



BHARATHIDASANUNIVERSITY, TIRUCHIRAPPALLI-620024

B.Sc. BIOTECHNOLOGY

**CHOICE BASED CREDIT SYSTEM–LEARNING OUTCOMES BASED
CURRICULUM FRAME WORK (CBCS - LOCF)**

(Applicable to the candidates admitted from the academic year 2026–2027 onwards)

Sem	Part	Courses	Title	Ins. Hrs.	Credits	Exam. Hours	Maximum Marks		
							Int.	Ext.	Total
I	I	Ability Enhancement Course – I (AEC - I)	(Tamil\$ / Other Languages+, #)	6	3	3	30	70	100
	II	Ability Enhancement Course –II (AEC - II)	English Course - I	6	3	3	30	70	100
	III	Core Course -1 (CC - 1)	Cell biology	4	4	3	30	70	100
		Core Practical - 1 (CP - 1)	Cell biology Practical	4	4	3	40	60	100
		Allied Course – 1 (AC - 1)	Biochemistry	4	4	3	30	70	100
		Allied Course Practical - 1 (ACP-1)	Biochemistry and Microbiology Practical	2	**	**	**	**	**
	IV	Value Education		2	2	3	30	70	100
		Interdisciplinary Course – 1 (IDC - 1) #	One Course from Outside Department	2	2	3	30	70	100
	Total				30	22	--	--	--
II	I	Ability Enhancement Course –III (AEC - III)	(Tamil\$ / Other Languages+, #)	6	3	3	30	70	100
	II	Ability Enhancement Course –IV (AEC - IV)	English Course - II	6	3	3	30	70	100
	III	Core Course- 2(CC - 2)	Molecular biology	4	4	3	30	70	100
		Core Practical - 2(CP - 2)	Molecular biology Practical	4	4	3	40	60	100
		Allied Course - 2 (AC - 2)	Microbiology	4	4	3	30	70	100
		Allied Course Practical - 1 (ACP-1)	Biochemistry and Microbiology Practical	2	4	3	40	60	100
	IV	Skill Enhancement Course - 1(SEC - 1) ##	Naan Mudhalvan Course / Fundamentals of Computer applications in Biotechnology	2	2	3	30	70	100
		Interdisciplinary Course – 2 (IDC - 2) #	One Course from Outside Department	2	2	3	30	70	100
	Total				30	26	--	--	--

III	I	Ability Enhancement Course –V(AEC - V)	(Tamil\$ / Other Languages+, #)	6	3	3	30	70	100
	II	Ability Enhancement Course –VI (AEC - VI)	English Course - III	6	3	3	30	70	100
	III	Core Course- 3(CC - 3)	Genetics	4	4	3	30	70	100
		Core Practical - 3 (CP - 3)	Genetics Practical	4	4	3	40	60	100
		Allied Course - 3 (AC - 3)	Bioinstrumentation	4	4	3	30	70	100
		Allied Course Practical - 2 (ACP-2)	Bioinstrumentation and Immunology Practical	2	**	**	**	**	**
	IV	Skill Enhancement Course - 2 (SEC - 2) ##	Naan Mudhalvan Course/ Mushroom Technology	2	2	3	30	70	100
		Interdisciplinary Course – 3 (IDC - 3) \$\$	One Course from Outside Department	2	2	3	30	70	100
		Health & Wellness @		--	1	--			100
	Total			30	23	--	--	--	800
I	Ability Enhancement Course –VII (AEC - VII)	(Tamil\$ / Other Languages+, #)	6	3	3	30	70	100	
IV	II	Ability Enhancement Course –VIII (AEC - VIII)	English Course - IV	6	3	3	30	70	100
	III	Core Course - 4(CC - 4)	rDNA Technology	4	4	3	30	70	100
		Core Practical - 4(CP - 4)	rDNA Technology Practical	4	4	3	40	60	100
		Allied Course - 4 (AC - 4)	Immunology	4	4	3	30	70	100
		Allied Course Practical - 2 (ACP-2)	Bioinstrumentation and Immunology Practical	4	4	3	40	60	100
	IV	Skill Enhancement Course - 3 (SEC - 3) ##	Naan Mudhalvan Course / Bromatology	2	2	3	30	70	100
		Interdisciplinary Course – 4 (IDC - 4) \$\$	One Course from Outside Department	2	2	3	30	70	100
	Total			30	26	--	--	--	800
	Summer Internship / Industrial Activity during the Summer Vacation after II Year								

V	III	Core Course - 5 (CC - 5)	Microbial Biotechnology	4	4	3	30	70	100
		Core Course - 6 (CC - 6)	Plant Biotechnology	5	4	3	30	70	100
		Core Course - 7 (CC - 7)	Animal Biotechnology	5	4	3	30	70	100
		Core Course - 8 (CC - 8)	Environmental Biotechnology	5	4	3	30	70	100
		Core Practical - 5 (CP - 5)	Microbial - Plant - Animal & Environmental - Biotechnology Practical	5	4	3	40	60	100
	IV	Skill Enhancement Course - 4 (SEC - 4)	Organic gardening	2	2	3	30	70	100
		Skill Enhancement Course - 5 (SEC - 5) ##	Naan Mudhalvan Course / Medical Diagnostics and Clinical Lab Technology	2	2	3	30	70	100
		Introduction to Disaster Management		2	2	3	30	70	100
		Summer Internship / Industrial Activity @@	(with Viva-Voce)	--	2	--	20	80	100
	Total			30	28	--	--	--	900
VI	III	Core Course - 9 (CC - 9)	Genomics and Proteomics	4	4	3	30	70	100
		Core Course - 10 (CC - 10)	Biostatistics and Biosafety	5	4	3	30	70	100
		Core Course - 11 (CC - 11)	IPR & Bioethics	5	4	3	30	70	100
		Core Project Work (CPW) @@	Project Work (with Viva-Voce)	6	4	3	20	80	100
	IV	Value Added Course	General Studies for Competitive Examinations	2	1	--	30	70	100
		Skill Enhancement Course - 6 (SEC - 6)	Pharmacology	2	2	3	30	70	100
		Skill Enhancement Course - 7 (SEC - 7) ##	Naan Mudhalvan Course / QA, QC and regulatory affairs in Biotechnology	2	2	3	30	70	100
		Environmental Studies		2	2	3	30	70	100
		Gender Studies		2	1	3	30	70	100
		Extension Activities *		--	1	--	--	--	--
	Total			30	25	--	--	--	900
Grand Total			180	150	--	--	--	4900	

ALLIED COURSE

First Year	Second Year
1. Biochemistry 2. Biochemistry and Microbiology (P) 3. Microbiology	1. Bioinstrumentation 2. Bioinstrumentation and immunology (P) 3. Immunology

SKILL ENHANCEMENT COURSE(SEC)			
Sl. No.	Title of paper	Sl. No.	MANDATORY Naan Mudhalvan Scheme##
1.	Fundamentals of Computer applications in Biotechnology	1.	2nd Semester:
2.	Mushroom Technology		
3.	Bromatology	2.	3rd Semester:
4.	Organic gardening		
5.	Medical Diagnostics and Clinical Lab Technology	3.	4th Semester:
6.	Pharmacology		
7.	QA, QC and regulatory affairs in Biotechnology	4.	5th Semester:
--		5.	6th Semester:

INTERDISCIPLINARY COURSE (IDC) FOR WHO HAVE OPT TAMIL AS PART-I (for other Department Students only)	
1 st Semester	Understanding Biodiversity
2 nd Semester	Basics of Biotechnology
3 rd Semester	Forensic Biotechnology
4 th Semester	Bioentrepreneurship

INTERDISCIPLINARY COURSE (IDC) # FOR WHO HAVE NOT OPTED TAMIL AS PART - I		
Those who have studied Tamil upto 10th+2 but opt for other languages in degree	1st Semester	Special Tamil - I
	2nd Semester	Special Tamil - II
Those who have not studied Tamil in school level	1st Semester	Basic Tamil - I
	2nd Semester	Basic Tamil – II
Those students who opt for either special Tamil (or) Basic Tamil as IDCs, have to choose 2 more IDCs courses in their 3rd and 4th Semester from Outside his/her department.		

INTERDISCIPLINARY COURSE (IDC) \$\$ FOR NCC CADETS ONLY	
NCC Course is a Compulsory Course for the NCC Cadets in the 3rd Semester:	NCC Course is a Compulsory Course for the NCC Cadets in the 4th Semester:
Introduction to NCC	1. Special Subject Army (or) 2. Special Subject Navy (or) 3. Special Subject Air force
Those students who opt for NCC Courses as IDCs, have to choose 2 more IDCs courses in their 1 st and 2 nd Semester from Outside his/her department.	

SUMMARY OF CURRICULUM STRUCTURE OF UG PROGRAMMES

Sl. No.	Part	Types of the Courses	No. of Courses	Credits for each Course	Total Credits	Marks
1.	I	Ability Enhancement Course	4	3	12	400
2.	II	Ability Enhancement Course	4	3	12	400
3.	III	Core Course	11	4	44	1100
4.		Core Practical	5	4	20	500
5.		Allied Course	4	4	16	400
6.		Allied Course Practical	2	4	8	200
7.		Core Project Work (CPW)	1	4	4	100
8.	IV	Skill Enhancement Course (SEC)	7	2	14	700
9.		Interdisciplinary Course (IDC)	4	2	8	400
10.		Value Education	1	2	2	100
11.		Health and Wellness	1	1	1	100
12.		Introduction to Disaster Management	1	2	2	100
13.		Summer Internship / Industrial Activity	1	2	2	100
14.		Value Added Course	1	1	1	100
15.		Environmental Studies	1	2	2	100
16.		Gender Studies	1	1	1	100
17.		EXTENSION ACTIVITIES (NCC / NSS / SPORTS / ANTI DRUG CELL / YRC & Any Other Activities)	--	1	1	--
Total			49	-	150	4900

\$ For those who have studied Tamil upto 10th+2 (Regular Stream)

+ Syllabus for other Languages should be on par with Tamil at degree level

Those who have studied Tamil upto 10th+2 but opt for other languages in degree level under Part –I should study special Tamil and those who have not studied Tamil in the school level should study Basic Tamil in Part– IV under the Interdisciplinary Course.

** Examination at the end of the next semester

Naan Mudhalvan Scheme: As per the Naan Mudhalvan Scheme instructions, 5 courses from 2nd to 6th semester should be studied under Skill Enhancement Course.

\$ NCC Course is one of the Choices in the Interdisciplinary Course.

\$ Only the NCC Cadets are eligible to choose this course. However, NCC Course is a Compulsory Course for the NCC Cadets.

@ **Health and Wellness: Assessments:**

- Use self-reflective worksheets to assess their understanding
- submit the worksheets to internal audit / external audit
- Every student's activity report should be documented and the same have to be assessed by the Physical Director with Mentor. The evaluation should be for 100 marks. No examination is required.

Scheme of Evaluation:

Part	Description	Marks
A	Report	40
B	Attendance	20
C	Activities (Observation During Practice)	40
Total		100

@ **Summer Internship / Industrial Activity**

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Internship will be carried out during the summer vacation after the second year. Viva-Voce will be conducted by the college and Marks shall be sent to the University and the same will be included in the 5th semester Mark Statement.

Summer Internship / Industrial Activity & Project Work

Scheme of Evaluation:

Description	Marks
Report	80
Viva-Voce	20
Total	100

* Extension Activities shall be outside instruction hours.

First Year

CORE COURSE 1

Semester I

Code:

**CELL BIOLOGY
(Theory)**

Credits: 4

COURSE OBJECTIVES:

The main objectives of this course are to:

- Familiarize the student in different areas of cell biology, including cell structure and functions and its organelles.
- Develop a comprehensive understanding of the cellular membranes and matrices.
- Impart the knowledge of microscopic techniques to understand the cell structure.

UNIT – I: FUNDAMENTALS OF CELL STRUCTURE:

Diversity of cell size and shape. Cell theory, Protoplasm theory, Isolation and growth of cells; Basic properties of cells; Different classes of cells – Prokaryotic and eukaryotic cells. Cell division and cell cycle - Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

UNIT – II: CELLULAR MEMBRANES AND MATRICES:

Chemical composition and fluidity of membranes; lipid bilayer and membrane protein. Dynamic nature of membranes; membrane potentials; transportation across the cell membrane; Diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, Extracellular matrices – structure and function; cytoskeleton – structure and function.

UNIT –III: CELLULAR ORGANELLES IN METABOLISM:

Endoplasmic reticulum (ER)– smooth & rough; functions of ER; Golgi complex – structure and function; Ribosomes – Types, structure and function; Morphology and functions of peroxisomes and glyoxisomes; Plant cell vacuoles; endocytic pathways – endocytosis, phagocytosis; membrane trafficking.

UNIT – IV: ENERGY METABOLISM:

Mitochondria –Morphology – structural variations; Chemical compositions and Functions; Enzyme system of Mitochondria; Mode of energy production – oxidation of carbohydrates: Glycolysis, Krebs cycle-Chloroplast – structure and function. Photosynthesis;

UNIT – V: CELL SIGNALING AND COMMUNICATION

Concept and significance of cell signaling; Types of cell signaling and cell surface/intracellular receptors; Signal transduction mechanisms, second messengers and major signaling pathways; Cell junctions, cell communication and apoptosis.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Watson JD, Gilman M, Witkowski J and Zoller M. 2010. Recombinant DNA. Scientific American Books. 4th Edition. New York.
2. Blackburn GM and Gait MJ. 2006. Nucleic Acids in Chemistry and Biology. Oxford University Press.
3. Lodish H, Baltimore D, Beck A, Zipursky SL, Matsudaria P and Darnell J. 2007. Molecular Cell Biology. 4th Edition. Scientific American Books.
4. Cooper M. 2007. The Cell- A Molecular Approach. 2nd Edition. ASM Press.
5. Lewis JK and Valerie M Kish. 1995. Principle of Cell and Molecular Biology 2nd Edition. Benjamin-Cummings Publishing Company.
6. De Robertis, EDP and E.M.F Robertis. 1987. Cell and Molecular Biology. 8th Edition. Saunders Company.
7. Brown. T.A. 2011. Introduction to genetics: A molecular approach. 1st Edition. Garland Science.
8. Watson, J. D. (2013). Molecular Biology of the Gene, Books a la Carte Edition. Benjamin Lewin. 2010. Genes XI. 11th Edition. Jones & Bartlett Learning.
9. Meyers, R. A. (Ed.). (1996). Molecular biology and biotechnology: a comprehensive desk reference. John Wiley & Sons.
10. Freifelder D. 1987. Molecular Biology, Narosa Publishing House. New Delhi.
11. Lewin B. 2017. Genes XII. Oxford University Press, London.
12. Ajoy Paul. 2014. Textbook of Cell and Molecular Biology. Books and Allied Ltd.
13. Karp, G., Iwasa, J., & Marshall, W. (2018). Karp's Cell Biology. John Wiley & Sons.
14. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., & Walter, P. (2015). Essential cell biology. Garland Science.
15. Lodish, H., Berk, A., Kaiser, C. A., Kaiser, C., Krieger, M., Scott, M. P. & Matsudaira, P. (2008). Molecular cell biology. Macmillan.
16. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. (2016). Cell Elsevier Health Sciences.
17. Verma PS, Agarwal VK. 2016. Cell Biology. S.Chand & Company Pvt. Ltd.
18. <https://archive.nptel.ac.in/courses/102/103/102103012/>
19. <https://archive.nptel.ac.in/course.html>

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Exhibit a knowledge base in classes of cells and types of cell division.
- Outline a clear and concise idea about cell membrane and cytoskeleton.
- Discuss the properties and functions of the cytoplasmic organelles.
- Illustrate the reactions that comprise energy metabolism.
- Explain the principles and applications of the microscopes.

COURSE OBJECTIVES:

The main objectives of this course are to:

- Study the cells and their enumeration by appropriate techniques.
- Study the different types of cell division.
- Acquire knowledge in subcellular fractionation.

