome in obesity, diabetes, inflammatory bowel disease, colorectal cancer, cardiovascular disorders, autoimmune diseases, neurological disorders, allergies, and infectious diseases; antimicrobial resistance and microbiome modulation.	9
5	**Therapeutic Applications and Future Perspectives.** Fecal microbiota transplantation; engineered probiotics; microbiome therapeutics; microbiome biomarkers; personalized nutrition; microbiome-based diagnostics; artificial intelligence in microbiome research; ethical and regulatory considerations; future prospects.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the diversity and functions of the human microbiome.	K2
CO2	Describe host-microbiome interactions in health and disease.	K2
CO3	Interpret microbiome sequencing and bioinformatics approaches.	K4
CO4	Evaluate microbiome-based therapeutic and diagnostic strategies.	K5
CO5	Discuss emerging applications of microbiome science in precision medicine.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	-	1	2	-	-
CO2	3	1	1	-	2	1	-	-	1	2	1	-
CO3	3	2	1	-	3	1	-	1	1	2	2	-
CO4	3	2	2	1	3	1	-	1	2	2	3	1
CO5	3	2	2	2	3	2	-	1	2	2	3	2
Avg.	**3.0**	**1.6**	**1.5**	**1.5**	**2.4**	**1.2**	**-**	**1.0**	**1.4**	**2.0**	**2.2**	**1.5**

Text Books

1. White, B. A., et al. The Human Microbiota and Microbiome. ASM Press.
2. Wilson, M. Microbial Inhabitants of Humans. Cambridge University Press.

Reference Books

1. Floch, M. H. The Microbiota in Gastrointestinal Pathophysiology. Academic Press.
2. Human Microbiome Project Consortium publications.
3. Huttenhower, C. Computational Approaches to the Human Microbiome. Springer.

BITT3604(B): Clinical Research and Good Clinical Practice (GCP)

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Program Elective

Course Description

This course introduces the principles and practices of clinical research with emphasis on Good Clinical Practice (GCP), clinical trial design, ethics, regulatory requirements, data management, pharmacovigilance, and quality assurance. It prepares students to understand clinical development of pharmaceuticals, biologics, and medical devices.

Course Objectives

1. Understand the fundamentals of clinical research and clinical trial methodologies.
2. Explain the principles and requirements of Good Clinical Practice.
3. Describe ethical and regulatory aspects of clinical research.
4. Understand clinical data management and pharmacovigilance.
5. Appreciate quality assurance and emerging trends in clinical research.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Clinical Research.** Introduction to clinical research; drug development process; translational research; phases of clinical trials; observational and interventional studies; randomized controlled trials; protocol development; clinical research organizations; investigator responsibilities.	9
2	**Good Clinical Practice (GCP).** ICH-GCP guidelines; ethical principles; informed consent; Institutional Ethics Committee (IEC); investigator brochure; essential documents; monitoring; auditing; quality assurance; participant safety; documentation and record keeping.	9
3	**Clinical Trial Operations.** Site selection and initiation; participant recruitment; randomization; blinding; trial conduct; adverse event reporting; pharmacovigilance; data collection; electronic data capture; clinical trial management systems; quality control.	9
4	**Regulatory Affairs and Data Management.** Regulatory agencies including CDSCO, FDA, EMA, and WHO; clinical trial registration; clinical data management; biostatistics in clinical research; medical writing; regulatory submissions; inspections; post-marketing surveillance.	9
5	**Emerging Trends in Clinical Research.** Decentralized clinical trials; adaptive trial designs; real-world evidence; AI in clinical research; wearable health technologies; personalized medicine; biosimilars; vaccine clinical trials; ethical challenges; future perspectives.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of clinical research and drug development.	K2
CO2	Describe Good Clinical Practice guidelines and ethical requirements.	K2
CO3	Apply concepts of clinical trial conduct, monitoring, and data management.	K3
CO4	Evaluate regulatory and pharmacovigilance processes in clinical research.	K5
CO5	Discuss emerging technologies and innovations in clinical trials.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	2	1	-	-	-	-	-	1
CO2	3	1	1	-	3	1	-	-	1	-	1	1
CO3	2	1	1	3	3	1	-	-	-	2	1	3
CO4	2	1	2	3	3	1	-	-	-	3	2	5
CO5	2	1	2	3	3	2	-	-	-	3	3	5
Avg.	**2.4**	**1.0**	**1.5**	**3.0**	**2.8**	**1.2**	**-**	**-**	**1.0**	**2.7**	**1.8**	**3.0**

Text Books

1. Friedman, L. M., Furberg, C., & DeMets, D. Fundamentals of Clinical Trials.
2. ICH Harmonised Guideline for Good Clinical Practice (E6 R2/R3).

Reference Books

1. Gallin, J. I., Ognibene, F. P., & Johnson, L. L. Principles and Practice of Clinical Research.
2. Spilker, B. Guide to Clinical Trials.
3. CDSCO Guidance Documents on Clinical Trials.

BITT3604(C): Biotechnology Product Development and Commercialization

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Program Elective

Course Description

This course provides an understanding of the complete lifecycle of biotechnology product development, from concept generation and laboratory research to scale-up, regulatory approval, manufacturing, commercialization, and market launch. It emphasizes innovation, technology transfer, quality management, intellectual property, and entrepreneurship in biotechnology.

Course Objectives

1. Understand the stages involved in biotechnology product development.
2. Explain technology transfer, product validation, and commercialization strategies.
3. Describe quality management, regulatory compliance, and manufacturing processes.
4. Understand intellectual property protection and market analysis.
5. Appreciate innovation and entrepreneurship in biotechnology industries.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Biotechnology Product Development.** Product development lifecycle; idea generation; unmet clinical and industrial needs; product design; proof of concept; feasibility studies; prototype development; market analysis; technology readiness levels; innovation management.	9
2	**Product Development and Scale-Up.** Research and development; process optimization; pilot-scale production; scale-up strategies; process validation; manufacturing workflows; Good Manufacturing Practices (GMP); quality control; quality assurance; documentation.	9
3	**Technology Transfer and Commercialization.** Technology transfer; licensing; contract research organizations; contract manufacturing organizations; university-industry partnerships; commercialization pathways; product positioning; branding; pricing strategies; distribution and supply chain management.	9
4	**Regulatory Affairs and Intellectual Property.** Patent landscape; intellectual property protection; regulatory approval pathways; risk assessment; biosafety; clinical validation; reimbursement strategies; product registration; market access; post- market surveillance.	9
5	**Entrepreneurship and Emerging Trends.** Business planning; startup development; funding opportunities; venture capital; biotechnology incubators; digital biotechnology; AI-enabled product development; personalized healthcare products; sustainable biotechnology; future opportunities in biotechnology commercialization.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the biotechnology product development lifecycle.	K2
CO2	Describe technology transfer, manufacturing, and commercialization strategies.	K2
CO3	Apply quality management and regulatory principles in biotechnology industries.	K3
CO4	Evaluate intellectual property and market strategies for biotechnology products.	K5
CO5	Discuss entrepreneurship and innovation in biotechnology product development.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	-	-	3	2	-	-	-	1	-	1
CO2	2	1	1	-	3	3	-	-	-	1	1	1
CO3	2	1	2	-	3	3	1	-	1	1	1	2
CO4	2	1	2	1	3	3	1	-	1	1	2	2
CO5	2	1	2	2	3	3	2	-	1	1	2	3
Avg.	**2.0**	**1.0**	**1.8**	**1.5**	**3.0**	**2.8**	**1.3**	**-**	**1.0**	**1.0**	**1.5**	**1.8**

Text Books

1. Crommelin, D., Sindelar, R., & Meibohm, B. Pharmaceutical Biotechnology: Fundamentals and Applications.
2. Walsh, G. Biopharmaceuticals: Biochemistry and Biotechnology.

Reference Books

1. Hisrich, R., Peters, M., & Shepherd, D. Entrepreneurship.
2. Guarino, R. New Drug Approval Process.
3. OECD. Commercialising Public Research: New Trends and Strategies.

BITP3501: Mini Project

L	T	P	C	Total hours	Semester	Category
0	0	6	3	90	V	Project

Course Description

The Mini Project gives students their first structured experience of independent investigation. Working individually or in small teams under a faculty guide, students take up a short laboratory, computational or survey-based problem in biotechnology and apply the knowledge gained in Semesters I to V.

Course Objectives

1. To enable students to identify a focused problem in biotechnology and review the relevant literature.
2. To train students to plan and carry out a short investigation using appropriate laboratory or computational methods.
3. To develop skills in data recording, analysis and interpretation.
4. To build skills in scientific writing and oral presentation.
5. To instil research ethics, data integrity and teamwork.

Note: *The source document gives no syllabus for the Mini Project. The description, objectives, hours and outcomes here are drafted for the Board of Studies to confirm.*

Project Phases with Hours

Phase	Activity	Hours
1	Problem identification, guide allocation and literature survey	15
2	Planning of methodology and approval by the department project committee	15
3	Execution of laboratory or computational work with regular guide review	40
4	Data analysis, interpretation and preparation of the project report	15
5	Final presentation and viva-voce	5
	Total	90

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Identify a researchable problem in biotechnology and review the literature on it	K3
CO2	Plan an investigation using appropriate laboratory or computational methods	K6
CO3	Carry out experiments or computations and record observations accurately	K3
CO4	Analyse and interpret results and draw justified conclusions	K4
CO5	Communicate the work through a structured report and presentation, observing research ethics	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	2	3	-	2	1	2	1	-
CO2	3	3	1	-	2	3	-	3	2	3	1	-
CO3	3	3	2	-	1	3	-	3	2	3	2	2

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO4	3	2	2	3	2	3	-	2	3	3	3	3
CO5	2	2	3	3	3	3	2	2	1	3	3	3
Avg.	**2.8**	**2.4**	**2.0**	**3.0**	**2.0**	**3.0**	**2.0**	**2.4**	**1.8**	**2.8**	**2.0**	**2.7**

Text Books and Reference Resources

1. Guidelines issued by the department project committee.
2. Faculty-recommended primary literature and laboratory manuals relevant to the chosen topic.
3. Software tools: Python, R, Bioconductor (as applicable).

SEMESTER VI (B.SC. 3-YEAR EXIT)

BITT3605: MOOCs Course 1

L	T	P	C	Total hours	Semester	Category
2	0	0	2	30	VI	MOOC

Course Description

A self-paced online course taken from an approved platform (SWAYAM, NPTEL or an equivalent recognised provider) in biotechnology or an allied discipline, chosen with the approval of the department. Credit is awarded on successful completion of the course assessments and submission of the certificate.

Course Objectives

1. To enable self-directed learning in an advanced or allied area of biotechnology.
2. To broaden the learner's knowledge beyond the core curriculum.
3. To develop the habit of lifelong learning through online platforms.

Note: *The source lists the MOOC courses by code and credit only. This sheet is a generic template; the title, platform and syllabus of the selected course are to be recorded for each batch.*

Course Structure

Component	Activity	Hours
Learning	Completion of the video lectures, readings and assignments of the approved MOOC	24
Assessment	Weekly quizzes and the proctored final examination of the platform	4
Mentoring	Course approval, progress review and credit transfer by the department mentor	2
	Total	30

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the core concepts of the chosen course	K2
CO2	Apply the concepts learned to biotechnology problems	K3
CO3	Complete the platform assessments and obtain certification	K3
CO4	Relate the course content to the programme outcomes and career interests	K4
CO5	Plan further self-directed learning in the area	K6

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	-	-	-	-	3	-	-	-	1	-	-
CO2	2	1	-	-	1	3	-	-	-	1	1	-
CO3	2	1	-	-	2	3	-	-	-	1	1	1
CO4	1	-	-	-	2	3	-	-	-	-	-	-
CO5	1	-	-	1	2	3	-	-	-	-	1	1
Avg.	**1.6**	**1.0**	**-**	**1.0**	**1.8**	**3.0**	**-**	**-**	**-**	**1.0**	**1.0**	**1.0**

Text Books and Reference Resources

1. As specified by the platform for the selected course.

BITT3606: MOOCs Course 2

L	T	P	C	Total hours	Semester	Category
2	0	0	2	30	VI	MOOC

Course Description

A self-paced online course taken from an approved platform (SWAYAM, NPTEL or an equivalent recognised provider) in biotechnology or an allied discipline, chosen with the approval of the department. Credit is awarded on successful completion of the course assessments and submission of the certificate.