EXPERIMENTS:

1. Microscope – Bright field and Dark field.
2. Structure observation of Prokaryotic cells
3. Structure observation of Eukaryotic cell
4. Enumeration of Prokaryotic cells using Haemocytometer
5. Enumeration of Eukaryotic cells using Haemocytometer
6. Observation – Different types of cells – parenchyma, collenchyma, sclerenchyma, epithelium
7. Size and shape of an organism (prokaryote) – simple staining, use of ocular micrometer
8. Motility of an organism – Hanging drop
9. Cell Staining – Cytochemical methods.
10. Sub cellular fractionation.
11. Osmosis and tonicity
12. Cell division - Mitotic stages - Preparation of Onion Root Tip
13. Cell division - Meiotic stages - Preparation of Tradescantia Flower bud
14. Cell division – Binary fission of yeast
15. Polytene and diplotene chromosome – Chironomid larva

REFERENCES:

1. David A. Thompson. 2011. Cell and Molecular Biology Lab Manual. Create Space Independent Publishing Platform'
2. Harley, J., & P Harley, J. (2002). Laboratory exercises in microbiology. The McGraw – Hill.
3. Gunasekaran, P. (2007). Laboratory manual in microbiology. New Age International
4. <https://youtu.be/Izk1QMg8190>
5. <https://youtu.be/IR5jps-xmzA>

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Describe the principle and applications of Microscope.
- Demonstrate the observation of different types of cells and their enumeration.
- Illustrate the different types of cell division.
- Outline a clear and concise idea about specialized chromosomes.
- Identify the motility of an organism.

First Year

ALLIED COURSE 1

Semester I

Code:

**BIOCHEMISTRY
(Theory)**

Credits: 4

COURSE OBJECTIVES:

- Gain knowledge about the structure, properties and functions of biomolecules.
- Provide information about the deficiency manifestation of vitamins and Minerals

UNIT – I: STRUCTURE AND CATALYSIS

Water – Properties and significance; Weak Interactions in Aqueous Systems; Ionization of Water, Weak Acids, and Weak Bases; Biological buffer system.

UNIT – II: AMINO ACIDS, ENZYMES AND PROTEINS

Basic structure of amino acids - Peptide bond - Configuration and confirmation; Classification, properties and functions of amino acids; Zwitterion and isoelectric point; Proteins –structure (primary to quaternary).

Enzymes: Biocatalyst – Activation Energy – Active site – Allosteric site – Enzymes mechanism: Lock and Key and induced fit; Enzyme Kinetics – Michaelis and Menten Equation – Sigmoidal curve.

UNIT – III: CARBOHYDRATES

Carbohydrates: Definition and classification of carbohydrates; structure, properties and functions: Monosaccharides – Glucose; Disaccharides – Sucrose; Polysaccharides – starch, glycogen and peptidoglycan. Isomerism, anomeric forms and mutarotation.

UNIT – IV: LIPIDS

Definition and classification of lipids; Fatty acids – classification, properties and functions; Simple, compound and derived lipids; Structure and functions of phospholipids, glycolipids and steroids.

UNIT – V: NUCLEIC ACIDS

Structure and functions of nucleotides and nucleic acids; DNA – Watson and Crick model, forms and properties; RNA – structure, types and functions (mRNA, tRNA and rRNA).

UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)

Students are encouraged to develop scientific knowledge, analytical thinking, research aptitude, communication skills, and lifelong learning (PO1, PO2, PO4, PO5, PO6, PO9, PO10) by undertaking self-directed activities such as preparing concept maps, developing molecular models, reviewing recent research articles, conducting nutritional or health awareness surveys, and presenting reports on the structure, functions, and applications of biomolecules, vitamins, and minerals in biological systems and human health.

Recommended Books, References, and e-Books:

1. Allan Fershi. 1984. Enzyme structure and mechanism. 2nd Edition. W.H.Freeman & Co. Ltd., USA.
2. Trevor Palmer, 1985. Understanding Enzymes. 2nd Edition. Ellis, Horwood Limited.
3. Victor W. Rodwell, David A Bender, Kathleen M. Botham, Peter J. Kennelly and Anthony P. Weli. 2015. Harper's Illustrated Biochemistry 30th Edition. Mc Graw Hill Lange Medical Books.
4. Donald Voet and Judith G.Voet, 2004. Biochemistry. 3rd Edition. John Wiley, New York.
5. <https://nptel.ac.in/courses/102/105/102105034/>
6. https://nptel.ac.in/content/storage2/courses/126104004/Lectur eNotes/Week-1_06-Carbohydrate.pdf

BIOCHEMISTRY		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Explain the classification, structure, properties, and biological significance of carbohydrates, including mono-, di-, homo-, and heteropolysaccharides.	K2
CO2	Describe the classification, properties, and functions of amino acids and explain the structural organization of proteins	K2
CO3	Explain the structure and functions of nucleic acids and distinguish between DNA and different types of RNA.	K3
CO4	Classify lipids and explain the structure, properties, and biological functions of fatty acids, phospholipids, glycolipids, and steroids.	K4
CO5	Explain the sources, functions, daily requirements, and deficiency disorders of vitamins and minerals and evaluate their nutritional significance.	K4

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy: The mapping reflects the strong alignment of Knowledge in Life Sciences (PO1), Problem analysis (PO3), and Practical skills / Experimental ability (PO3).

Mean Calculation: Each CO mean is derived by calculating the average correlation score across all 10 POs. The Overall Mean Score of 2.30 indicates a moderate-to-high level of alignment between the course and the programme outcomes.

COURSE OBJECTIVES:

The main objectives of this course are to:

- Impart knowledge of the safety measure for working in Biochemistry
- Laboratory.
- Acquire knowledge about the qualitative analysis of Biochemistry.
- Acquire knowledge about sterilization techniques
- Comprehend the various methods for identification of various types of microorganisms
- Study about the various culture techniques.

EXPERIMENTS:**BIOCHEMISTRY**

1. General guidelines and laboratory safety measure for working in Biochemistry Laboratory.
2. Units of volume, weight, density and concentration measurements and their range in biological measurements.
3. Demonstration of proper use of volume and weight measurement devices.
4. Preparation of buffer –titration of a strong acid and a weak base.
5. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars
6. Qualitative analysis of amino acids (Tryptophan, Tyrosine, Arginine, Proline and Histidine)
7. Preparation of starch from potato.
8. Preparation of casein from milk.
9. Preparation of albumin from egg

MICROBIOLOGY

1. Standard Operating Procedure (SOP) and Good Laboratory Practices (GLP)
2. Sterilization – glassware & media – wet, dry & filtration
3. Preparation of Microbiological media
4. Isolation of microorganisms from various samples
5. Counting of microbes – Use of haemocytometer, colony counting
6. Biochemical identification of bacteria – IMViC
7. Staining of bacteria – Simple & differential staining - Gram, spore.

8. Motility Test – Hanging Drop Method
9. Culture Techniques - Pure culture - slant, stab, streak etc.
10. Staining of fungi – Lactophenol Cotton Blue

REFERENCES:

1. Dr. J. Jayaraman, 2011. Manuals in Biochemistry, New Age International Pub, Bangalore.
2. Plummer, 2000. Practical Biochemistry, New Delhi: Tata Mcgraw Hill Publishing Company.
3. S.Sadasivam, V.A Manickam, 2006. Biochemical methods –2 ed New Age International Publishers.
4. Anil Kumar, Sarika Garg and Neha Garg, 2012. Biochemical Tests – Principles and Protocols.
5. Gunasekaran, P. 2009. Laboratory Manual in Microbiology. 1st Edition. New Age International Publishers. Reprint 2009.
6. Brown, A., & Smith, H. (2014). Benson's Microbiological Applications, Laboratory
7. Manual in General Microbiology, Short Version. McGraw-Hill Education.
8. Leboffe, M. J., & Pierce, B. E. (2015). Microbiology: laboratory theory and application. Morton Publishing Company.
9. Atlas, R. M. (2004). Handbook of microbiological media. CRC press.
10. James G. Cappuccino and Natalie Sherman. 2013. Microbiology: A laboratory
11. Manual. 10th Edition. Benjamin Cummings.
12. Arnold L. Demain & Julian E. Davies. 1999. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. ASM press.

BIOCHEMISTRY AND MICROBIOLOGY PRACTICAL		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Understand the principles, theory and calculations of each experiment.	K2
CO2	Gain hands-on preparation of all the solutions and standardize solutions individually.	K3
CO3	Acquire the concept of pH meter and preparation of Buffer solution.	K3
CO4	Gain practical knowledge about the chromatographic technique.	K3
CO5	Carry out qualitative analysis of carbohydrates and amino acids.	K4
CO6	Demonstrate the different types of sterilization used in microbiological laboratory	K3
CO7	Illustrate the methods used for the isolation and counting of microbes.	K3
CO8	Summarise the various staining techniques for the identification of microbes	K2
CO9	Apply various biochemical tests for the identification of bacteria	K4

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy: The Course Outcomes (COs) of the **Biochemistry and Microbiology Practical** course are mapped with the Programme Outcomes (POs) based on the extent to which the laboratory experiments contribute to the development of practical skills, scientific reasoning, analytical ability, research aptitude, and professional competence. The mapping follows a **three-point scale: 3 – High Correlation, 2 – Moderate Correlation, 1 – Low Correlation, and 0 – No Correlation.** The practical course strongly supports **PO1 (Disciplinary Knowledge), PO2 (Critical Thinking), PO3 (Practical Skills), PO4 (Scientific Reasoning), PO5 (Modern Tool Usage), PO6 (Research Aptitude), PO9 (Communication Skills), and PO10 (Lifelong Learning)** by enabling students to perform biochemical analyses, microbiological techniques, laboratory calculations, and bacterial identification using standard laboratory protocols.

Mean Calculation: Each CO mean is derived by calculating the average correlation score across all 10 POs. The Overall Mean Score of 2.60 indicates a moderate-to-high level of alignment between the course and the programme outcomes.

First Year

INTERDISCIPLINARY COURSE 1

Semester I

Code:

**UNDERSTANDING BIODIVERSITY
(Theory)**

Credits: 2

COURSE OBJECTIVES:

- To understand the concept, levels, and measurement of biodiversity.
- To describe the ecological, economic, ethical, and cultural importance of biodiversity.
- To explain the major drivers responsible for biodiversity loss.
- To identify biodiversity hotspots and species of conservation concern.
- To describe conservation strategies and legal frameworks for biodiversity protection.
- To create awareness of emerging trends and tools used in biodiversity conservation.

UNIT - I: BIODIVERSITY AND ITS LEVELS

Concept and scope of biodiversity; importance of studying biodiversity. Hierarchical levels of biodiversity: genetic diversity, species diversity, and ecosystem diversity, with simple examples of each.

UNIT - II: MEASURING BIODIVERSITY

Species richness and species evenness. Introduction to diversity indices: Shannon-Wiener Index and Simpson's Index (with simple numerical examples). Basic concept of Alpha, Beta, and Gamma diversity.

UNIT - III: VALUE OF BIODIVERSITY

Ecosystem services; economic value; ethical and aesthetic value; traditional ecological knowledge and community biodiversity registers. Introduction to biopiracy and indigenous rights.

UNIT - IV: THREATS TO BIODIVERSITY

The H.I.P.P.O framework: Habitat loss, Invasive species, Pollution, Population pressure, and Overexploitation. Impact of climate change on biodiversity.

UNIT - V: BIODIVERSITY HOTSPOTS

Concept of biodiversity hotspots and mega-diversity regions; Western Ghats and Indo-Burma hotspots. Indicator species, flagship species, and keystone species.

UNIT - VI: CONSERVATION AND EMERGING TRENDS

In-situ and ex-situ conservation. Convention on Biological Diversity (CBD); Kunming-Montreal Global Biodiversity Framework; Biological Diversity Act; National Biodiversity Authority. Brief introduction to emerging tools: environmental DNA (eDNA) and DNA barcoding, Artificial Intelligence (AI)/remote sensing/GIS in biodiversity monitoring, ecosystem restoration, and the One Health approach.

UNDERSTANDING BIODIVERSITY		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Describe biodiversity at genetic, species, and ecosystem levels.	K2
CO2	Explain and apply basic biodiversity indices such as Shannon-Wiener and Simpson's Index.	K3
CO3	Explain the major drivers of biodiversity loss using the H.I.P.P.O framework.	K2
CO4	Identify biodiversity hotspots and prioritise areas for conservation.	K3
CO5	Describe conservation strategies and relevant legal frameworks.	K2
CO6	Discuss emerging trends in biodiversity conservation, including eDNA, DNA barcoding, AI, and GIS.	K3

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy: At the undergraduate level, this course primarily aligns with Disciplinary Knowledge (PO1), Environmental Sustainability (PO7), and Lifelong Learning (PO10), with introductory exposure to Problem Solving (PO3) and Ethics (PO6). The syllabus builds foundational knowledge in biodiversity concepts, measurement, and conservation awareness appropriate for a first-degree science student.

Mean Calculation: To be computed by the department from the UG PO–CO correlation matrix; the PG mean score of 2.47 does not carry over, as UG course outcomes are pitched at lower Bloom's knowledge levels (K2–K3) than the parent PG course (K3–K5).

COURSE OBJECTIVES:

- The main objectives of this course are to:
- To Introduce the organization and structure of genetic material
- To explain the experimental evidence for DNA as the genetic material
- To understand the processes of DNA replication, transcription and translation in prokaryotic and eukaryotic organisms.
- To explain DNA damage and repair mechanisms, including excision repair, mismatch repair and SOS repair.
- To understand the principles of gene expression and its regulation in prokaryotes and eukaryotes.

UNIT - I: ORGANIZATION OF GENETIC MATERIAL

Identification of genetic material: Griffith, Avery, and Hershey-Chase experiments. Organization of genetic material - nucleus, nuclear envelope, nucleoplasm, chromatin, and chromosomes; allele, loci, gene. Structure and function of nucleic acids: nucleosides and nucleotides, purines and pyrimidines. Watson and Crick model of DNA structure; A, B, and Z forms of DNA; supercoiled and relaxed DNA; denaturation and renaturation of DNA.

UNIT - II: TRANSCRIPTION

Prokaryotic and eukaryotic transcription. Enzymes involved in transcription - RNA polymerase. Post-transcriptional processing of mRNA: 5' capping, 3' polyadenylation, and splicing.

UNIT - III: TRANSLATION

Factors involved in translation. Mechanism of translation in prokaryotes and eukaryotes - initiation, elongation, and termination. Translational inhibitors. Post-translational modification of proteins: importance of glycosylation and phosphorylation. Characteristics of the genetic code.

UNIT - IV: DNA REPLICATION AND REPAIR

Prokaryotic and eukaryotic DNA replication. Mechanism of DNA replication; enzymes and proteins involved. Models of replication: semi-conservative, unidirectional, bidirectional, and rolling circle. Inhibitors of DNA replication. Types of DNA damage; DNA repair mechanisms - excision repair, SOS repair, and mismatch repair.

UNIT - V: REGULATION OF GENE EXPRESSION

In prokaryotes: lac operon, ara operon, trp operon, and attenuation. In eukaryotes: gene loss, gene amplification, and gene rearrangement. Regulation of primary transcript synthesis; transcriptional control by hormones.

UNIT - VI: CURRENT CONTOURS (FOR CONTINUOUS INTERNAL ASSESSMENT ONLY)

Recent advancements in molecular biology to be introduced through expert lectures, online seminars webinars.

Text and Reference Books:

1. Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P. (2014). Molecular Biology of the Cell. Garland Science.
2. Tropp BE. (2012). Molecular Biology — Genes to Proteins. Jones and Bartlett Publishers.
3. Malacinski GM. (2013). Freifelder's Essentials of Molecular Biology. Narosa Publishing House.
4. Maloy SR, Cronan JE, Freifelder D. (1994). Microbial Genetics. 2nd Edition. Jones and Bartlett Publishers.
5. Streips UN, Yasbin RE. (2002). Modern Microbial Genetics. 2nd Edition. Wiley-Blackwell.
6. Primrose SB, Twyman RM, Old RW. (2008). Principles of Gene Manipulation. 6th Edition. Blackwell Science.
7. Krebs JE, Kilpatrick ST, Goldstein ES. (2013). Lewin's Genes XI. Jones & Bartlett Learning.
8. Paul A. (2011). Textbook of Cell and Molecular Biology. Books and Allied Ltd.
9. Allison LA. (2012). Fundamental Molecular Biology. 2nd Edition. John Wiley and Sons.
10. Berg JM, Tymoczko JL, Gatto GJ, Stryer L. (2015). Biochemistry. 8th Edition. WH Freeman & Co.
11. Lewin B. (2007). Genes IX. 9th Edition. Jones and Bartlett Publishers.
12. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (2007). Molecular Biology of the Gene. 6th Edition. Benjamin Cummings.
13. Watson JD, Gilman M, Witkowski J, Zoller M. (1992). Recombinant DNA. Scientific American Books.
14. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R. (2008). Molecular Biology of the Gene. 6th Edition. Cold Spring Harbor Laboratory Press.
15. Freifelder D. (2012). Molecular Biology. 5th Edition. Narosa Publishing House.

16. Freifelder D, Malacinski GM. (2005). Essentials of Molecular Biology. 4th Edition. Jones and Bartlett Publishing.

COURSE OUTCOMES

CO No.	Course Outcome (On completion of the course, students will be able to)	Knowledge Level
CO1	Describe the organization of genetic material, including nuclear structure, chromatin, chromosomes, and nucleic acid structure.	K2
CO2	Explain the mechanism of transcription and post-transcriptional processing in prokaryotes and eukaryotes.	K2
CO3	Explain the mechanism of translation and post-translational modification of proteins.	K2
CO4	Explain the mechanism of DNA replication and repair in prokaryotes and eukaryotes.	K2
CO5	Describe the regulation of gene expression in prokaryotes and eukaryotes.	K2
CO6	Discuss recent advances in molecular biology through expert lectures, seminars, or webinars.	K2

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy: This course primarily aligns with **Disciplinary Knowledge (PO1), Problem Solving (PO3), and Research Aptitude (PO4)**, with introductory exposure to Scientific Reasoning (PO2) and Lifelong Learning (PO10). It builds the molecular-level foundation — structure of genetic material, gene expression, replication, and repair — on which later courses in genetics, genomics, and biotechnology techniques are built.

Mean Calculation: To be computed by the department from the UG PO–CO correlation matrix once faculty assign course-specific correlation scores (0–3) across all Programme Outcomes

COURSE OBJECTIVES:

The main objectives of this course are to:

- To develop practical skills in the isolation and purification of genomic DNA from prokaryotic and eukaryotic cells.
- To Introduce basic techniques for the separation, visualization and quantification of nucleic acids.
- To develop practical knowledge of protein detection and quantification
- To understand basic bacterial genetic manipulation techniques, including physical and chemical mutagenesis.
- To demonstrate the preparation of competent bacterial cells and bacterial transformation using the CaCl_2 method.

EXPERIMENTS:

1. Isolation and purification of genomic DNA from prokaryotes.
2. Isolation and purification of genomic DNA from eukaryotes.
3. Observation of DNA - Agarose gel electrophoresis.
4. Quantification of nucleic acids – DNA & RNA.
5. Staining of proteins - Amido black, coomassie brilliant blue & AgNO_3 .
6. Quantification of Proteins - Bradford Method
7. Bacterial mutagenesis – physical & chemical methods.
8. Preparation of E. coli competent cells (Demo)
9. Transformation of bacteria – CaCl_2 method (Demo)
10. Bacterial conjugation (Demo)

REFERENCES:

1. M. Mooyoung. (1985). Comprehensive Biotechnology. Vol. 2, 3 & 4. Pergamon press.
2. Dr. David A Thompson. (2011). Cell and Molecular Biology Lab Manual.
3. George M. Malacinski. (2013). Freifelder's Essentials of Molecular Biology. Norosa Publishing House.
4. Stanely R. Maloy, Jhon E Cornan Jr, David Freifelder. (1994). Microbial Genetics. 2nd Edition. Jones and Bartlett publisher.
5. <http://www.fastbleep.com/biology-notes/41/122/1216>

6. <http://cshprotocols.cshlp.org/content/2006/1/pdb.prot4455>
7. <http://www.med.upenn.edu/lamitinalab/documents/EthanolPrecipitationofDhttp://bitesizebio.com/384/the-basics-how-phenol-extraction-works/>
8. [http://physiology.med.cornell.edu/faculty/mason/lab/zumbo/files/PHE NOLCHLOR OFORM.pdf](http://physiology.med.cornell.edu/faculty/mason/lab/zumbo/files/PHE%20NOLCHLOR%20OFORM.pdf)

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Know about how DNA is isolated from prokaryotes as well eukaryotes
- Develop the basic knowledge on estimation of nucleic acids
- Gain the experience on separation of proteins
- Identify bacterial growth reduction using physical and chemical mutagens
- Learn about how gene transfer methods are used to reproduce bacteria

PO MAPPING STRATEGY

The course strongly supports **PO1 (Disciplinary Knowledge)**, **PO2 (Critical Thinking)**, **PO3 (Problem Solving)**, **PO4 (Research Aptitude)**, **PO5 (Modern Tool Usage)**, **PO6 (Communication Skills)**, **PO8 (Health Awareness)**, **PO9 (Entrepreneurial Skills)**, and **PO10 (Lifelong Learning)** by providing hands-on training in DNA and protein analysis, electrophoresis, nucleic acid and protein quantification, bacterial mutagenesis, transformation and conjugation.

Mean Score:

The **Overall Mean Score of 2.18** indicates a **moderate-to-high level of alignment** between the practical course and the Programme Outcomes, with strong emphasis on **laboratory skills, disciplinary knowledge, problem solving, research aptitude and modern biotechnology techniques**.

First Year

ALLIED COURSE 2

Semester II

Code:

**MICROBIOLOGY
(Theory)**

Credits: 4

COURSE OBJECTIVES:

Study about the history and development of Microbiology.

- Study about the different types of microorganisms- their structure and organization.
- Study the viruses and associated diseases.

UNIT – I: History and Scope of Microbiology (Include Microscopy)

History, scope and importance of microbiology; Discovery of microorganisms, spontaneous generation and germ theory; Contributions of major scientists to medical, industrial and environmental microbiology; Concept and applications of fermentation.

UNIT – II: Diversity of the Microbial World

Classification and nomenclature of microorganisms; Whittaker's five-kingdom, Woese's and Haeckels three-domain classification systems; General characteristics of bacteria, archaea, mycoplasma, rickettsiae, chlamydiae and acellular microorganisms.

UNIT – III: Algae and Fungi

General characteristics, classification, structure, pigments, reproduction and economic importance of algae; Types of algal life cycles; Life cycle of **Chlamydomonas** and **Spirogyra**. General characteristics, classification, structure, nutrition and reproduction of fungi; Fungal cell organization, heterokaryosis and parasexuality; Life cycle of **Rhizopus** and **Aspergillus**.

UNIT – IV: Protozoa, Viruses, Viroids and Prions

General characteristics and significance of protozoa with examples (**Amoeba**, **Paramecium** and **Giardia**); Structure, classification and replication of viruses; Lytic and lysogenic cycles; Introduction to viroids, prions, coronaviruses and vaccines.

UNIT – V: Sterilization, Culture Media and Preservation

Sterilization – Principles, physical and chemical methods of sterilization, aseptic techniques and disinfection; **Culture Media** – Types, composition, preparation and sterilization of culture media; **Microbial Preservation** – Short-term and long-term preservation methods, maintenance of pure cultures and culture collection.

UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)

Students are encouraged to develop **scientific knowledge, critical thinking, practical skills, research ability, and communication skills (PO1, PO2, PO3, PO4, PO6, PO9)** through self-directed learning activities such as preparing charts, models, field observation reports, seminars, and assignments on microorganisms, algae, fungi, protozoa, and viruses.

Recommended Books, References, and e-Books

1. Tortora, G. J., Case, C. L., & Funke, B. R. 2016. Microbiologia-12^a Edi Microbiology:An Introduction. Pearson Education.
2. Pommerville, J. C., & Pommerville, J. C. 2011. Alcamo's fundamentals of
3. microbiology. Jones & Bartlett Learning.
4. Black, J. G., & Black, L. J. (2018). Microbiology: principles and explorations. John Wiley & Sons.
5. Gillespie, S. H., & Hawkey, P. M. (Eds.). (2006). Principles and practice of clinical bacteriology. John Wiley & Sons.
6. Saxena, S. (2015). Applied microbiology. New Delhi: Springer.
7. Powar and Dagainwala. 2010. General Microbiology. Vol. I. Himalaya Publisher.
8. Kumar, S. 2012. Textbook of microbiology. JP Medical Ltd.
9. Willey, J. M., Sherwood, L., & Woolverton, C. J. 2009. Prescott's principles of microbiology.
10. Alcamo, I. E. 1987. Fundamentals of microbiology. 1987. Benjamin/Cummings Publishing, Menlo Park, Ca(Usa).
11. Ananthanarayan, R. (2006). Ananthanarayan and Paniker's textbook of microbiology. Orient Blackswan.
12. Pelzer, Chan and Kreig. 2008. Fundamentals of Microbiology. 7th Edition. McGraw-Hill.
13. <https://archive.nptel.ac.in/courses/102/103/102103015/>
14. <https://dth.ac.in/medical/courses/Microbiology/block-1/1/index.php>

MICROBIOLOGY		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Recall the history and scope of Microbiology.	K1
CO2	Outline the classifications of microorganisms.	K2
CO3	Summarises the structural organization of Bacteria, Algae and Fungi.	K3
CO4	Explain the different types of reproduction in Protozoa and Viruses.	K4
CO5	Describe the corona virus and associated diseases.	K4

MAPPING WITH PROGRAMME OUTCOMES

- **PO Mapping Strategy:** The mapping reflects the strong alignment of Knowledge in Microbiology (PO1), Problem analysis (PO3), and Practical skills / Experimental ability (PO3).
- **Mean Calculation:** Each CO mean is derived by calculating the average correlation score across all 10 POs. The Overall Mean Score of 2.35 indicates a moderate-to-high level of alignment between the course and the programme outcomes.

First Year

SKILL ENHANCEMENT COURSE 1

Semester II

Code:

**FUNDAMENTALS OF COMPUTER
APPLICATIONS IN BIOTECHNOLOGY
(Theory)**

Credits: 2

COURSE OBJECTIVES:

- To understand basic computer concepts and operations.
- To develop skills in common computer applications.
- To introduce computer-based data handling and presentation.
- To understand basic applications of computers in biotechnology.
- To recognize the role of computational tools in biotechnology.

UNIT – I: Computer Fundamentals

Introduction to computers; hardware and software; input and output devices; memory and storage; operating systems; files and folders.

UNIT – II: Word Processing and Presentation

Basic word processing; document creation and formatting; tables; scientific documents; preparation of simple presentations.

UNIT – III: Spreadsheets and Data Handling

Introduction to spreadsheets; data entry; basic formulas and functions; sorting and filtering; tables; simple charts and graphs.

UNIT – IV: Internet and Scientific Resources

Internet and web browsers; email; search techniques; online scientific information; scientific databases; downloading and organizing information.

UNIT – V: Computer Applications in Biotechnology

Biological databases; sequence databases; introduction to FASTA and BLAST; retrieval of biological sequences; basic bioinformatics applications.

UNIT – VI: Introduction to Computational Biotechnology

Basic programming concepts; introduction to Python/R; computational biology; simple applications of artificial intelligence in biotechnology.

Text Books

1. Rajaram, V. (2021). Fundamentals of Computers. 6th Edition. PHI Learning, New Delhi.
2. Sinha, P.K. and Sinha, P. (2020). Computer Fundamentals. 8th

Edition. BPB Publications, New Delhi.

3. Pevzner, P.A. and Compeau, P. (2020). Bioinformatics Algorithms: An Active Learning Approach. 3rd Edition. Active Learning Publishers.
4. Attwood, T.K. and Parry-Smith, D.J. (2022). Introduction to Bioinformatics. 2nd Edition. Pearson.

Reference Books

1. Kanehisa, M., Furumichi, M., Tanabe, M., Sato, Y. and Morishima, K. (2021). KEGG: New Perspectives on Genomes, Pathways and Diseases. Nucleic Acids Research.
2. Mount, D.W. (2022). Bioinformatics: Sequence and Genome Analysis. 3rd Edition. Cold Spring Harbor Laboratory Press.
3. Vandamme, A.M. and Peeters, K. (2021). Computational Biology and Bioinformatics. 1st Edition. Springer.
4. McKinney, W. (2022). Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter. 3rd Edition. O'Reilly Media.

Course Outcomes

CO1: Explain basic computer concepts and operations.

CO2: Use word processing, presentation and spreadsheet applications.

CO3: Handle and present basic scientific data using computer applications.

CO4: Access and use internet-based scientific resources.

CO5: Use basic biological databases and bioinformatics tools.

PO Mapping Strategy: The course strongly supports **PO1 (Disciplinary Knowledge)**, **PO2 (Critical Thinking)**, **PO3 (Problem Solving)**, **PO4 (Research Aptitude)**, **PO5 (Modern Tool Usage)**, **PO6 (Communication Skills)**, **PO9 (Entrepreneurial Skills)**, and **PO10 (Lifelong Learning)** by providing basic computer skills, scientific data handling, internet-based information retrieval, biological database usage, sequence analysis and introductory computational tools such as Python/R and artificial intelligence.

Mean Calculation: Each CO mean is derived by calculating the average correlation score across all **10 POs** using the correlation scale **3 – Strong, 2 – Moderate, 1 – Low, 0 – No correlation**. The **Overall Mean Score of 2.25** indicates a **moderate-to-high level of alignment** between the course and the programme outcomes.

First Year

INTERDISCIPLINARY COURSE 2

Semester II

Code:

**BASICS OF BIOTECHNOLOGY
(Theory)**

Credits: 2

COURSE OBJECTIVES:

The main objectives of this course are to:

- Introduce the basic concepts of biology and biotechnology.
- Provide fundamental knowledge of biomolecules, microorganisms and genetics.
- Familiarize students with the basic principles of molecular biology.
- Introduce the major applications of biotechnology in agriculture, healthcare, industry and environment.
- Create awareness about biosafety and bioethics.

UNIT – I: BASICS OF BIOLOGY

Introduction to biology and biotechnology - Cell structure and types - Basic functions of cell organelles - Central Dogma

UNIT – II: BIOMOLECULES

Biomolecules and its classification; Types and function: Carbohydrates, proteins and lipids – Nucleic acids - Enzymes and their applications

UNIT – III: MICROORGANISMS

Introduction to microorganisms - Bacteria, fungi, viruses and algae - Beneficial and harmful microorganisms - Microbial growth and basic culture methods - Role of microorganisms in food and industry.

UNIT – IV: Applications of Biotechnology:

Application of Transgenic plants in Agriculture, Edible vaccine, Secondary metabolite and Antibody production by transgenic plants. Animal cloning, in vitro fertilization, gene therapy, applications of transgenic animals. Industrial applications of recombinant DNA technology (Insulin, Antibody and ethanol production), application of genetically engineered microorganisms in environment protections. DNA markers and its applications in Forensic science.

UNIT – V: Biotechnology and Ethics:

Socio - Economic and legal impacts of biotechnology, Controversy over GM crops, bioterrorism, IVF technologies - Embryonic cell Research - Amniocentesis - Sex determination and abortion, Surrogate mother, Human cloning - Regulation pertaining to organ transplantation.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

TEXT BOOKS

1. Thieman, W. J., & Palladino, M. A. (2021). *Introduction to Biotechnology*. **4th Edition**. Pearson Education.
2. Godbey, W. T. (2021). *Biotechnology and Its Applications: Using Cells to Change the World*. **2nd Edition**. Academic Press, Elsevier.
3. Wink, M. (Ed.). (2021). *An Introduction to Molecular Biotechnology: Fundamentals, Methods and Applications*. **3rd Edition**. Wiley-VCH.