Course Objectives

1. To enable self-directed learning in an advanced or allied area of biotechnology.
2. To broaden the learner's knowledge beyond the core curriculum.
3. To develop the habit of lifelong learning through online platforms.

Note: *The source lists the MOOC courses by code and credit only. This sheet is a generic template; the title, platform and syllabus of the selected course are to be recorded for each batch.*

Course Structure

Component	Activity	Hours
Learning	Completion of the video lectures, readings and assignments of the approved MOOC	24
Assessment	Weekly quizzes and the proctored final examination of the platform	4
Mentoring	Course approval, progress review and credit transfer by the department mentor	2
	Total	30

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the core concepts of the chosen course	K2
CO2	Apply the concepts learned to biotechnology problems	K3
CO3	Complete the platform assessments and obtain certification	K3
CO4	Relate the course content to the programme outcomes and career interests	K4
CO5	Plan further self-directed learning in the area	K6

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	-	-	-	-	3	-	-	-	1	-	-
CO2	2	1	-	-	1	3	-	-	-	1	1	-
CO3	2	1	-	-	2	3	-	-	-	1	1	1
CO4	1	-	-	-	2	3	-	-	-	-	-	-
CO5	1	-	-	1	2	3	-	-	-	-	1	1
Avg.	**1.6**	**1.0**	**-**	**1.0**	**1.8**	**3.0**	**-**	**-**	**-**	**1.0**	**1.0**	**1.0**

Text Books and Reference Resources

1. As specified by the platform for the selected course.

BITP3502: Major Project (B.Sc. 3-year exit)

L	T	P	C	Total hours	Semester	Category
0	0	32	16	480	VI	Project

Course Description

The Major Project provides an opportunity to apply knowledge and skills in biotechnology to real-world problems through research, experimentation and innovation. The project focuses on health informatics, molecular diagnostics, bioinformatics or data science applications in healthcare. Students work individually or in small teams.

Course Objectives

1. To apply knowledge and skills in biotechnology to solve real-world problems through research, experimentation and innovation.
2. To formulate a research question on a healthcare problem aligned with medical biotechnology (diagnostics and biomarkers, personalised medicine, computational biology and multi-omics, biopharmaceuticals, AI in healthcare).
3. To design experiments or data-driven studies with ethical compliance and data security.
4. To analyse and interpret data using appropriate bioinformatics, statistical and machine-learning tools.
5. To communicate findings through a comprehensive project report and a final presentation.

Note: *Hours per task are allocated here so that the tasks total the 480 hours of the semester (32 hours per week for 15 weeks). The source gives week-wise deadlines (reproduced below) but no hours.*

Project Tasks with Hours

Task	Activity	Hours
1	Identify a research problem: select a specific healthcare problem aligned with medical biotechnology (diagnostics and biomarker discovery, personalised medicine and pharmacogenomics, computational biology and multi-omics integration, biopharmaceutical development, AI and machine learning in healthcare)	30
2	Literature review and hypothesis development: review the current state of research; formulate a research question and hypothesis	50
3	Data acquisition and experimental design: identify datasets (genomic databases, clinical datasets, bioinformatics repositories) or design laboratory experiments; ensure ethical compliance and data security	90
4	Data preprocessing and analysis: clean, preprocess and integrate datasets; exploratory data analysis; use of bioinformatics or statistical tools	110
5	Feature engineering and model development (data-driven projects): feature selection; predictive models using machine learning; training and validation with suitable metrics	80
6	Results interpretation and discussion: interpret findings, compare with existing studies, discuss applications and limitations	60
7	Project report and presentation: comprehensive report on methodology, findings and conclusions; final presentation to faculty and peers	60
	Total	480

Evaluation Criteria (from the Major Project Guidelines)

Criterion	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
Problem Definition	Clearly defined and highly significant	Well-defined and significant	Adequately defined, could be more significant	Somewhat unclear or lacks significance	Unclear or irrelevant
Literature Review	Comprehensive and well-referenced	Good coverage with relevant sources	Adequate review with minor gaps	Limited review with significant gaps	Minimal or no review
Experimental Design / Data Acquisition	Highly appropriate methodology with strong justification	Well-designed methodology	Adequate methodology with minor weaknesses	Poorly designed methodology	No clear methodology
Data Preprocessing and Analysis	Thorough and effective data processing	Effective preprocessing with minor issues	Somewhat effective but lacks completeness	Incomplete or ineffective	Missing or poorly done
Feature Engineering / Model Development	Highly relevant features and models with strong results	Relevant features and models with good results	Somewhat relevant features and models with moderate results	Poorly designed features and models	Features and models missing or ineffective
Results Interpretation	Insights are clear, significant and actionable	Clear and significant insights	Somewhat clear insights	Unclear or lacks significance	Missing or irrelevant insights
Project Report	Well-written, organised and comprehensive	Well-written and organised	Adequate but lacks clarity	Poorly written or lacks detail	Incomplete or missing
Presentation	Clear, engaging and well-communicated	Clear and well-communicated	Somewhat clear but lacks engagement	Unclear or lacks coherence	Missing or ineffective

Overall score	Grade
23 - 25	Exceptional
19 - 22	Good
15 - 18	Fair
11 - 14	Needs Improvement
0 - 10	Inadequate

Note: *The source rubric has eight criteria scored 1 to 5 (maximum 40) but the overall score bands stop at 25. Please confirm whether the bands should be scaled to 40 or whether five criteria are intended.*

Project Timeline (from the Major Project Guidelines)

Task	Deadline
Problem Selection	Week 2
Literature Review	Week 4
Experimental Design / Data Collection	Week 6
Data Analysis and Model Development	Week 10
Results and Interpretation	Week 12
Report Writing	Week 14
Final Presentation	Week 16