REFERENCE BOOKS

1. Chawla, P. C. (2021). *Basic Biotechniques*. **1st Edition**. National Book Trust, India.
2. Hasija, Y. (Ed.). (2021). *Translational Biotechnology: A Journey from Laboratory to Clinics*. **1st Edition**. Academic Press, Elsevier.
3. Evens, R. P. (2021). *Biotechnology: The Science, the Products, the Government, the Business*. **1st Edition**. CRC Press.
4. Satyanarayana, U. (2021). *Biochemistry*. **6th Edition**. Elsevier.

S.No.	Course Outcome	Knowledge Level
CO1	Explain the basic concepts of biology, biotechnology, cell structure, and major cell organelles.	K2
CO2	Describe the structure, functions, and biological importance of carbohydrates, proteins, lipids, nucleic acids, and enzymes.	K2
CO3	Explain the major groups of microorganisms and describe their useful and harmful roles in daily life and industry.	K2
CO4	Explain the basic concepts of genes, chromosomes, DNA, and genetic engineering.	K3
CO5	Describe the applications of biotechnology in agriculture, healthcare, industry, and environment and explain the importance of biosafety and bioethics.	K3

MAPPING WITH PROGRAMME OUTCOMES

- **PO Mapping Strategy:** This course aligns strongly with Disciplinary Knowledge (PO1), Problem Solving (PO3), Environment and Sustainability (PO7), Health Awareness (PO8) and Entrepreneurial Skills (PO9).
- **Mean Calculation:** The Overall Mean Score of 2.8 indicates a high level of alignment with the programme outcomes. **Overall Mean Score: 2.11**

COURSE OBJECTIVES

- To understand the basic concepts of genetics and genome mapping.
- To describe the classical concepts of Mendelian genetics across model organisms, including yeast genetics.
- To explain the relationship between genotype and phenotype using *Drosophila* as a model system in classical genetics.
- To understand the basics of population genetics and evolution.
- To understand the concept of Quantitative Trait Loci (QTLs).

UNIT – I: GENE CONCEPTS

Historical concepts of the gene before the discovery of DNA. Genetic mapping in bacteria and bacteriophages using classical genetic crosses. Fine-structure analysis of genes, genetic complementation, phenotypic markers. Relationship between genotype and phenotype and the development of gene concepts prior to molecular genetics.

UNIT – II: INHERITANCE AND RECOMBINATION

Mendelian and non-Mendelian patterns of inheritance, monohybrid and dihybrid crosses, linkage and genetic recombination, meiotic crossing over, tetrad analysis in fungi, gene conversion, dominant and recessive genes and mutations, genetic interactions and epistasis, complementation tests, and applications of genetic analysis in understanding gene function and inheritance.

UNIT – III: POPULATION GENETICS

Introduction to population genetics; genetic variation in populations; mutation, natural selection, genetic drift, and migration; Hardy–Weinberg equilibrium and factors affecting gene frequencies; linkage disequilibrium; inbreeding and mating systems; population bottlenecks and their effects on genetic diversity; concepts of fitness, adaptation, and adaptive landscapes; spatial genetic variation; and a brief introduction to Bayesian approaches in population genetics.

UNIT – IV: GENETICS OF COMPLEX TRAITS

Complex traits and their inheritance; principles of QTL mapping; identification of genomic regions associated with quantitative traits; use

of yeast as a model organism to understand the genetic basis of complex traits.

UNIT – V: PLANT BREEDING

Laws of segregation in plant crosses; inbreeding and self-pollination; heterosis (hybrid vigour); maintenance of genetic purity; and gene pyramiding for crop improvement.

UNIT – VI: CURRENT CONTOURS (CIA ONLY)

Students are to explore recent developments in genetics and genomics to enhance their understanding of genetic principles, data interpretation, and applications in agriculture, medicine, and evolutionary biology (PO2, PO4, PO5, PO6). Suggested activities:

RECOMMENDED BOOKS, REFERENCES, AND E-BOOKS

1. Hartl DL, Jones EW. (1998). Genetics: Principles and Analysis. Jones and Bartlett.
2. Pierce BA. (2020). Genetics: A Conceptual Approach. 7th Edition. W.H. Freeman.
3. Tamarin RH. (1999). Principles of Genetics. 6th Edition. WCB/McGraw-Hill.
4. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. (2015). Introduction to Genetic Analysis. 11th Edition. W.H. Freeman.
5. Klug WS, Cummings MR, Spencer CA, Palladino MA. (2019). Concepts of Genetics. 12th Edition. Pearson.
6. Snustad DP, Simmons MJ. (2015). Principles of Genetics. 7th Edition. Wiley.
7. Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM. (2018). Genetics: From Genes to Genomes. 6th Edition. McGraw-Hill.
8. Falconer DS, Mackay TFC. (1996). Introduction to Quantitative Genetics. 4th Edition. Longman.

COURSE OUTCOMES

CO No.	Course Outcome (Upon completion of the course, students will be able to)	Knowledge Level
CO1	Explain the historical development of gene concepts, principles of classical genetic mapping in bacteria and bacteriophages, gene structure and complementation, and the relationship between genotype and phenotype.	K1, K2
CO2	Describe the principles of Mendelian and non-Mendelian inheritance, genetic linkage and recombination, gene interactions, and complementation.	K2
CO3	Explain the principles of population genetics, including the factors influencing genetic variation, gene frequencies, population structure, and adaptation.	K2, K4
CO4	Describe the genetic basis of complex traits, principles of QTL mapping, and the use of model organisms such as yeast to study quantitative trait inheritance.	K3, K4
CO5	Explain the principles of plant breeding, including segregation, inbreeding, heterosis, maintenance of genetic purity, and gene pyramiding for crop improvement.	K3, K4
CO6	Explore and present recent developments in genetics and genomics through field visits, dataset analysis, or case studies, as self-directed learning.	K3

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy: This course aligns strongly with **Disciplinary Knowledge (PO1) and Problem Solving (PO3)**, with the Unit VI self-directed learning activities additionally engaging Scientific Reasoning (PO2), Research Aptitude (PO4), Modern Tool Usage (PO5), and Ethics and Professionalism (PO6).

Mean Calculation: To be computed by the department from the UG PO–CO correlation matrix once faculty assign course-specific correlation scores (0–3) across all Programme Outcomes.

COURSE OBJECTIVES:

- To understand chromosome structure, organization, and behavior during mitosis and meiosis, and relate these processes to inheritance and genetic variation.
- To apply the principles of Mendelian genetics and statistical methods to analyze inheritance patterns, genetic crosses, and experimental data.
- To evaluate human and population genetics data through pedigree analysis, karyotype interpretation, and Hardy–Weinberg equilibrium calculations.
- To perform fundamental molecular genetics techniques, including genomic DNA isolation and agarose gel electrophoresis, for the analysis of genetic material.
- To utilize bioinformatics tools and genetic databases for the retrieval, comparison, and interpretation of biological sequence information.

Experiments:

1. Study of Mitosis in Onion Root Tip: Observation and identification of different stages of mitosis.
2. Study of Meiosis in Flower Bud: Observation and identification of meiotic stages and chromosome behavior.
3. Human Karyotype Analysis: Classification of chromosomes and identification of chromosomal abnormalities using prepared karyograms.
4. Monohybrid and Dihybrid Cross Analysis: Verification of Mendel's laws of segregation and independent assortment using genetic datasets.
5. Chi-Square Analysis of Genetic Ratios: Statistical evaluation of observed and expected Mendelian ratios.
6. Pedigree Analysis: Construction and interpretation of pedigrees for various modes of inheritance.
7. Hardy–Weinberg Equilibrium Calculations: Determination of allele and genotype frequencies in populations.
8. Isolation of Genomic DNA from Plant Tissue: Extraction and qualitative assessment of genomic DNA.
9. Agarose Gel Electrophoresis of DNA: Separation and visualization of DNA fragments using agarose gel electrophoresis.

10. **Retrieval of Gene Sequences from Public Databases:** Use of NCBI for gene sequence retrieval.
11. **Sequence Similarity Search:** Performing BLAST analysis for DNA sequences.
12. **Identification of Open Reading Frames (ORFs):** Basic gene prediction exercises.
13. **Comparative Analysis of Gene Sequences:** Pairwise sequence alignment and interpretation.

UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)

Students are to explore recent advances in experimental and computational genetics through laboratory exposure, bioinformatics resources, and scientific communication to strengthen practical skills, data interpretation, and analytical abilities (PO2, PO3, PO4, PO5).

1. Analyze published human karyotypes or pedigrees to identify chromosomal abnormalities and inheritance patterns, and present the findings.
2. Perform an independent bioinformatics exercise involving sequence alignment, ORF prediction, or phylogenetic analysis using freely available online tools and submit a practical report.

Recommended Books, References, and e-Books

1. Gardner, E. J., Simmons, M. J. & Snustad, D. P. (2013). Principles of Genetics, 8th Edition, John Wiley and Sons.
2. Hotter, P. (2007). Dictionary of Genetics, IVY Publishing House, Delhi
3. Jayaraman, K. & Jayaraman, R. (1979). Laboratory manual in Molecular Genetics, John Wiley and Sons.
4. Tamarin, R.H. (2002). Principles of Genetics, 7 th Edition, Tata McGraw-Hill Publishing Company Ltd.

Genetics Practical		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
C01	Identify stages of mitosis and meiosis.	K3 & K4
C02	Analyze inheritance patterns using Mendelian principles.	K2 & K5
C03	Interpret pedigree charts and population genetic data.	K2 & K5
C04	Perform basic DNA isolation and electrophoresis.	K3 & K5
C05	Use bioinformatics tools for genetic sequence analysis and apply statistical methods to genetic data.	K3 & K5

MAPPING WITH PROGRAMME OUTCOMES (POs)

PO Mapping Strategy: This course aligns strongly with Disciplinary Knowledge (PO1) and understand the applications (PO3).

Mean Calculation: The Overall Mean Score of 2.8 indicates a high level of alignment with the programme outcomes.

COURSE OBJECTIVES:

The main objectives of this course are to:

- Explain the principles and applications of cell disruption, subcellular fractionation and centrifugation techniques.
- Describe the principles and applications of microscopy, biosensors, X-ray techniques and radioactivity.
- Apply electrophoretic techniques for the separation and analysis of biological molecules.
- Explain and apply different chromatographic techniques for separation and purification of biomolecules.
- Describe the principles and applications of major spectroscopic and analytical techniques. Integrate biochemical techniques for scientific investigation, data interpretation and research applications.

UNIT – I: General Approaches to Biochemical Investigations:

Cell disruption methods and subcellular fractionation. Centrifugation techniques: Basic principles of sedimentation, Svedberg's constant and RCF. Principle, technique and applications of preparative centrifugation-differential and density gradient centrifugation. Analytical ultracentrifugation.

UNIT – II: Microscopy and Radioactivity:

Basic principles, instrumentation and applications of Light microscopy, Fluorescence microscopy, Phase contrast microscopy and Electron microscopy. Biosensors, X-ray diffraction, X-ray absorption, Radioactivity, Safety aspects of radiation, Detection and Measurement of radiation.

UNIT – III: Electrophoretic Techniques:

General principle, technique and applications of Gel electrophoresis-Agarose gel electrophoresis- Polyacrylamide gel electrophoresis (PAGE): Native and SDS-PAGE. 2D-Gel.

UNIT – IV: Chromatographic Techniques:

Principles of chromatography, technique and applications of Paper chromatography, Thin Layer chromatography (TLC), Adsorption, Partition, Ion exchange, Gel filtration and Affinity chromatography.

Principle, components and applications of Gas chromatography (GC), High performance liquid chromatography (HPLC).

UNIT – V: Spectroscopy:

Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV-visible spectrophotometry, ESR, NMR, IR and spectrofluorimetry. Basic principles of turbidimetry and nephelometry.

Atomic spectroscopy – principle and applications of atomic flame and flameless spectrophotometry. Use of lasers for spectroscopy.

UNIT – VI: Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Ghosal Sabari and Srivastava A. 2009. Fundamentals of Bio Analytical Techniques and Instrumentation,. K., PHI Learning Pvt. Ltd. India.
2. Dr. Istvan Bak, 2011. Modern analytical techniques in the pharmaceutical-and bioanalysis,
3. Ghosal and Srivastava, 2009. Fundamentals of Bioanalytical Techniques and Instrumentation, PHI Learning Pvt. Ltd.
4. K Wilson and J Walker, 2005. Principles and Techniques of Practical Biochemistry, Cambridge University Press, India.
5. A Upadhyay, K Upadhyay and N Nath, 2014. Biophysical Chemistry (Principles and Techniques) 4th Edition, Himalaya Publishing House, India.
6. A Shourie and SS Chapadgaonkar, 2015. Bioanalytical Techniques, the Energy and Resources Institute, TERI, India.
7. C.R. Kothari, Methods and Techniques, 2004 2nd ed, Research Methodology, New Age International Publishers. India.
8. R.P. Braun, 1987. Introduction to Instrumental Analysis, Tata McGraw Hill, India.
9. <https://nptel.ac.in/courses/102/103/102103044>

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Develop the skills to understand the theory and practice of bioanalytical techniques.

- Describe the working principle, techniques and applications of bioinstrumentation.
- Gain knowledge and apply the concept of electrophoretic techniques, their procedure, principle and applications.
- Describe the concepts of chromatography and concept of partition coefficient and perform various chromatographic techniques.
- Understand the various approaches employed in spectroscopic characterization.

PO Mapping Strategy: The course demonstrates strong alignment with Disciplinary Knowledge (PO2), Critical Thinking (PO3), Analytical Reasoning (PO4), Scientific Reasoning (PO5), Reflective Thinking (PO7), Problem Solving (PO8), Research-related Skills (PO9), and Lifelong Learning (PO10).

Mean Calculation:

Each PO mean is derived by calculating the average correlation score across all **6 Course Outcomes (COs)**. The **Overall Mean Score of 2.28** indicates a **moderate-to-high level of alignment** between the **Biochemical Techniques course** and the **B.Sc. Programme Outcomes**.

COURSE OBJECTIVES:

The main objectives of this course are to:

- Impart knowledge of the safety measure for working in Laboratory Instruments.
- Acquire knowledge about the principles of Laboratory Instruments.
- Enrich the practical skills on the immunological techniques
- Understand the immune reactions, antigen-antibody reactions, separation of lymphocytes, purify immunoglobulins and detect antigens via techniques like western blotting

EXPERIMENTS:**BIO-INSTRUMENTS**

1. Principles of laminar air flow chamber and incubator.
2. Determination of pH - pH meter.
3. Paper and Thin layer Chromatography (Separation of amino acids).
4. Column chromatography.
5. Separation of biomolecules using centrifuge.
6. Demonstration of flowcytometry.
7. Microscope – Bright field and Dark field.

IMMUNOLOGY

1. Preparation of serum & plasma from blood samples
2. Precipitation reaction – AGID, SRID, Ouchterlony double immunodiffusion, and
3. Rocket immunoelectrophoresis
4. Agglutination - Blood grouping, Latex agglutination, WIDAL.
5. Labelled assays – IF, RIA (Theory), ELISA (Demo)
6. Western Blotting.
7. Isolation of and quantification of immunoglobulin from serum.
8. Separation of lymphocytes from whole blood
9. Preparation of lymphocytes from peripheral blood by density gradient centrifugation

REFERENCES:

1. Plummer, 2000. Practical Biochemistry, New Delhi: Tata Mcgraw Hill Publishing Company.
2. S.Sadasivam, V.A Manickam, 2006. Biochemical methods –2 ed New Age International Publishers.
3. Practical Immunology - Frank C. Hay, Olwyn M.R. Westwood
4. Text of Practical Immunodermatology - Xing Hua Gao and Hong Duochen.
5. Practical immunology - Mohamed Mohsin Ahmed.
6. Immunology: A Laboratory Manual, Richard L. Myers, 1989
7. Diagnostic Immunology Laboratory Manual, Ronald J. Harbeck, 1991
8. Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby. 2003.
9. Immunology. 5th Edition, W. H. Freeman & Company
10. J. Sambrook and D.W. Russel, CSHL. 2001. Molecular Cloning: A Laboratory
11. Manual, Vols 1-3. Cold spring Harbor Laboratory press.
12. Topley and Wilson. G. Wilson, A.Miles, M.T.Paker. Arnold, Heineman, 1984.
13. Principles of Bacteriology, Virology and immunology. Willy – Blackwell.