Resources

- Genomic and clinical datasets
- Software tools (Python, R, MATLAB, Bioconductor, etc.)
- Tutorials on data preprocessing, analysis and modelling
- Faculty mentorship and peer discussions

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Formulate a researchable problem and hypothesis in medical biotechnology after a critical literature review	K6
CO2	Design laboratory experiments or data-driven studies with ethical compliance and data security	K6
CO3	Acquire, preprocess and analyse biological or clinical data using appropriate tools	K4
CO4	Develop and validate models or experimental results and interpret them against existing studies	K5
CO5	Communicate the project through a comprehensive report and presentation	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	2	3	-	2	1	2	1	-
CO2	3	3	1	-	2	3	-	3	2	3	1	-
CO3	3	3	2	-	1	3	-	3	2	3	2	2
CO4	3	2	2	3	2	3	-	2	3	3	3	3
CO5	2	2	3	3	3	3	2	2	1	3	3	3
Avg.	**2.8**	**2.4**	**2.0**	**3.0**	**2.0**	**3.0**	**2.0**	**2.4**	**1.8**	**2.8**	**2.0**	**2.7**

Text Books and Reference Resources

1. Major Project Guidelines for B.Sc. Biotechnology (as reproduced above).
2. Genomic and clinical datasets, bioinformatics repositories and tutorials on preprocessing, analysis and modelling made available by the department.

SEMESTER VI (B.SC. HONOURS WITH RESEARCH)

BITT3519: Clinical Biochemistry

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	VI	Honours Core

Course Description

This course provides exploration of biochemical principles crucial for understanding human health and disease. It covers specimen collection techniques, blood disorders, and the mechanisms of blood clotting. Students will be able to understand carbohydrate and lipid metabolism disorders, including diabetes and atherosclerosis, and examine amino acid metabolism, clinical enzymology, and gastrointestinal tract disorders. The course also addresses cancer genetics, including oncogenes and tumour markers, and therapeutic interventions.

Course Objectives

1. To explain techniques for collecting and preserving biological specimens.
2. To understand blood clotting mechanism, identify common blood clotting disorders.
3. To enable students to diagnose and manage disorders related to carbohydrate and lipid metabolism.
4. To identify the significance of various diagnostic enzymes, their role in disease states. and how to interpret enzyme levels for accurate diagnosis
5. To understand genetic basis of cancer and use of tumour markers in cancer diagnosis and monitoring.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Specimen Collection and Blood Disorders.** Introduction and Maintenance of clinical Biochemistry laboratory. Collection, preparation and preservation of biological specimens such as blood, urine, CSF bile Saliva and faeces. Disorders of blood – Blood diseases (agranulocytosis, thrombocytopenia, haemolytic anaemia, haematuria, hemoglobinopathies and Thrombosis) Blood clotting mechanism and disorders. Anticoagulants. Tests to evaluate acid base status of blood and their significance.	12
2	**Disorders of Carbohydrate and Lipid Metabolism.** Disorders of carbohydrates metabolism Hyper and Hypoglycaemia, regulation of blood glucose, renal threshold, diabetes mellitus classification, metabolic abnormalities, diagnosis and management. Acute and long-term complications of diabetes. Glucose tolerance test, glycosylated haemoglobin, glycogen storage diseases. Galactosemia, fructosuria, pentosuria, keto bodies. Atherosclerosis- risk factors, biochemical findings and management. Plasma lipids and lipoproteins and heir functions. Hyper lipoproteinemia classification – primary and secondary, Cardiovascular disorders.	12
3	**Inborn Errors of Amino Acid Metabolism and Clinical Enzymology.** Nonprotein nitrogenous constituents of blood Urea, Uric acid and creatinine. Plasma protein abnormalities, deficiency agammaglobulinemia, phenylketonuria, albinism, Hartnup's disease and Maple syrup urine disease, multiple myeloma, homocystinuria, histidinuria, disorders of urea cycle. Clinical enzymology- Diagnostic applications of enzymes, clinical significance of Aspartate transaminase, Creatinine kinase, lactate dehydrogenase amylase, r-glutamyl transferase. Disorders of thyroid secretions and thyroid functional tests.	12
4	**Disorders of the Gastrointestinal Tract, Liver and Kidney.** Composition of gastric juice, gastric function. Stimulation of gastric secretion, Composition of gastric secretion, Composition of gastric secretion. Trest for gastric function- Fractional test meal, Penta gastrin test, hyperchlorhydria achlorhydria, achylia gastric. Liver function tests related to protein carbohydrate lipid, pigment metabolism detoxification and excretion. Jaundice – Classification and differential diagnosis. Kernicterus Renal Function tests- Glomerular and tubular functions. Tests for evaluation- concentration, dilution, excretion, creatinine clearance tests, nephritic syndrome.	12

Unit	Title and contents	Hours
5	**Cancer.** Genetic rearrangements in progenitor cells, Oncogenes, tumour suppressor genes, mechanism of protooncogene activation. Cancer and cell cycle, 2wtrVirus induced cancer, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth, cancer stem cells, embryonic signature in cancer stem cells, stem cell markers and factors. Apoptosis and Necrosis. Tumour markers- AFP (Alpha fetoprotein), CEA (Carcinoembryonic antigen), hcG (human chorionic gonadotropin) Carcinogenic agents.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the collection, preparation and preservation of biological specimens and interpret diagnostic tests for blood disorders	K4	1
CO2	Identify disorders of carbohydrate and lipid metabolism using appropriate diagnostic tests	K3	2
CO3	Interpret inborn errors of amino acid metabolism, plasma protein abnormalities and diagnostic enzyme profiles	K4	3
CO4	Explain gastric, liver and renal function tests and their use in disease diagnosis	K2	4
CO5	Describe the molecular basis of cancer, tumour markers and therapeutic interventions for cancer management	K2	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	1	1	-	-	1	2	-	-
CO2	3	1	1	-	2	1	-	-	1	2	1	-
CO3	3	2	1	-	3	1	-	1	1	2	2	-
CO4	3	2	2	1	3	1	-	1	2	2	3	1
CO5	3	2	2	2	3	2	-	1	2	2	3	2
Avg.	**3.0**	**1.6**	**1.5**	**1.5**	**2.4**	**1.2**	**-**	**1.0**	**1.4**	**2.0**	**2.2**	**1.5**

Text Books

1. Textbook of Medical Biochemistry: A clinically oriented approach – Dinesh Puri living stone., India.
2. Varley's Practical clinical Biochemistry- Alan H Gowenlock, published by CBS Publishers and distributors, 2008,6th edition.
3. Mayne, Clinical Chemistry in Diagnosis and Treatment, ELBS.

Reference Books

1. Mosby, clinical Chemistry Marshall.
2. Willaims and Wilkins,2006, Biochemistry and Disease, Cohn and Roth.
3. Harpers 2013. Biochemistry, 26th ed. Mc Graw Hill.
4. Harrison's Principles of Internal Medicien. Vol1 and 2, 14thed. Mc Graw Hill.
5. Mosby, Biochemistry- A case Oriented Approach Montgomery et al.

BITT3520: AI in Healthcare

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	VI	Honours Core

Course Description

This course introduces the principles and applications of Artificial Intelligence (AI) in modern healthcare and life sciences. It covers the fundamentals of machine learning, deep learning, medical data analytics, clinical decision support systems, medical imaging, genomics, drug discovery, and digital health technologies. The course also explores ethical, legal, and regulatory considerations associated with AI-driven healthcare solutions.

Course Objectives

1. Understand the fundamental concepts of Artificial Intelligence, Machine Learning, and Deep Learning in healthcare.
2. Explain the applications of AI in disease diagnosis, medical imaging, genomics, and precision medicine.
3. Understand the role of AI in drug discovery, clinical decision support, and healthcare data analytics.
4. Analyze the ethical, legal, and regulatory challenges associated with AI-based healthcare systems.
5. Appreciate emerging trends in AI-enabled digital healthcare and biomedical research.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Artificial Intelligence in Healthcare.** Introduction to Artificial Intelligence; history and evolution of AI; AI, Machine Learning, Deep Learning, and Generative AI; types of AI systems; healthcare data and electronic health records (EHRs); medical data sources; AI workflow in healthcare; overview of AI applications in clinical practice, biomedical research, and public health.	12
2	**Machine Learning and Medical Data Analytics.** Fundamentals of supervised, unsupervised, and reinforcement learning; data preprocessing and feature engineering; classification, regression, clustering, and dimensionality reduction; evaluation metrics for AI models; predictive analytics; AI applications in disease prediction, patient risk assessment, and clinical decision support systems.	12
3	**AI in Medical Imaging, Genomics, and Drug Discovery.** AI applications in medical imaging including X-ray, CT, MRI, ultrasound, and digital pathology; image segmentation and pattern recognition; AI in genomics, transcriptomics, and precision medicine; AI-assisted biomarker discovery; virtual screening; drug target identification; protein structure prediction; AI applications in pharmaceutical research and development.	12
4	**Digital Health and Intelligent Healthcare Systems.** Clinical decision support systems; wearable devices and Internet of Medical Things (IoMT); telemedicine and remote patient monitoring; smart hospitals; healthcare robotics; AI-powered virtual health assistants and chatbots; natural language processing (NLP) in healthcare; applications of AI in epidemiology and public health surveillance.	12
5	**Ethical, Legal, and Future Perspectives of AI in Healthcare.** Ethical principles in AI; bias and fairness in AI algorithms; patient privacy and data security; explainable AI; regulatory guidelines for AI-based medical devices; responsible AI in healthcare; challenges in AI adoption; emerging technologies including foundation models, AI agents, digital twins, and personalized healthcare; future prospects of AI in medicine.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of Artificial Intelligence, Machine Learning, and Deep Learning in healthcare.	K2
CO2	Describe the applications of AI in medical imaging, genomics, disease diagnosis, and clinical decision-making.	K2
CO3	Analyze healthcare datasets using appropriate AI concepts and evaluate their clinical significance.	K5
CO4	Evaluate the applications of AI in drug discovery, digital health, and precision medicine.	K5
CO5	Discuss the ethical, legal, regulatory, and societal implications of AI in healthcare and emerging trends in intelligent healthcare systems.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	-	1	1	-	-	1	2	2	-
CO2	3	2	1	-	1	1	-	1	2	3	2	-
CO3	3	2	2	-	2	1	-	2	3	3	3	-
CO4	3	2	2	1	2	1	-	2	3	3	3	1
CO5	2	2	3	2	3	1	-	2	2	3	3	1
Avg.	**2.8**	**1.8**	**1.8**	**1.5**	**1.8**	**1.0**	**-**	**1.8**	**2.2**	**2.8**	**2.6**	**1.0**

Text Books

1. Jiang, F., Jiang, Y., Zhi, H., et al. Artificial Intelligence in Healthcare. Springer.
2. Holzinger, A. Artificial Intelligence for Healthcare: Methods, Applications, and Challenges. Springer.

Reference Books

1. Bishop, C. M. Pattern Recognition and Machine Learning. Springer.
2. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press.
3. Topol, E. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books.

BITT3521: Neuroscience

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	VI	Honours Core

Course Description

This course provides an introduction to the structure and function of the nervous system with emphasis on the cellular and molecular mechanisms underlying neural communication, sensory perception, motor control, learning, memory, and behavior. Students will explore the organization of the brain, neuronal signaling, neurotransmission, sensory and motor systems, and the molecular basis of neurological and psychiatric disorders. The course integrates concepts from neurobiology, physiology, and molecular neuroscience, providing a foundation for understanding normal brain function and diseases of the nervous system.