BIOINSTRUMENTATION AND IMMUNOLOGY PRACTICAL		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
C01	Gain hands-on preparation of all the solutions and standardize solutions	K3
C02	Understand the principles, theory and calculations of each experiment.	K2
C03	Acquire the concept of pH meter and preparation of Buffer solution.	K3
C04	Gain practical knowledge about the chromatographic technique.	K3
C05	Prepare the serum and plasma from blood and perform blood grouping assay	K4

MAPPING WITH PROGRAMME OUTCOMES

- **PO Mapping Strategy:** The **Bio-instruments and Immunology Practical** course is mapped with the Programme Outcomes (POs) based on how each practical activity contributes to student learning. The mapping uses a **three-point scale: 3 – High, 2 – Moderate, 1 – Low, and 0 – No Correlation.**
- **Mean Calculation:** Each CO mean is derived by calculating the average correlation score across all 10 POs. The Overall Mean Score of 2.65 indicates a moderate-to-high level of alignment between the course and the programme outcomes.

COURSE OBJECTIVES:

- The course contents are designed as to gain basic science knowledge of mushroom cultivation.
- The learners will understand the nutritional benefits of the microbes concerned and also related drawbacks.
- Learners can acquire knowledge about the prevailing market demands and scope of these technologies.
- They will learn to apply the gained knowledge for strain improvement to support their entrepreneurship talents.
- Students can develop their knowledge to start an industry as an entrepreneur.

UNIT – I: Applied Mushroom Biology:

Introduction and Definition of a Mushroom, Mushroom Hunting, Ecological Classification of Mushrooms, Magnitude of Mushroom Species. Mushroom Science -Food Supply through Mushroom Themselves, Mushroom technology. Mushroom spoilages and mushroom borne diseases.

UNIT – II: History of Mushroom Cultivation:

Biology of mushrooms; Nutritional value: (Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins); Medicinal value of mushrooms; Poisonous mushrooms and mushroom poisoning; edible mushrooms and cultivation in India and world; Mycorrhizal mushrooms and their role in plant growth.

UNIT – III: Cultivation Technology:

Infrastructure, equipment and substrates required for mushroom cultivation: Polythene bags, vessels, inoculation hook, inoculation loop, love cost stove, sieves, culture racks, mushroom unit or mushroom house, water sprayer, tray, boilers, driers, pure culture, Spawns - types of spawn, preparation of spawn, mushroom bed preparation and factors affecting mushroom bed preparation. Compost - materials used for compost preparation, compost technology in mushroom production.

UNIT – IV: Casing and Mass Cultivation:

Casing - raw material used for casing, preparation of casing material; important sanitation during various stages of mushroom cultivation.

Cultivation of important mushrooms - General process for the cultivation of *Agaricus bisporus*, *Pleurotus ostreatus* and *Volvariella volvacea*. Pests and Pathogens of mushrooms and their management with reference to *Agaricus bisporus*.

UNIT – V: Storage and Food Preparation from Mushrooms:

Methods of storage of mushroom cultivation, Long term and short term storage of mushrooms Foods/recipes from mushrooms. Mushroom research centers or farms - National level and regional level. Marketing of mushrooms in India and world.

UNIT – VI: Current Contours (For continuous internal assessment only):

Field trip to mushroom farms and research Institutes. Analysis of biological properties in the mushroom products awareness (PO4, PO6). Awareness to the industrialists about the prevention of microbial contamination in the mushroom farms and products.

Recommended Books, References, and e-Books

1. Tavis Lynch, 2018. Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home. Quarto Publishing. USA.
2. Kaul, T.N. and B. L. Dhar, 2007. Biology and Cultivation of Edible Mushrooms. Westville Publishing House. New Delhi, 240pp
3. Chang, S.T., Miles, P.G., 2004. Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact (Second Edition). CRC Press. Boca Raton, 451pp.
4. Delcaire, J.R., 1978. Economics of cultivated mushrooms. In The Biology and Cultivation of Edible Mushrooms, Chang, S.T. and H.A. Hayes, ed., Academic Press. Inc. New York. 726-793.
5. Dewhurst, M., 2002. Phase III –the future? The Mushroom J. 626, 17-18.
6. Bhalla, T.C., Sharma, N.N., Sharma, M., 2007. Production of Metabolites, Industrial Enzymes, Amino Acids, Organic Acids, Antibiotics, Vitamins and Single Cell Proteins. National Science Digital Library, India.
7. <https://www.mushroomoffice.com/mushroom-cultivation/>
8. <https://vikaspedia.in/agriculture/farm-based-enterprises/mushroomproduction/button-mushroom-production>
9. <https://krishijagran.com/agripedia/a-complete-guide-to-profitable-mushroomfarming-in-india-read-composting-harvesting-techniques/>
10. <https://cropbag.in/mushroom-cultivation-complete-guide/>

MUSHROOM TECHNOLOGY		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Draw out the importance of mushrooms and their applications in health and nutraceuticals.	K2
CO2	Work out the production process for optimum mushroom yield.	K3
CO3	Explain their beneficial and erratic role during human consumption.	K2
CO4	List out the substrates employed in mushroom cultivation and sketch out the methods for improvement.	K1/K2
CO5	Gain well-rounded knowledge and get fully prepared for employment, marketing and entrepreneur activities related to mushroom industries.	K3/K6

MAPPING WITH PROGRAMME OUTCOMES

- **PO Mapping Strategy:** The Mapping reflects the strong alignment of knowledge of mushroom cultivation knowledge (PO1), effectively contribute knowledge of practical application (PO3), and use of modern tools in for (PO5). Environment & Sustainability (PO6) and Ethics & Safety (PO7).
- **Mean Calculation:** Each CO mean is derived by calculating the average correlation score across all 10 POs. The Overall Mean Score of 2.60 indicates a moderate-to-high level of alignment between the course and the programme outcomes.

COURSE OBJECTIVES:

- Introduce the basic principles and methodologies of recombinant DNA technology.
- Explain the types and applications of cloning vectors.
- Develop knowledge of gene cloning, PCR, DNA libraries and screening techniques.
- Understand recombinant DNA analysis, gene sequencing and gene modification.
- Explain the applications of recombinant DNA technology in plants, animals and biotechnology industries.

UNIT – I: Fundamentals of Forensic Biotechnology

Introduction, history, and scope of forensic biotechnology, Role of biotechnology in forensic science, Crime scene investigation and chain of custody, Forensic laboratories and ethical aspects

UNIT – II: Biological Evidence Analysis

Collection and preservation of biological samples: blood, saliva, semen, hair, and tissue analysis. Forensic serology and immunological techniques, blood grouping, and body fluid identification

UNIT – III: Molecular Techniques in Forensics

DNA structure and genetic markers, DNA extraction and quantification, PCR and electrophoresis techniques, RFLP, STR, SNP, and mitochondrial DNA analysis

UNIT – IV: DNA Profiling and Applications

DNA fingerprinting and profiling methods, Paternity and kinship analysis, Missing person identification and disaster victim identification, Forensic databases and DNA evidence interpretation

UNIT – V: Emerging Trends in Forensic Biotechnology

Wildlife and microbial forensics, Forensic bioinformatics, Next Generation Sequencing (NGS) in forensics, AI applications in forensic investigations, Case studies in forensic biotechnology.

UNIT – VI: Current Contours (Self-Directed Learning Activities – Continuous Internal Assessment Only)

Students are required to undertake self-directed learning activities on recent advancements in forensic biotechnology. Students shall prepare reports covering emerging technologies such as rapid DNA analysis, forensic genomics, Next Generation Sequencing (NGS), forensic bioinformatics, mitochondrial DNA analysis, epigenetic markers, forensic microbiome analysis, environmental DNA (eDNA) applications, and Artificial Intelligence (AI)-based forensic investigations.

Text Books

1. Forensic Science: Fundamentals and Investigations – Anthony J. Bertino & Patricia Nolan Bertino, Cengage Learning, 2016.
2. Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers – John M. Butler, Academic Press (Elsevier), 2005.
3. Forensic Biology – Richard Li, CRC Press, 2015.
4. An Introduction to Forensic Genetics – William Goodwin, Adrian Linacre & Sibte Hadi, Wiley-Blackwell, 2011.

Reference Books

1. Criminalistics: An Introduction to Forensic Science – Richard Saferstein, Pearson Education, 2018.
2. Forensic DNA Evidence Interpretation – John S. Buckleton, Christopher M. Triggs & Simon J. Walsh, CRC Press, 2005.
3. Forensic Science: The Basics – Jay A. Siegel & Kathy Mirakovits, CRC Press, 2020.
4. Molecular Biology of the Cell – Bruce Alberts et al., Garland Science, 2022.
5. Principles of Gene Manipulation and Genomics – Sandy B. Primrose & Richard Twyman, Wiley-Blackwell, 2006.
- 6.

S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Explain the principles, history, scope, and applications of forensic biotechnology in scientific investigations.	K2
CO2	Apply methods for the collection, preservation, and analysis of biological evidence used in forensic investigations.	K3
CO3	Analyse molecular techniques, including PCR, electrophoresis, and genetic marker analysis, used in forensic identification.	K3

C04	Evaluate DNA profiling methods and their applications in criminal investigations, paternity analysis, and human identification.	K4
C05	Examine ethical, legal, and regulatory aspects associated with forensic biotechnology practices.	K5
C06	Assess emerging trends in forensic biotechnology, including forensic genomics, NGS, forensic bioinformatics, AI-based forensic analysis, and advanced molecular approaches, through a critical review of current developments. (Current Contours – Continuous Assessment Only)	K5

PO Mapping Strategy:

The course demonstrates strong alignment with **Disciplinary Knowledge (PO1), Problem Analysis (PO2), Problem Solving (PO3), Research Aptitude (PO4), Modern Tools and Techniques (PO5), Ethics and Professionalism (PO6), Communication Skills (PO8), and Lifelong Learning (PO10).**

Mean Calculation:

The Overall Mean Score of 2.30 indicates a **moderate-to-high level of alignment** between the Course Outcomes and Programme Outcomes, demonstrating the course's contribution to developing competency in forensic analysis, DNA-based identification, evidence interpretation, and application of biotechnology in legal and societal contexts.

COURSE OBJECTIVES:

The main objectives of this course are to:

- Introduce the concepts of gene and genomics for gene cloning vectors and current cloning methods.
- Familiarize with the tools used for gene manipulation towards selection strategies and screening of transformants.
- Impart the knowledge about applications of cloning and its current development.

UNIT – I: Introduction to rDNA Technology:

Introduction to genetic engineering and recombinant DNA technology. Methodologies involved in rDNA technology. Isolation and analysis of genes. Enzymes involved in rDNA technology - Restriction endonucleases, exonuclease, DNA modifying enzymes - Polymerase, Transferase, Kinase and Ligase.

UNIT – II: Different Types of Vectors:

Plasmids, Phage vectors, Cosmids, Phagemids, Virus vectors, Shuttle vectors and expression vectors- YAC, BAC- *S. cerevisiae* system as a model.

UNIT – III: Cloning Strategies:

Methods of transformation. Construction of genomic libraries and cDNA Libraries. Probe construction and screening and Gateway Cloning. DNA amplification using polymerase chain reaction (PCR): key concepts, Analysis of amplified products. Applications of PCR: Ligase chain reaction. RFLP, RAPD and DNA Finger printing. Principles of Southern, Northern and Western blotting techniques. Real-Time qPCR.

UNIT – IV: Screening of rDNA Products and Gene Sequencing:

Analysis of recombinant DNA - Selection methods – antibiotics, expression basis, GUS expression. Sequencing - chemical degradation; chain termination and automated sequence. Altered expression and engineering genes. Site-directed mutagenesis.

UNIT – V: Application of rDNA Technology:

Transgenic plants- virus and pest resistance, herbicide tolerance and stress tolerance (cold, heat and salt); cytoplasmic male sterility; delay of fruit ripening; resistance to fungi and bacteria. Biopharmaceuticals and secondary metabolite production. Transgenic animals – Pharmaceutical products - insulin. Farm animal production.

UNIT – VI: CURREN CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th Ed.). New York: Garland Science.
2. Stanley Maloy.,(1994). *Microbial genetics*. (2nd Edition). Jones and Bartlett publisher.
3. Uldis N. Streips and Ronalad E. Yasbin. (2002). *Modern Microbial Genetics*. (2nd Edition). Wiley-Blackwell.
4. Sandy B., Primrose, Richard M., Twyman, Robert W. Old. (2008). *Principles of Gene Manipulation*. 6th Edition. Blackwell Science.
5. Brown TA.,(2008). *Genomes*. (3rd Edition). New York: Garland Publishing Co. New York: Garland Science.
6. Old, R.W., and Primrose S.B.(1996). *Principles of Gene Manipulation: An Introduction to Genetic Engineering*. (2nd Edition). Blackwell Scientific Publications, Oxford.
7. Glover, DM. and BD. Hames. (1995). *DNA Cloning: A Practical Approach*. (2nd Edition). IRL Press, Oxford.
8. Innis, M.A., D.H. Gelfand and J.J. Sninsky. (1995). *PCR Strategies*. Academic Press, San Diego.
9. Persing, D.H., K T.F Smith, F.C. Teower and T. J. While. (1993). *Diagnostic Molecular Microbiology*. (2nd Edition). ASM Press, Washington D.C.
10. Watson J.D., Gilman M., Witkowski, J. and Zoller M. (1992). *Recombinant DNA*. (2nd Edition). Scientific American Books, New York.
11. Daniel L.Hartl. (2011). *Analysis of Genes and Genomes*. 8th edition. Maryellen Ruvolo. Laxmi Publications.
12. Keya Chaudhuri. (2012). *Recombinant DNA Technology*. The Energy and Resources Institute, TERI.
13. J.F. Sambrook and D.W. Russell. (2011). *Molecular Cloning: A*

Laboratory Manual. (3rd Edition) Volume 1, 2 and 3. Cold Spring Harbor Laboratory Press.

14. Tvan R.S. (1997). Recombinant Gene Expression Protocols. Humana Press Inc., Tokowa.

15. <http://epgp.inflibnet.ac.in/>

16. <https://nptel.ac.in/courses/102/103/102103013/>

17. <https://www.ncbi.nlm.nih.gov/books/NBK21498/>

18. <https://www.genome.gov/genetics-glossary/Electrophoresis>

19. <https://genome.crg.cat/courses/laCaixa05/Genomes/index.html>

20. https://onlinecourses.swayam2.ac.in/cec20_bt07

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

CO	Course Outcome	Knowledge Level
CO1	Explain the basic principles of recombinant DNA technology and the functions of enzymes used in gene cloning.	K2
CO2	Describe different types of cloning and expression vectors and their applications.	K2
CO3	Apply basic concepts of gene cloning, PCR, DNA libraries, blotting and DNA fingerprinting.	K3
CO4	Explain methods for screening recombinant DNA, gene sequencing and site-directed mutagenesis.	K2
CO5	Describe the applications of recombinant DNA technology in transgenic plants, animals and biopharmaceutical production.	K2

PO Mapping Strategy:

The course demonstrates strong alignment with **Disciplinary Knowledge (PO1), Problem Analysis (PO2), Problem Solving (PO3), Research Aptitude (PO4), Modern Tools and Techniques (PO5), Ethics and Professionalism (PO6), Environment and Sustainability (PO7), Health Awareness (PO8), Entrepreneurial Skills (PO9), and Lifelong Learning (PO10).**

Mean Calculation:

The **Overall Mean Score of 2.30** indicates a **moderate-to-high level of alignment** between the Course Outcomes and Programme Outcomes, demonstrating the course's contribution to developing competency in **recombinant DNA technology, gene cloning, molecular analysis, gene sequencing, genetic engineering, and biotechnological applications in plants, animals, healthcare, and industry.**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Develop practical skills in the isolation and purification of genomic and plasmid DNA.
- Understand restriction digestion and ligation techniques used in recombinant DNA technology.
- Learn the preparation of competent *E. coli* cells and basic transformation procedures.
- Develop practical knowledge of selection and screening of recombinant DNA products.
- Demonstrate molecular techniques such as PCR, Southern blotting, RAPD and RFLP.

EXPERIMENTS:

1. Isolation of genomic DNA from plant, animal cells & bacterial cells
2. Isolation of plasmid DNA
3. Restriction digestion – single & double digestion.
4. Ligation.
5. Preparation of competent *E. coli* cells
6. Selection & screening of rDNA products – Antibiotic resistance, Blue white colony.
7. PCR amplification
8. Southern blotting (Demo)
9. RAPD (Demo)
10. RFLP (Demo)

REFERENCES:

1. J. Sambrook and D.W. Russel. 2001. Molecular Cloning: A Laboratory Manual, Vols 1-3. CSHL.
2. T.A. Springer. 1985. Hybridoma Technology in the Biosciences and Medicine.
3. Plenum Press New York.
4. Judith W. Zyskind and Sanford I. Bernstein. 1989. Recombinant DNA Laboratory Manual. Academic press.
5. Ashish S. Verma., Surajit Das., Anchal Singh., (2014). Laboratory Manual in Biotechnology Students Laboratory Manual in Biotechnology Students Chand Publisher.
6. Chawla (2004). Plant Biotechnology. Oxford & IBH Publishing

Company Pvt. Limited.

7. <https://www.slideshare.net/AsmaAshraf7/dna-isolation-73144905>

8. [http://www2.southeastern.edu/Academics/Faculty/jtemple/486/experiment% 202.pdf](http://www2.southeastern.edu/Academics/Faculty/jtemple/486/experiment%202.pdf)

COURSE OUTCOMES:

CO	Course Outcome	Knowledge Level
CO1	Perform isolation of genomic DNA from plant, animal and bacterial cells and plasmid DNA from bacteria.	K3
CO2	Demonstrate restriction digestion and ligation of DNA for recombinant DNA construction.	K3
CO3	Prepare competent E. coli cells and understand selection and screening of recombinant colonies.	K3
CO4	Perform PCR amplification and interpret basic molecular biology results.	K3
CO5	Demonstrate and explain the principles of Southern blotting, RAPD and RFLP techniques.	K3

PO Mapping Strategy:

The course demonstrates strong alignment with **Disciplinary Knowledge (PO1), Problem Analysis (PO2), Problem Solving (PO3), Research Aptitude (PO4), Modern Tools and Techniques (PO5), Ethics and Professionalism (PO6), Communication Skills (PO8), Entrepreneurial Skills (PO9), and Lifelong Learning (PO10).**

Mean Calculation:

The **Overall Mean Score of 2.20** indicates a **moderate-to-high level of alignment** between the Course Outcomes and Programme Outcomes, demonstrating the practical contribution of the course towards developing skills in **DNA isolation, restriction digestion, ligation, recombinant DNA screening, PCR amplification, and molecular analysis techniques such as Southern blotting, RAPD and RFLP.**

COURSE OBJECTIVES

The main objectives of this course are to:

- Introduce the basic concepts and functions of the immune system.
- Understand the major immune cells, tissues and organs.
- Explain innate and adaptive immunity and their role in disease protection.
- Describe the basic structure and functions of antibodies and immune responses.
- Introduce common immunological techniques, vaccines and their applications.

UNIT – I: INTRODUCTION TO IMMUNOLOGY

Introduction and scope of immunology. Basic terms: **antigen, antibody, immunogen and hapten**. Types of immunity: **innate and adaptive immunity**. Primary and secondary lymphoid organs. Cells of the immune system: **B cells, T cells, macrophages, neutrophils and NK cells**. Basic functions of immune cells. Haematopoiesis and lymphocyte development. Primary and Secondary Lymphoid organs.

UNIT – II: INNATE IMMUNITY

Physical and chemical barriers of the body. Skin and mucosal defence. Phagocytosis and phagocytic cells. Inflammation and its basic mechanism. Complement system – basic functions. Natural killer cells. Cytokines and interferons – introduction. Role of innate immunity in protection against infections.

UNIT – III: ADAPTIVE IMMUNITY

Characteristics of adaptive immunity. Antigen recognition - **B-cell and T-cell responses** - Humoral and cell-mediated immunity - T-cell development and functions - B-cell activation and antibody production. Antigen processing and presentation. Major Histocompatibility Complex (**MHC**) – basic concept - Primary, secondary and memory responses.

UNIT – IV: ANTIBODIES AND IMMUNE RESPONSES

Structure of an antibody. Classes of immunoglobulins: **IgG, IgM, IgA, IgE and IgD**. Functions of different antibody classes. Antigen–antibody interactions. Immune response and immunological memory. Basic

concepts of immune tolerance and autoimmunity. Introduction to hypersensitivity and immunodeficiency.

UNIT – V: IMMUNOLOGICAL TECHNIQUES AND VACCINES

Basic principles of antigen–antibody reactions. **Agglutination and precipitation tests**. Introduction to **ELISA**. Immunization and vaccination. Types of vaccines: **live, killed, subunit and recombinant vaccines**. Importance of vaccination in disease prevention. Applications of immunology in **diagnosis, healthcare and biotechnology**.

UNIT – VI: Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

COURSE OUTCOMES

Upon completion of the course, students will be able to:

CO	Course Outcome	Knowledge Level
CO1	Explain the basic concepts, cells, tissues and organs of the immune system.	K2
CO2	Describe the mechanisms of innate immunity and its role in protection against infections.	K2
CO3	Explain the basic mechanisms of B-cell and T-cell mediated adaptive immunity.	K2
CO4	Describe antibody structure, immunoglobulin classes and antigen–antibody interactions.	K2
CO5	Explain basic immunological techniques and the principles and importance of vaccines.	K2

PO Mapping Strategy:

The course demonstrates strong alignment with **Disciplinary Knowledge (PO1), Problem Analysis (PO2), Problem Solving (PO3), Research Aptitude (PO4), Modern Tools and Techniques (PO5), Ethics and Professionalism (PO6), Environment and Sustainability (PO7), Health Awareness (PO8), Entrepreneurial Skills (PO9), and Lifelong Learning (PO10)**.

Mean Calculation:

The **Overall Mean Score of 2.00** indicates a **moderate level of alignment** between the Course Outcomes and Programme Outcomes, demonstrating the course's contribution to developing fundamental knowledge of **immune cells, innate and adaptive immunity, antibodies, antigen–antibody interactions, basic immunological techniques, vaccination and healthcare applications**.

COURSE OBJECTIVES:

- To obtain comprehensive knowledge of food groups, their composition, and their role in a balanced diet.
- To establish a strong foundation in the chemical and nutritional principles of food science.
- To gain insights into plant- and animal-derived foods and their respective nutritive values.
- To analyze various industrial and domestic methods of food processing and cooking.
- To cultivate the characteristics required for a competent biotechnology-based entrepreneur.

UNIT – I: Food Science Principles

Functional food groups: energy-yielding, body-building, and protective foods. Study of the Food Pyramid. Principles of food preparation: boiling, steaming, stewing, frying, baking, roasting, broiling, and pressure cooking. Composition of cereals (rice, wheat) and principles of starch cookery, including gelatinization.

UNIT – II: Pulses and Beverages

Varieties, composition, and nutritive value of pulses and grams. Cooking quality, germination, and its effects on nutrition. Classification and nutritive value of beverages, including an overview of alcoholic beverages.

UNIT – III: Meat, Poultry, and Fish

Structure, composition, and nutritive value of animal-derived foods. Factors influencing aging, tenderness, and selection. Standardized methods of cooking for meat, poultry, and fish.

UNIT – IV: Biotechnology in Functional Foods

Role of biotechnology in the development of functional foods. Overview of prebiotics, probiotics, and synbiotics. Importance of dietary lipids, vitamins, and minerals in promoting human health.

UNIT – V: Food Quality and Additives Principles of food quality control. Classification, usage, and optimum levels of leavening agents. Detailed

study of food additives: preservatives, coloring agents, flavoring agents, emulsifiers, and antioxidants.

UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessment only)

Students are required to document food processing practices, perform a comparative analysis of food additives in common commercial products, and present a report on quality control standards for a selected food group.

Recommended Books, References, and e-Books

1. Food Science, Chemistry, and Experimental Foods, M. Swaminathan, Bappco Publication, 2019.
2. Food Science, Norman N. Potter, CBS Publishers, 2021.
3. Experimental Study of Foods, Griswold R.M., Houghton Mifflin, 2018.
4. Food Science, Srilakshmi B., New Age International, 2022.

Bromatology		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
C01	Outline the historical and functional overview of food science and major food groups.	K3
C02	Comprehend the chemical composition and processing qualities of diverse food materials.	K2
C03	Analyze the functional properties of nutraceutical compounds and their health benefits.	K1
C04	Demonstrate the application of biotechnological processes in modern food development.	K6
C05	Evaluate the standards for food quality control and the safe use of additives.	K5

PO Mapping Strategy: This course aligns strongly with Disciplinary Knowledge (PO1), Problem Solving (PO3), and Entrepreneurial Skills (PO9).

Mean Calculation: The Overall Mean Score of **2.8** indicates a high level of alignment with the programme outcomes.

COURSE OBJECTIVES

- To understand the roles of Indian biotechnology regulatory bodies
- To analyze the lifecycles of biological products and conduct target market surveys
- To master the core pathways of technology transfer
- To evaluate the operational stages of bioprocess scale-up from laboratory to industrial scale
- To navigate the biotechnology startup ecosystem

UNIT – I: INTRODUCTION TO BIOTECH MANAGEMENT

Indian biotech bodies (DBT, CSIR) and support programs • Basic strategic vs. tactical planning • Creating a company mission statement • SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) • Basic growth options: scaling up, partnerships, and joint ventures •

UNIT – II: BIOTECH TECHNOLOGY TRANSFER (14 Hours)

Technology Transfer • Pricing and licensing a biological patent or process • Sourcing standard cell lines and bioprocess methods • Basic components of a tech transfer package • Simple legal agreements used in science business.

UNIT – III: BIOPROCESS OPERATIONS & LOGISTICS (14 Hours)

Steps to scale up – Lab – pilot-industry • Basic production planning and inventory control • Introduction to quality rules - Good Manufacturing Practices – GMP • Cold Chain Logistics.

UNIT – IV: EVALUATING BIOTECH PRODUCTS & MARKETS

Lifecycle of biological products • -"Make vs. buy" choices in research labs • Conducting basic market surveys for diagnostics and medicines -Basic steps in launching a new biotech product.

UNIT – V: BIOTECHNOLOGY START UPS (14 Hours)

Bio-incubators, technology parks, and specialized grant funding mechanisms - BIRAC, BIG, SBIRI, BIPP, MSME.

UNIT – VI: CURRENT CONTOUR (Internal Assessment Only)

Study of real-world biotech companies, local incubators, and startup success stories through simple business journal reviews.

TEXT & REFERENCE BOOKS

1. Taylor F.W., The Principles of Scientific Management, Kessinger Publishing, 2006.
2. Desai V., Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 2011.
3. Shimasaki C., Biotechnology Entrepreneurship: Leading, Managing, and Commercializing Innovative Technologies, Academic Press, 2020.
4. Patel S., Operations and Supply Chain Management in Biotech Industries, Springer, 2016.
5. MIT Open Course Ware (Sloan School of Management): Entrepreneurial Strategy / Management Notes, mit.edu, 2005.

COURSE OUTCOMES (COs)

CO1: Execute strategic and operational plans tailored to biotech lifecycles.

CO2: Deploy the marketing mix to position new bio-products using techno-market surveys.

CO3: Identify core competencies to maximize operational productivity.

CO4: Design commercially viable licensing and technology transfer agreements.

CO5: Build scalable bioprocess scale-up pipelines and secure cold chain logistics.

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy: This course aligns strongly with Disciplinary Knowledge (PO1), Problem Solving (PO3), Environment and Sustainability (PO7), Health Awareness (PO8) and Entrepreneurial Skills (PO9).

Mean Calculation: The Overall Mean Score of 2.11 indicates a high level of alignment with the programme outcomes.

Overall Mean Score: 2.11

COURSE OBJECTIVES

The course is designed to enable students to:

- Understand the growth and characteristics of industrially important microorganisms.
- Learn the basic principles and types of fermentation and fermenters.
- Understand upstream and downstream processing of fermentation products.
- Learn the basic methods used for recovery and purification of microbial products.
- Understand the applications of microorganisms in food production and fermentation.

UNIT – I: INDUSTRIAL MICROORGANISMS

Isolation, screening and maintenance of industrially important microorganisms – microbial growth and death – growth kinetics – strain improvement for better production and desirable properties.

UNIT – II: FERMENTATION PROCESS

Basic concepts of fermentation – types of fermentation: solid-state and submerged fermentation – batch, fed-batch and continuous fermentation – fermentation media – basic fermenter design – stirred tank, bubble column and airlift fermenters – basic fermentation economics.

UNIT – III: UPSTREAM PROCESSING

Media preparation and formulation – sterilization – aeration and agitation – monitoring and control of pH, temperature and dissolved oxygen – basic scale-up and scale-down of fermentation processes.

UNIT – IV: DOWNSTREAM PROCESSING

Recovery and separation of microbial products – filtration and centrifugation – cell disruption – precipitation – solvent extraction – chromatography – ultrafiltration – crystallization and drying – storage and packaging – treatment and disposal of fermentation waste.

UNIT – V: MICROBIAL APPLICATIONS AND GENERAL PRODUCTION

Production of fermented foods and beverages – production of ethanol – general applications of microorganisms in the production of enzymes,

organic acids, vitamins, antibiotics, biofuels and other industrially important products.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only)

Recent developments in industrial fermentation, microbial cell factories, precision fermentation, sustainable bioprocessing, food biotechnology and microbial production of value-added products, through expert lectures, seminars and webinars.

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Develop the skills to understand the theory and practice of bio analytical techniques.
- Describe the working principle, techniques and applications of bioinstrumentation.
- Gain knowledge and apply the concept of electrophoretic techniques, their procedure, principle and applications.
- Describe the concepts of chromatography and concept of partition coefficient and perform various chromatographic techniques.
- Understand the various approaches employed in spectroscopic characterization.

PO Mapping Strategy: The course demonstrates strong alignment with **Disciplinary Knowledge (PO2), Critical Thinking (PO3), Analytical Reasoning (PO4), Scientific Reasoning (PO5), Reflective Thinking (PO7), Problem Solving (PO8), Research-related Skills (PO9), and Lifelong Learning (PO10).**

Mean Calculation:

Each PO mean is derived by calculating the average correlation score across all **6 Course Outcomes (COs)**. The **Overall Mean Score of 2.28** indicates a **moderate-to-high level of alignment** between the **Biochemical Techniques course** and the **B.Sc. Programme Outcomes**.

COURSE OBJECTIVES:

The course is designed to enable students to:

- Understand the basic concepts of plant biotechnology and plant cell culture.
- Learn important techniques used for in vitro propagation and conservation of plants.
- Understand the principles and applications of plant genetic transformation.
- Gain knowledge of molecular tools used in plant improvement.
- Explore the applications of biotechnology in agriculture and crop improvement.

UNIT – I: INTRODUCTION TO PLANT BIOTECHNOLOGY

Introduction, scope and importance of plant biotechnology – basic structure and organization of plant cells – plant growth and development – plant growth regulators: **auxins, cytokinins, gibberellins and ethylene** – their functions and applications. Introduction to plant metabolism – photosynthesis and nitrogen fixation – importance of plant biotechnology in agriculture and crop improvement.

UNIT – II: PLANT TISSUE CULTURE

Principles and importance of plant tissue culture – **totipotency and differentiation** – organization of a plant tissue culture laboratory – culture media and plant growth regulators – sterilization and aseptic techniques. Types of cultures – **callus, suspension, embryo and organ culture** – micropropagation and its applications.

UNIT – III: PLANT PROPAGATION AND CONSERVATION

In vitro regeneration of plants – **organogenesis and somatic embryogenesis** – production of disease-free plants. Haploid plant production and its importance. Plant germplasm conservation – **in vitro conservation and cryopreservation** – importance of conservation of plant genetic resources.