Course Objectives

1. To understand the structure and functional organization of the nervous system and the brain.
2. To explain the cellular and molecular mechanisms of neuronal communication and synaptic transmission.
3. To understand the organization and functions of sensory and motor systems.
4. To describe the neural basis of learning, memory, and behavior.
5. To familiarize students with the molecular basis of neurological and psychiatric disorders.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to the Nervous System and Neuronal Communication.** Introduction to neuroscience; Organization of the nervous system; Structure and functions of the brain; The brain and behavior; Structure of neurons and neuroglia; Nerve cells and neuronal communication; Ion channels; Resting membrane potential and action potential; Synaptic transmission; Intracellular signaling pathways.	12
2	**Synaptic Function, Neurotransmitters and Higher Brain Functions.** Synaptic integration; Excitatory and inhibitory synapses; Neurotransmitters and neuromodulators; Neurotransmitter receptors; Cortical organization; Association cortices; Neural basis of learning and memory; Synaptic plasticity; Long-term potentiation (LTP) and long-term depression (LTD) (overview).	12
3	**Sensory Systems.** Overview of sensory systems; Somatic sensation; Pain and temperature sensation; Visual system— Structure of the eye, photoreceptors, visual pathway and visual cortex; Auditory system—Structure of the ear and auditory pathway; Chemical senses—Taste and smell; Integration of sensory information; Introduction to motor system organization.	12
4	**Motor Systems.** Organization of the motor system; Voluntary movement; Upper and lower motor neurons; Motor unit and muscle action; Neuromuscular junction; Spinal reflexes; Control of posture and locomotion; Control of eye movements (gaze); Basal ganglia and their functions; Cerebellum and motor coordination.	12
5	**Neurological and Psychiatric Disorders.** Introduction to neurological disorders; Alzheimer's disease; Parkinson's disease; Epilepsy; Stroke; Multiple sclerosis; Introduction to psychiatric disorders; Depression; Anxiety disorders; Schizophrenia; Autism spectrum disorder (overview); Neurodegenerative diseases; Principles of diagnosis, prevention, and management (overview).	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the structure and functional organization of the nervous system and the molecular mechanisms of neuronal signaling.	K2
CO2	Describe synaptic transmission, neurotransmitter function, cortical organization, learning, and memory.	K2
CO3	Interpret the organization and physiological functions of sensory and motor systems.	K4
CO4	Explain the neural control of voluntary movement, posture, reflexes, and motor coordination.	K2
CO5	Describe the causes, pathophysiology, clinical features, and basic management of common neurological and psychiatric disorders.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	-	-	1	-	-	1	2	-	-
CO2	3	1	-	-	-	1	-	-	1	2	1	-
CO3	3	1	1	-	1	1	-	1	1	1	2	-
CO4	3	1	2	1	1	1	-	1	2	1	2	2
CO5	2	1	2	2	2	1	-	2	1	2	3	1
Avg.	**2.8**	**1.0**	**1.7**	**1.5**	**1.3**	**1.0**	**-**	**1.3**	**1.2**	**1.6**	**2.0**	**1.5**

Text Books

1. Bear, M. F., Connors, B. W., & Paradiso, M. A. (2020). Neuroscience: Exploring the Brain (4th Ed.). Jones & Bartlett Learning.
2. Purves, D., Augustine, G. J., Fitzpatrick, D., et al. (2018). Neuroscience (6th Ed.). Oxford University Press.

Reference Books

1. Kandel, E. R., Koester, J. D., Mack, S. H., & Siegelbaum, S. A. (2021). Principles of Neural Science (6th Ed.). McGraw-Hill.
2. Nolte, J. (2019). The Human Brain: An Introduction to its Functional Anatomy (8th Ed.). Elsevier.
3. Squire, L. R., Berg, D., Bloom, F. E., et al. (2018). Fundamental Neuroscience (5th Ed.). Academic Press.
4. Blumenfeld, H. (2021). Neuroanatomy through Clinical Cases (3rd Ed.). Oxford University Press.
5. Breedlove, S. M., & Watson, N. V. (2023). Behavioral Neuroscience (10th Ed.). Oxford University Press. Program Electives Program Elective -1 BITT2601

SEMESTERS VII AND VIII (B.SC. HONOURS WITH RESEARCH)

BITP4502: Major Project (two semesters, Honours with Research)

L	T	P	C	Total hours	Semester	Category
0	0	72	36	2160	VII and VIII	Research Project

Course Description

The Honours Major Project is a two-semester, research-intensive project in which students carry out an original investigation in medical biotechnology, health informatics, molecular diagnostics, bioinformatics or data science applications in healthcare, under a research supervisor. The work is expected to lead to a thesis and, where possible, a manuscript for publication.

Course Objectives

1. To apply knowledge and skills in biotechnology to solve real-world problems through research, experimentation and innovation.
2. To formulate a research question on a healthcare problem aligned with medical biotechnology (diagnostics and biomarkers, personalised medicine, computational biology and multi-omics, biopharmaceuticals, AI in healthcare).
3. To design experiments or data-driven studies with ethical compliance and data security.
4. To analyse and interpret data using appropriate bioinformatics, statistical and machine-learning tools.
5. To prepare a thesis and a journal-ready manuscript and defend the work before an examination panel.

Note: *The source gives a single guideline for the Major Project and no separate syllabus for the Honours project (72 periods per week for two semesters). Phases and hours (2160 in total) are drafted here for the Board of Studies to confirm.*

Project Phases with Hours (two semesters)

Phase	Activity	Hours
1	Problem identification, research proposal and ethics clearance	180
2	Literature review and research design (hypothesis, methodology, data plan)	300
3	Data acquisition and experimentation	600
4	Analysis, modelling and validation	540
5	Interpretation, comparison with existing work and manuscript preparation	300
6	Thesis writing, presentation and viva-voce	240
	Total	2160

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Formulate an original, ethically sound research proposal after a critical review of the literature	K6
CO2	Design and execute experiments or data-driven studies using appropriate methods	K6
CO3	Analyse and validate results using advanced bioinformatics, statistical or machine-learning tools	K4
CO4	Evaluate findings against the existing literature and discuss implications and limitations	K5
CO5	Prepare a thesis and a journal-ready manuscript and defend the work before a panel	K6

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	2	3	-	2	1	2	1	-
CO2	3	3	1	-	2	3	-	3	2	3	1	-
CO3	3	3	2	-	1	3	-	3	2	3	2	2
CO4	3	2	2	3	2	3	-	2	3	3	3	3
CO5	2	2	3	3	3	3	2	2	1	3	3	3
Avg.	**2.8**	**2.4**	**2.0**	**3.0**	**2.0**	**3.0**	**2.0**	**2.4**	**1.8**	**2.8**	**2.0**	**2.7**

Text Books and Reference Resources

1. Major Project Guidelines for B.Sc. Biotechnology (reproduced under BITP3502); the evaluation rubric and bands apply to each semester’s review.
2. Primary research literature and datasets identified with the research supervisor.

APPENDIX A: PROGRAMME ARTICULATION MATRIX (COURSE-LEVEL AVERAGE CO-PO-PSO MAPPING)

Each value is the average of the non-zero CO mappings of the course for that PO or PSO (taken from the "Avg." row of each course sheet). A dash means the course does not address that outcome. University Elective placeholders are excluded until their sheets are attached.

Code	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PS1	PS2	PS3	PS4	PS5
BITT1501	Cell Biology and Genetics	2.8	1.2	1.5	1.0	1.0	1.0	-	2.0	1.5	1.5	2.3	1.0
BITT1502	Biochemistry	3.0	1.2	1.2	1.0	1.3	1.0	-	1.0	1.5	2.0	2.3	1.0
BITT1503	Data Science	2.6	1.7	1.5	-	1.5	1.2	-	1.7	1.7	2.2	1.8	-
TAUT1101	University Core 1: Communicative English	1.0	-	1.2	2.0	2.6	2.0	-	-	-	-	1.3	2.0
BITL1501	Data Science Lab	2.2	2.8	1.5	1.0	2.2	1.2	-	1.8	2.0	2.0	2.2	1.0
BITL1502	Biochemistry Lab	2.6	2.8	1.8	2.0	1.6	1.5	-	2.2	2.4	1.2	1.8	1.0
BITT1504	Molecular Biology and Genetic Engineering	3.0	2.4	2.0	1.0	1.4	1.2	-	2.6	2.6	1.4	2.0	2.0
BITT1505	Microbiology	3.0	1.6	1.5	1.5	2.4	1.2	-	1.0	1.4	2.0	2.2	1.5
BITT1506	Bioanalytical Techniques	3.0	2.4	2.0	1.0	1.4	1.2	-	2.6	2.6	1.4	2.0	2.0
TAUT1102	University Core 2: Environmental Studies	2.6	1.0	1.0	2.0	1.0	1.4	3.0	1.7	1.0	1.4	1.8	2.0
BITL1503	Molecular Biology and Genetic Engineering Lab	2.6	2.8	1.8	2.0	1.6	1.5	-	2.2	2.4	1.2	1.8	1.0
BITL1504	Microbiology Lab	2.6	2.8	1.8	2.0	1.6	1.5	-	2.2	2.4	1.2	1.8	1.0
BITT2507	Immunology	3.0	1.6	1.5	1.5	2.4	1.2	-	1.0	1.4	2.0	2.2	1.5
BITT2508	Plant Biotechnology	2.8	1.6	1.0	1.5	2.2	1.0	1.0	1.6	1.6	2.2	2.2	1.5
BITT2509	Enzyme Technology	3.0	2.4	2.0	1.0	1.4	1.2	-	2.6	2.6	1.4	2.0	2.0
BITT2510	Nanobiotechnology	2.8	1.6	1.0	1.5	2.2	1.0	1.0	1.6	1.6	2.2	2.2	1.5
TAUT2101	University Core 3: Health and Wellness	3.0	1.6	1.5	1.5	2.4	1.2	-	1.0	1.4	2.0	2.2	1.5
BITL2503	Immunology Lab	2.6	2.8	1.8	2.0	1.6	1.5	-	2.2	2.4	1.2	1.8	1.0
BITL2504	Enzyme Technology Lab	2.6	2.8	1.8	2.0	1.6	1.5	-	2.2	2.4	1.2	1.8	1.0
BITT2511	Animal Cell Culture and Techniques	3.0	2.4	2.0	1.0	1.4	1.2	-	2.6	2.6	1.4	2.0	2.0
BITT2512	Industrial Biotechnology	2.8	1.6	1.0	1.5	2.2	1.0	1.0	1.6	1.6	2.2	2.2	1.5
BITT2513	Bioinformatics	2.8	1.8	1.8	1.5	1.8	1.0	-	1.8	2.2	2.8	2.6	1.0
BITT2514	Biosafety and Ethics	2.4	1.0	1.5	3.0	2.8	1.2	-	-	1.0	2.7	1.8	3.0
BITT2601(A)	Stem Cell Biology and Regenerative Medicine	3.0	1.6	1.5	1.5	2.4	1.2	-	1.0	1.4	2.0	2.2	1.5
BITT2601(B)	Synthetic Biology and Biological Circuit Design	3.0	2.4	2.0	1.0	1.4	1.2	-	2.6	2.6	1.4	2.0	2.0
BITT2601(C)	Biotechnology for Sustainable Development	2.6	1.0	1.0	2.0	1.0	1.4	3.0	1.7	1.0	1.4	1.8	2.0
BITT2602(A)	Marine Biotechnology and Blue Bioeconomy	2.8	1.6	1.0	1.5	2.2	1.0	1.0	1.6	1.6	2.2	2.2	1.5
BITT2602(B)	Systems Biology and Network Medicine	2.8	1.8	1.8	1.5	1.8	1.0	-	1.8	2.2	2.8	2.6	1.0
BITT2602(C)	Computational Biology and Multi-Omics	2.8	1.8	1.8	1.5	1.8	1.0	-	1.8	2.2	2.8	2.6	1.0
BITL2505	Bioinformatics Lab	2.2	2.8	1.5	1.0	2.2	1.2	-	1.8	2.0	2.0	2.2	1.0
BITL2506	Industrial Biotechnology Lab	2.6	2.8	1.8	2.0	1.6	1.5	-	2.2	2.4	1.2	1.8	1.0
BITT3515	Protein Engineering	2.8	1.6	1.0	1.5	2.2	1.0	1.0	1.6	1.6	2.2	2.2	1.5
BITT3516	Food Biotechnology	2.8	1.6	1.0	1.5	2.2	1.0	1.0	1.6	1.6	2.2	2.2	1.5
BITT3517	Medical and Pharmaceutical Biotechnology	3.0	1.6	1.5	1.5	2.4	1.2	-	1.0	1.4	2.0	2.2	1.5
BITT3518	Principles of Bioprocess Engineering	2.8	1.6	1.0	1.5	2.2	1.0	1.0	1.6	1.6	2.2	2.2	1.5
BITT3603(A)	Entrepreneurship and Biotechnology Venture Creation	2.0	1.0	1.8	1.5	3.0	2.8	1.3	-	1.0	1.0	1.5	1.8