UNIT – IV: PLANT GENETIC ENGINEERING

Basic concepts of plant genetic engineering – introduction to transgenic plants. Methods of gene transfer – **Agrobacterium-mediated transformation and direct gene transfer methods**. Selection and identification of transformed plants. Applications of transgenic plants for

insect resistance, disease resistance, herbicide tolerance and improved crop quality.

UNIT – V: MOLECULAR TOOLS AND PLANT IMPROVEMENT

Introduction to molecular markers and their importance. Basic concepts of **RAPD, RFLP, AFLP and SSR markers**. DNA fingerprinting and its applications. Marker-assisted selection and its role in plant breeding and crop improvement. Applications of plant biotechnology in the development of improved crops and sustainable agriculture.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only)

Recent developments in **plant tissue culture, transgenic crops, genome editing, molecular markers, plant breeding and sustainable agriculture** through expert lectures, seminars and webinars.

REFERENCES:

1. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi.
2. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - The genetic manipulation of plants. Oxford University press, USA.
3. Gupta, P. K. 1994. Elements of Biotechnology. Rastogi Publications. Meerut.
4. Ignacimuthu , S., 2003. Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Kalyan Kumar De., 1997. Plant Tissue Culture – New Central Book Agency (P) Ltd., Calcutta.
6. Mascarenhas A.F., 1991. Hand book of Plant Tissue Culture. Indian Council of Agricultural Research. New Delhi.
7. Devlin, O.P. 1974. Plant Physiology, Affiliated East West Press Pvt. Ltd.
8. Jain, V.K. 2005. Text Book of Plant Physiology, S. Chand & Company Ltd., New Delhi.
9. Phundan Singh, 2013. Principles of Plant Biotechnology. Kalyani Publishers, India.
10. V. Kumaresan, 2015. Applied Plant Biotechnology. Saras Publication, India.
11. Singh, 2014. Plant Biotechnology, 2nd Revised Edition, Kalyani Publishers, India.
12. Ashwani Kumar, Sudhir K. Sopory. (2013). Recent Advances in Plant Biotechnology and its Applications. L.K. International Pvt. Ltd. New Delhi.
13. B.D. Singh. Plant Biotechnology (2015). Kalyani Publishers.

14. Razdan M.K. Introduction to Plant Tissue Culture. (3rd Edition). Oxford & IBH Publishing Co Pvt. Ltd.
15. Leyser, O. and Day, S. Mechanisms in plant development. John Wiley & Sons. 2009.
16. Howell, S.H. Molecular genetics of plant development. Cambridge University Press. 1998.
17. Taiz, L. and Zeiger, E. Plant Physiology. Sinauer Associates. 2010 5th Eds.
18. Raven, P.H. Evert, R.F. and Eichhorn, S.E. Biology of plants. Macmillan. 2005 8th Eds.
19. https://onlinecourses.swayam2.ac.in/cec19_bt09/preview
20. https://onlinecourses.nptel.ac.in/noc19_bt17/preview
21. <https://youtu.be/LQA2d3t82ho>

COURSE OUTCOMES

On successful completion of the course, the students will be able to:

- **CO1:** Explain the basic concepts of plant biotechnology, plant growth regulators, photosynthesis and nitrogen fixation.
- **CO2:** Describe the principles, techniques and applications of plant tissue culture, including different types of cultures and micropropagation.
- **CO3:** Explain plant regeneration, haploid production, in vitro conservation and cryopreservation of plant genetic resources.
- **CO4:** Describe the basic principles of plant genetic engineering, methods of gene transfer and applications of transgenic plants in crop improvement.
- **CO5:** Explain molecular markers, DNA fingerprinting and marker-assisted selection for plant identification, breeding and crop improvement.

Program Mapping Strategy:

The mapping is based on the B.Sc. Programme Outcomes, with particular relevance to **Disciplinary Knowledge (PO2), Critical Thinking (PO3), Analytical Reasoning (PO4), Scientific Reasoning (PO5), Reflective Thinking (PO7), Problem Solving (PO8), Research-related Skills (PO9), and Lifelong Learning (PO10)**

Mean Score: Each PO mean is derived by calculating the average correlation score across **all 5 Course Outcomes (COs)**. The **Overall Mean Score of 2.10** indicates a **moderate-to-high level of alignment** between the **Plant Biotechnology course** and the **B.Sc. Biotechnology Programme Outcomes**.

Third Year

CORE COURSE 7

Semester V

Code:

**ANIMAL BIOTECHNOLOGY
(Theory)**

Credits: 4

COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand the fundamentals and applications of animal cell culture.
- Gain knowledge of genetic engineering and gene transfer techniques.
- Understand the principles and applications of transgenic animals.
- Learn the basics of cloning, gene therapy and molecular diagnosis.
- To make awareness on ethical, biosafety and commercial aspects of animal biotechnology.

UNIT – I: Cell and Embryo Culture

Fundamentals, facilities and applications of animal cell culture. Culture media and types of cell culture: primary culture, secondary culture and cell lines. Insect and stem cell cultures. Cell viability and cytotoxicity. Cell growth, synchronization, senescence and apoptosis. Organ culture and cryopreservation. Artificial fertilization: IVF, IUF and ICSI. Superovulation, embryo transfer, collection, preservation and culture of embryos.

UNIT – II: Genetic Transformation and Cloning

Genetically Modified Organisms (GMOs). Methods of DNA transfer into animal cells: calcium phosphate co-precipitation, microinjection, electroporation and liposome-mediated transfer. Biological vectors: bacterial and viral vectors. Hybridoma technology. Animal cloning with reference to Dolly. Vaccine production.

UNIT – III: Transgenic Animals

Concept, production and applications of transgenic animals. Production of useful biological products from animal cell cultures: cytokines, plasminogen activators, blood-clotting factors, growth hormones and insulin. Merits and limitations of transgenic animals.

UNIT – IV: DNA Technology, Ethics and Patenting

DNA barcoding and its applications. Ethical issues in animal biotechnology. Transgenic microorganisms and animals.

Biotechnology patents and intellectual property rights. Basic aspects of Indian and U.S. patent systems.

UNIT – V: Gene Therapy and Molecular Diagnosis

Human Genome Project and genome mapping. RFLP and RAPD and their applications. Gene silencing. DNA fingerprinting and forensic applications. Basics of gene therapy. Molecular diagnosis of genetic disorders.

UNIT – VI: Current Contours

(For Continuous Internal Assessment Only)

Recent developments in animal biotechnology through expert lectures, seminars, webinars and other academic activities.

TEXT & REFERENCE BOOKS:

1. Verma, A.S. & Singh, A. (Eds.). (2020). Animal Biotechnology: Models in Discovery and Translation, 2nd Edition. Academic Press, Elsevier.
2. Mondal, S., et al. (Eds.). (2020). Advances in Animal Genomics, 1st Edition. Academic Press, Elsevier.
3. Mathur, S. (2021). Animal Cell and Tissue Culture. Agrobios (India).
4. Lee, B.H. (2021). Advanced Fermentation and Cell Technology, 1st Edition. Wiley.
5. Freshney, R.I. & Capes-Davis, A. (2021). Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 8th Edition. Wiley-Blackwell.
6. Khan, F.A. (Ed.). (2021). Advances in Application of Stem Cells: From Bench to Clinics. Springer.
7. Tian, H. & Chen, X. (Eds.). (2022). Gene Delivery. Springer.
8. Walther, W. (Ed.). (2022). Gene Therapy of Cancer: Methods and Protocols, 3rd Edition. Humana Press, Springer.
9. Khan, F.A. (2023). Animal Biotechnology: Applications and Future Perspectives. Springer.
10. Kolita, B. & Gogoi, P. (2024). Introduction to Animal Biotechnology & Bioinstrumentation: Animal Cell Culture and Genetic Engineering. Mahaveer Publications.

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

CO1: Explain the basic principles and applications of animal cell and embryo culture.

CO2: Describe major genetic transformation, gene transfer and animal cloning techniques.

CO3: Explain the production, applications, advantages and limitations of transgenic animals.

CO4: Apply basic concepts of DNA technology, DNA barcoding, DNA fingerprinting and molecular diagnosis.

CO5: Discuss the principles and applications of gene therapy, genome mapping, biosafety, ethics and patenting in animal biotechnology.

PO Mapping Strategy: The course demonstrates strong alignment with **Disciplinary Knowledge (PO2), Critical Thinking (PO3), Analytical Reasoning (PO4), Scientific Reasoning (PO5), Reflective Thinking (PO7), Problem Solving (PO8), Research-related Skills (PO9), and Lifelong Learning (PO10)**. The Programme Outcomes also include Communication Skill (PO1) and Self-directed Learning (PO6).

Mean Calculation:

Each PO mean is derived by calculating the average correlation score across all **5 Course Outcomes (COs)**. The **Overall Mean Score of 2.26** indicates a **moderate-to-high level of alignment** between the **Animal Biotechnology course** and the **B.Sc. Programme Outcomes**.

Third Year

CORE COURSE 8

Semester V

Code:

**ENVIRONMENTAL BIOTECHNOLOGY
(Theory)**

Credits: 4

COURSE OBJECTIVES:

The course aims to:

- Provide knowledge of ecosystems, ecology and environmental interactions.
- Explain different types of pollution and their impact on living systems.
- Introduce microbial and biotechnological approaches for environmental protection.
- Develop knowledge of bioremediation and sustainable waste management.
- Create awareness of environmental conservation, disaster management and emerging environmental issues.

UNIT – I: ENVIRONMENT, ECOLOGY AND ECOSYSTEMS

Introduction to environment and ecology; branches of ecology; biotic and abiotic factors; interactions among organisms—symbiosis, mutualism, commensalism, parasitism, predation and competition. Ecosystem structure and function; pond ecosystem; food chain, food web, trophic levels, ecological pyramids and energy flow.

UNIT – II: BIOGEOCHEMICAL CYCLES AND ENVIRONMENTAL POLLUTION

Primary and secondary production; nitrogen and phosphorus cycles. Introduction, sources and effects of environmental pollution; air, water and soil pollution; noise, thermal and radioactive pollution. Pesticides and emerging pollutants; greenhouse effect, ozone depletion, global warming, acid rain and bioaccumulation.

UNIT – III: ENVIRONMENTAL MICROBIOLOGY AND WASTE MANAGEMENT

Role of microorganisms in environmental processes; microbial diversity and communities. Microbial classification based on energy and carbon sources. Biological treatment of wastewater; major stages of wastewater treatment and common disinfection methods. Solid waste management, composting, biodegradation and biological control of pollutants.

UNIT – IV: BIOREMEDIATION AND ENVIRONMENTAL BIOTECHNOLOGY

Principles and applications of bioremediation; in situ and ex situ bioremediation; biostimulation and bioaugmentation. Phytoremediation and phycoremediation. Bioremediation of heavy metals, radionuclides, organic pollutants and industrial wastes. Biotechnological approaches for pollution control and mitigation of emerging contaminants.

UNIT – V: ENVIRONMENTAL CONSERVATION, DISASTER MANAGEMENT AND EMERGING ISSUES

Environmental conservation and sustainable development. Environmental hazards and disasters; natural and man-made disasters; risk and vulnerability. Principles and cycle of disaster management; disaster management policies and agencies. Awareness programmes and applications of GIS and remote sensing in disaster management. Recent developments and emerging trends in environmental biotechnology.

TEXT BOOKS

1. **Miller, G.T. & Spoolman, S.E. (2021).** *Environmental Science*. **17th Edition**. Cengage Learning.
2. **Raven, P.H., Hassenzahl, D.M. & Berg, L.R. (2022).** *Environment*. **10th Edition**. Wiley.
3. **Odum, E.P. & Barrett, G.W. (2020).** *Fundamentals of Ecology*. **6th Edition**. Cengage Learning.
4. **Manahan, S.E. (2022).** *Environmental Chemistry*. **11th Edition**. CRC Press.
5. **Pepper, I.L., Gerba, C.P. & Gentry, T.J. (2021).** *Environmental Microbiology*. **4th Edition**. Academic Press, Elsevier.

REFERENCE BOOKS

1. **Maier, R.M., Pepper, I.L. & Gerba, C.P. (2021).** *Environmental Microbiology*. **4th Edition**. Academic Press, Elsevier.
2. **Vallero, D.A. (2020).** *Environmental Biotechnology: A Biosystems Approach*. **2nd Edition**. Academic Press, Elsevier.
3. **Singh, A. & Ward, O.P. (Eds.). (2021).** *Applied Bioremediation and Phytoremediation*. Springer.
4. **Khan, I.A. & Khanum, A. (2021).** *Fundamentals of Environmental Biotechnology*. **Updated Edition**. Ukaaz Publications.
5. **Goel, P.K. (2022).** *Water Pollution: Causes, Effects and Control*. **Revised Edition**. New Age International Publishers.

S.No.	Course Outcome	Knowledge Level
CO1	Explain the basic principles of ecology, ecosystems, and interactions between biotic and abiotic components.	K2 & K3
CO2	Describe biogeochemical cycles and analyze the sources, effects, and impacts of major environmental pollutants.	K2 & K4
CO3	Explain the role of microorganisms in environmental processes, wastewater treatment, and waste management.	K2 & K3
CO4	Apply the principles of environmental biotechnology and bioremediation for the treatment and control of environmental pollutants.	K3 & K4
CO5	Analyze environmental conservation, disaster management, and emerging biotechnological approaches for sustainable environmental protection.	K4 & K5

MAPPING WITH PROGRAMME OUTCOMES (POs)

PO Mapping Strategy: The course strongly aligns with **Disciplinary Knowledge (PO2)**, **Critical Thinking (PO3)**, **Analytical Reasoning (PO4)**, **Scientific Reasoning (PO5)**, and **Problem Solving (PO8)**. The course develops students' understanding of ecological systems, environmental pollution, microbial processes, waste treatment, and bioremediation.

Mean Calculation: The **Overall Mean Score of 2.18** indicates a moderate-to-high level of alignment between the course outcomes and programme outcomes. The strongest alignment is observed with **PO2 – Disciplinary Knowledge** and **PO8 – Problem Solving**, reflecting the course's emphasis on applying biotechnology-based approaches to understand, manage, and solve environmental problems.

Third Year

CORE PRACTICAL 5

Semester V

Code:

**MICROBIAL - PLANT - ANIMAL &
ENVIRONMENTAL - BIOTECHNOLOGY
PRACTICAL
(Practical)**

Credits: 4

COURSE OBJECTIVES:

The main objectives of this course are to:

- Learn the principles of advanced techniques in biotechnology
- Obtain hands-on experience in performing complex and sensitive biological assays.
- Acquire hands on exposure to fermentation techniques
- Study about the antibiotic production by different strains of microorganisms
- Understand the potential of molecular assays to solve biological problems
- Equip the students with skills pertaining to isolation and enumeration of
- industrially important microbes

EXPERIMENTS:

MICROBIAL BIOTECHNOLOGY

1. Isolation of industrially important microorganisms.
2. Ethanol production by yeast.
3. Estimation of alcohol content by colorimetric method and GLC.
4. Wine production by yeast – setting up a lab experiment.
5. Enzyme production – amylase production.
6. Production of organic acids – citric acid production by solid-state fermentation.
7. Immobilization of yeast cells by alginate beads
8. Isolation & identification of microbes from spoiled food.
9. Production of yogurt, butter.

PLANT BIOTECHNOLOGY

1. Introduction to Safety Practices for plant cell culture laboratory (Theory & Demo).
2. Aseptic culture techniques for establishment and maintenance of cultures (Hands on).
3. Tissue culture media preparation: Preparation of stock solutions of Murashige Skoog basal medium and plant growth regulator stocks (Hands on).
4. Protoplast isolation – 1. Mechanical and 2. Enzymatic

5. Isolation of plant genomic DNA (Hands on).
6. Size analysis of DNA by Agarose Electrophoresis (Hands on).

ANIMAL BIOTECHNOLOGY

1. Isolation of DNA from human cheek cells
2. Isolation of DNA from blood
3. Quantification of DNA by spectrophotometric method
4. Animal cell culture - Preparation of media

ENVIRONMENTAL BIOTECHNOLOGY

1. Isolation of Air borne Pathogens
2. Study of Growth Curve and Generation time of Bacteria / Yeast using turbidometry.
3. Water Analysis – MPN and BOD.