Code	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PS1	PS2	PS3	PS4	PS5
BITT3603(B)	Regulatory Affairs and Intellectual Property in Biotechnology	2.4	1.0	1.5	3.0	2.8	1.2	-	-	1.0	2.7	1.8	3.0
BITT3603(C)	Cancer Biology and Precision Oncology	3.0	1.6	1.5	1.5	2.4	1.2	-	1.0	1.4	2.0	2.2	1.5
BITT3604(A)	Microbiome Science and Human Health	3.0	1.6	1.5	1.5	2.4	1.2	-	1.0	1.4	2.0	2.2	1.5
BITT3604(B)	Clinical Research and Good Clinical Practice (GCP)	2.4	1.0	1.5	3.0	2.8	1.2	-	-	1.0	2.7	1.8	3.0
BITT3604(C)	Biotechnology Product Development and Commercialization	2.0	1.0	1.8	1.5	3.0	2.8	1.3	-	1.0	1.0	1.5	1.8
BITP3501	Mini Project	2.8	2.4	2.0	3.0	2.0	3.0	2.0	2.4	1.8	2.8	2.0	2.7
BITT3605	MOOCs Course 1	1.6	1.0	-	1.0	1.8	3.0	-	-	-	1.0	1.0	1.0
BITT3606	MOOCs Course 2	1.6	1.0	-	1.0	1.8	3.0	-	-	-	1.0	1.0	1.0
BITP3502	Major Project	2.8	2.4	2.0	3.0	2.0	3.0	2.0	2.4	1.8	2.8	2.0	2.7
BITT3519	Clinical Biochemistry	3.0	1.6	1.5	1.5	2.4	1.2	-	1.0	1.4	2.0	2.2	1.5
BITT3520	AI in Healthcare	2.8	1.8	1.8	1.5	1.8	1.0	-	1.8	2.2	2.8	2.6	1.0
BITT3521	Neuroscience	2.8	1.0	1.7	1.5	1.3	1.0	-	1.3	1.2	1.6	2.0	1.5
BITP4502	Major Project (Honours)	2.8	2.4	2.0	3.0	2.0	3.0	2.0	2.4	1.8	2.8	2.0	2.7

Programme-level average (all courses listed above):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
Average	2.65	1.81	1.56	1.67	1.97	1.45	1.54	1.78	1.76	1.90	2.01	1.60

APPENDIX B: CORRECTIONS AND POINTS FOR BOARD OF STUDIES CONFIRMATION

The following were found while converting the source document into the OBE format. Items 1 to 12 were corrected in this document; items 13 to 22 need a decision before submission.

1. Course codes: BITTT1503 read as BITT1503; GMBL1501 as BITL1501; BITTT2507 as BITT2507; the second BITT3517 sheet (Principles of Bioprocess Engineering) as BITT3518.
2. Program Elective 3 and 4 sheets carried codes BITT2603 and BITT2604; renumbered BITT3603 and BITT3604 to match the Semester V structure.
3. The Industrial Biotechnology Lab sheet was titled “Bioinformatics Lab”; titled and coded BITL2506.
4. Biochemistry (BITT1502): objectives 1 to 4 referred to Microbiology and nursing infection control; replaced with Biochemistry objectives.
5. Data Science (BITT1503): objectives (statistics, machine learning) and learning outcomes (calculus, polynomial roots) did not match the units; aligned to the syllabus.
6. Immunology (BITT2507): learning outcomes on flow cytometry, communication and teamwork did not match the units; rewritten.
7. Animal Cell Culture (BITT2511): only three outcomes were given; five aligned outcomes written.
8. Health and Wellness (TAUT2101): objectives were embedded in the description; separated; five outcomes written.
9. Clinical Biochemistry (BITT3519) and Cell Biology and Genetics (BITT1501): outcomes reworded and aligned to units.
10. Communicative English (TAUT1101): unit-wise outcomes consolidated into five course outcomes; unit hours (10, 10, 10, 10, 5) retained.
11. Hours per unit were added to every theory course (12 hours per unit for 4-credit courses, 9 for 3-credit courses) and hours per experiment to every laboratory (60 or 45 hours in total).
12. Course Outcomes carry Bloom’s levels assigned from the action verb; Text Books and Reference Books were split from the “Recommended Books” lists (first two entries as Text Books).

Items needing confirmation:

13. Semester II credits: the printed total is 22 but the course table adds to 21 (labs at 1.5 credits and 3 hours). Confirm lab credits and hours.
14. Programme duration: the source says three years over six to eight semesters, while the title and structure describe a four-year Honours programme. State the exit and entry options clearly.
15. Sections of the source (eligibility, duration, preamble) refer to B.Sc. Biotechnology as a 3-year course; align with the Honours regulations (R-2025).
16. University Electives 1 to 3 (TAUT1201, TAUT1202, TAUT2201): no syllabi in the source; attach the University elective sheets.
17. MOOC courses (BITT3605, BITT3606): only credits are given; record the approved courses for each batch.
18. Mini Project (BITP3501) and the Honours Major Project (BITP4502): no syllabus in the source; the drafts here need approval.
19. Major Project rubric: eight criteria scored 1 to 5 give a maximum of 40, but the overall bands end at 25.
20. CO-PO-PSO mappings, the 40:60 CIE:SEE split and the attainment thresholds are proposed values; the source gives none.
21. Programme Outcomes: the source calls PO1 to PO7 “Program Objectives”. NAAC and NBA normally ask for graduate-attribute style Programme Outcomes plus separate Programme Educational Objectives; consider adding PEOs.
22. Market statistics in the source carry a 2025 horizon and US-based attributions; refresh before use in the Self-Study Report. Several textbook editions in the source are old (for example, Essential Cell Biology 7th edition is cited with a 2009 date); verify editions.