REFERENCES:

1. Glazer, A.N and H. Nikaido. 1995. Microbial Biotechnology. W.H. Freeman and Co., New York. Wolf. Cruzar and AnnaliseCruzer. 2000.
2. Biotechnology Text Book of Industrial Microbiology. Panima Publishing House, New Delhi.
3. Patel, A.H. 2019. Industrial Microbiology. Macmillan India Ltd.
4. M. S. Clark. 1997. Plant Molecular Biology: A Laboratory Manual. Springer-Verlag.
5. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology – the genetic manipulation of plants. 2nd Edition. Oxford University press, USA.
6. Harrison, M.S. and Bal, I.R. 1997. General techniques of all culture Cambridge University press.
7. Prasash M. and Arora. C.K. 1998. Plant tissue culture, Ammol publication Pvt. Ltd.
8. Darling D.C. and Morgan S.J. 1994. Animal cells, culture Media. Wiley, NewYork.
9. Razdan, M. K. (1993). An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta. India.
10. Reinert, J and Y. P. S. Bajaj (1995). Plant Tissue and Organ Culture: Applied and fundamental aspects. Narosa publishing House, New Delhi, India.
11. Vasil, I. K. and Thorpe. T. A. (1994). Plant Cell and Tissue Culture. Kluwer
12. Academic Publishers. The Netherlands.
13. <https://archive.nptel.ac.in/courses/102/107/102107075/>

MICROBIAL - PLANT - ANIMAL & ENVIRONMENTAL - BIOTECHNOLOGY PRACTICAL		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Prepare culture medium and transfer cultures without contamination.	K3
CO2	Sterilize instruments, lab wares, culture media and explants.	K3
CO3	Design and prepare various culture media, stock solutions of inorganic salts, growth regulators.	K4
CO4	Identify appropriate explant and learn inoculation techniques into suitable culture media under sterile condition.	K3
CO5	Isolate pure DNA from various sources and utilize it as source material for DNA based experiments	K3
CO6	Establish the technique of estimation of alcohol content.	K3
CO7	Discuss about the yogurt and butter production process	K2
CO8	Understand the immobilization techniques.	K2

MAPPING WITH PROGRAMME OUTCOMES

- **PO Mapping Strategy:** The microbial-plant-animal & environmental biotechnology Practical The course has a high correlation with PO1 (Disciplinary Knowledge), PO2 (Critical Thinking and Problem Solving), PO3 (Practical and Technical Skills), PO4 (Scientific Investigation), PO5 (Modern Tool Usage), and PO6 (Research and Innovation) through laboratory experiments such as microbial isolation, fermentation, enzyme production, DNA isolation, electrophoresis, spectrophotometric DNA quantification, tissue culture, animal cell culture, and environmental analysis.
- **Mean Calculation:** Each CO mean is derived by calculating the average correlation score across all 10 POs. The Overall Mean Score of 2.30 indicates a moderate-to-high level of alignment between the course and the programme outcomes.

COURSE OBJECTIVES:

- To introduce the basic principles of organic gardening.
- To understand soil, seeds, nutrients and natural methods of plant growth.
- To develop practical skills in organic cultivation and garden management.
- To understand the importance of sustainable and eco-friendly gardening.
- To practice sustainable and eco-friendly gardening methods.

UNIT – I: Basics of Organic Gardening

Concept and principles of organic gardening; types of gardens; site selection and garden planning; basic garden tools; soil preparation.

UNIT – II: Soil and Plant Nutrition

Types of soil; soil fertility; compost and vermicompost; organic manures; natural fertilizers; preparation and application of organic nutrients.

UNIT – III: Seeds and Plant Propagation

Selection and storage of seeds; seed treatment; sowing methods; seed germination; nursery preparation; vegetative propagation; transplanting.

UNIT – IV: Organic Crop Management

Water management; mulching; weeding; natural growth-promoting methods; crop rotation; companion planting; seasonal crops and garden maintenance.

UNIT – V: Organic Pest and Disease Management

Common pests and diseases; identification of symptoms; biological control; botanical pesticides; natural pest management; integrated organic pest management.

UNIT – VI: Harvesting and Sustainable Gardening

Harvesting and post-harvest handling; kitchen and terrace gardening; recycling of garden waste; water conservation; sustainable gardening practices; benefits of organic produce.

Text Books

1. Lampkin, N. (2021). Organic Farming. 2nd Edition. Farming Press, UK.
2. Gliessman, S.R. (2022). Agroecology: The Ecology of Sustainable Food Systems. 4th Edition. CRC Press.
3. Willer, H., Schlatter, B., Trávníček, J., Kemper, L. and Lernoud, J. (Eds.) (2021). The World of Organic Agriculture: Statistics and Emerging Trends 2021. Research Institute of Organic Agriculture (FiBL) and IFOAM Organics International.
4. Sullivan, P. (2020). Sustainable Gardening: The Complete Guide to Organic Gardening. 1st Edition. CRC Press.

Reference Books

1. Bavec, F. and Bavec, M. (2021). Organic Production and Use of Alternative Crops. 2nd Edition. CRC Press.
2. Altieri, M.A. and Nicholls, C.I. (2020). Agroecology: A New Approach to Organic Agriculture. 1st Edition. CRC Press.
3. Edwards, C.A., Arancon, N.Q. and Sherman, R. (2021). Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management. 2nd Edition. CRC Press.
4. Palada, M.C., Chang, L.C. and Yang, R.Y. (2022). Vegetable Production and Organic Gardening. 1st Edition. Asian Vegetable Research and Development Center.
5. IFOAM Organics International (2023). Principles of Organic Agriculture and Organic Production Guidelines. IFOAM Organics International.

Course Outcomes

CO1: Explain the basic principles and practices of organic gardening.
CO2: Understand soil fertility and the use of organic manures.
CO3: Apply basic methods of seed selection and plant propagation.
CO4: Demonstrate basic organic crop management practices.
CO5: Identify common pests and diseases and apply natural control methods.

PO Mapping Strategy: The course strongly supports **PO1 (Disciplinary Knowledge)**, **PO2 (Critical Thinking)**, **PO3 (Problem Solving)**, **PO5 (Modern Tool Usage)**, **PO7 (Environment and Sustainability)**, **PO8 (Health Awareness)**, **PO9 (Entrepreneurial Skills)**, and **PO10 (Lifelong Learning)** by providing knowledge of organic gardening, soil fertility, organic nutrients, plant propagation, natural pest management, sustainable cultivation, waste recycling and water conservation.

Mean Calculation: Each CO mean is derived by calculating the average correlation score across all **10 POs** using the correlation scale **3 – Strong, 2 – Moderate, 1 – Low, 0 – No correlation**. The **Overall Mean Score of 2.30** indicates a **moderate-to-high level of alignment** between the course and the programme outcomes.

Code: MEDICAL DIAGNOSTICS AND CLINICAL LAB TECHNOLOGY Credits: 2
(Theory)

COURSE OBJECTIVES

- To understand the **basic concepts of health, disease, clinical laboratories, laboratory safety, ethics, and professional practices.**
- To develop knowledge of **clinical specimen collection, handling, processing, preservation, and storage.**
- To understand the **principles and applications of basic laboratory instruments** used in clinical biochemistry and diagnostic investigations.
- To develop basic skills in **hematological investigations, blood grouping, urine analysis, and routine biochemical tests.**
- To understand the **basic methods of clinical microbiology, staining techniques, serological tests, and diagnostic procedures** used for the detection of common infections.

UNIT - I: Introduction to Clinical Laboratory & Safety, ethics, Concepts of Health:

Overview of disease, prevention, and basic health metrics. Laboratory Infrastructure Introduction to clinical laboratory departments Biochemistry, Microbiology, Pathology.

UNIT - II: Specimen Collection & Processing Sample Collection:

Standard methods for collecting clinical specimens (Blood, Urine, Stool, Sputum, and Cerebrospinal fluid). Anticoagulants & Preservatives: Types of blood collection tubes (vacutainers) and chemical preservatives. Sample Processing: Separation of serum and plasma, chemical preservation, and storage techniques

UNIT - III: Clinical Biochemistry Analysis Basic Instrumentation:

Maintenance and working principles of Centrifuges, pH meters, and colorimeters/spectrophotometers. Urine Analysis. Physical chemical and microscopic examinations. Blood Biochemistry. Standard clinical profiles including Blood Glucose. Blood Urea, Serum Creatinine, Cholesterol profile, and Liver Function Tests

UNIT - IV: Hematology & Blood Banking Blood Composition:

Fundamentals of blood cells and basic anatomy of the circulatory system. Routine Tests: Estimating Hemoglobin (Hb), Total Count (TC), Differential Count (DC) of WBCs, Erythrocyte Sedimentation Rate (ESR), and bleeding/clotting time. Blood Grouping

UNIT - V: Clinical Microbiology & Advanced Diagnostic Bacteriology:

Methods for staining microbes (Gram staining, Acid-Fast staining) and identifying infections. Serology & Immunology: Routine diagnostic tests like Widal (Typhoid), VDRL (Syphilis).

UNIT - VI: CURRENT CONTOURS (For Continuous Internal Assessment Only)

Recent advancements in clinical laboratory science, including automation and artificial intelligence in laboratory diagnostics, point-of-care testing, molecular diagnostic techniques, advanced biomarkers, digital pathology, laboratory information systems, and emerging approaches in clinical microbiology and blood banking, will be discussed through expert lectures, seminars, webinars and research articles.

Text Books

1. Godkar, P.B. and Godkar, D.P. Textbook of Medical Laboratory Technology. 3rd Edition, Bhalani Publishing House, 2014.
2. Mukherjee, K.L. and Ghosh, S. Medical Laboratory Technology. 2nd Edition, Tata McGraw-Hill, 2010.
3. Rajan, R. Medical Laboratory Technology. 1st Edition, Anmol Publications, 2013.
4. Ramnik Sood. Medical Laboratory Technology: Methods and Interpretations. 7th Edition, Jaypee Brothers Medical Publishers, 2015.
5. Bishop, M.L., Fody, E.P. and Schoeff, L.E. Clinical Chemistry: Principles, Techniques, and Correlations. 9th Edition, Wolters Kluwer, 2022.

Reference Books

1. McPherson, R.A. and Pincus, M.R. Henry's Clinical Diagnosis and Management by Laboratory Methods. 24th Edition, Elsevier, 2021.
2. Fischbach, F.T. and Dunning, M.B. A Manual of Laboratory and Diagnostic Tests. 11th Edition, Wolters Kluwer, 2021.
3. Harmening, D.M. Modern Blood Banking and Transfusion Practices. 7th Edition, F.A. Davis, 2019.
4. Rodak, B.F., Keohane, E.M. and Fritsma, G.A. Hematology: Clinical Principles and Applications. 6th Edition, Elsevier, 2020.

5. Cheesbrough, M. District Laboratory Practice in Tropical Countries. 2nd Edition, Cambridge University Press, 2006.
6. Tille, P.M. Bailey & Scott's Diagnostic Microbiology. 15th Edition, Elsevier, 2022.
7. Murray, P.R., Rosenthal, K.S. and Tenover, M.A. Medical Microbiology. 10th Edition, Elsevier, 2023.
8. Turgeon, M.L. Clinical Laboratory Science: The Basics. 3rd Edition, Elsevier, 2020.

S. No.	MEDICAL DIAGNOSTICS AND CLINICAL LAB TECHNOLOGY	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Apply appropriate principles and techniques used in medical diagnosis and clinical laboratory investigations.	K3
CO2	Explain the basic concepts, procedures and significance of various clinical laboratory tests.	K2
CO3	Identify the fundamental components, instruments and terminologies involved in clinical laboratory technology.	K1
CO4	Design and develop appropriate approaches for laboratory diagnosis and interpretation of clinical conditions techniques.	K6
CO5	Evaluate clinical laboratory results and assess their significance in the diagnosis and monitoring of diseases.	K5

MAPPING WITH PROGRAMME OUTCOMES (POs)

PO Mapping Strategy

This course aligns strongly with **PO1 (Disciplinary Knowledge)**, **PO2 (Problem Analysis)**, **PO3 (Problem Solving)**, **PO5 (Modern Tools and Techniques)**, **PO6 (Ethics & Professionalism)**, **PO8 (Health Awareness)**, and **PO10 (Lifelong Learning)** through clinical specimen handling, laboratory investigations, diagnostic techniques, instrumentation, laboratory safety, and interpretation of routine clinical findings.

Overall Mean Score: 2.45, indicating a **moderate-to-high level of alignment** with the selected Programme Outcomes.

COURSE OBJECTIVES:

- To provide fundamental knowledge of genomics, genome analysis, genetic mapping techniques, and DNA databases.
- To enable understanding of nucleotide sequencing methods and modern genome sequencing strategies.
- To develop knowledge on gene analysis techniques including blotting methods, ORF scanning, and transcriptome analysis.
- To introduce the principles and techniques of proteomics, including protein separation, identification, and purification methods.
- To impart knowledge on advanced proteomics applications such as mass spectrometry and its role in protein characterization and sequencing.

UNIT – I: GENOMICS

Introduction of Genomics, Studying the Genome, DNA data bases. Genetic Mapping -Markers for Genetic Mapping; RFLP, SSLP - VNTR's, STR's, SNP's; Physical Mapping - In situ hybridization, Sequence Tagged Sites Mapping.

UNIT – II: NUCLEOTIDES SEQUENCES ANALYSIS

Determination of nucleotide sequence: Chemical degradation method, Sanger's dideoxynucleotide synthetic method. Direct DNA sequencing using PCR, Sequencing by conventional shotgun method, Whole genome shot gun method, Clone contig method.

UNIT – III: BLOTTING TECHNIQUES

ORF scanning – Codon bias, Exon-Intron boundaries - Exon trapping, CpG island. Gene location – Southern and Northern blotting hybridization, Zoo blotting. Studying a transcriptome – Microarray or chip analysis, SAGE.

UNIT – IV: PROTEOMICS

Proteomics - ID-SDS-PAGE, 2D-PAGE. Detection and quantitation of proteins in gels. Protein staining techniques. Affinity purification of proteins.

UNIT – V: PROTEOMICS APPLICATIONS

Basics of Mass Spectroscopy- MALDI-TOF. ESI and their applications in proteomics. Tandem MS/MS spectrometry, De novo sequencing using mass spectrometric data

UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)

Students are to track their develops practical knowledge & sustainability awareness (PO4, PO6) Visit nearby farms or bioinformatics laboratory centers. Submit field observation report. Supports continuous assessment through assignments, reports, and seminars.

Recommended Books, References, and e-Books

1. Principles of Gene Manipulation and Genomics. B. Primrose, R. M. Twyman Blackwell Publishing / Wiley-Blackwell 7th Edition, 2006
2. Introduction to Genomics Arthur M. Lesk Oxford University Press 2nd Edition, 2012
3. Proteomics: From Protein Sequence to Function R. Pennington, M. J. Dunn BIOS Scientific Publishers 1st Edition, 2001
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten ASM Press 4th Edition.

GENOMICS AND PROTEOMICS		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO1	Explain the concepts of genomics, genome analysis, DNA databases, and genetic mapping techniques.	K1
CO2	Apply nucleotide sequencing methods and genome sequencing strategies to analyze DNA sequences.	K3
CO3	Analyze gene structure and expression using blotting techniques, ORF scanning, and transcriptome analysis.	K4
CO4	Analyze mass spectrometry data (MALDI-TOF, ESI, MS/MS) for protein identification and characterization.	K4
CO5	Apply proteomic techniques such as SDS-PAGE, 2D-PAGE, and protein purification for protein analysis.	K3

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy: The mapping reflects the strong alignment of Knowledge of COs emphasize analytical ability, research orientation, and interpretation skills, aligning with PO4 (analysis), PO5 (modern tools), and PO6 (scientific reasoning and societal relevance). Overall, the mapping ensures a balanced integration of knowledge, application, and analytical competencies in genomics and proteomics.

Mean Calculation: Each CO mean is derived by calculating the average correlation score across all 10 POs. The Overall Mean Score of 1.36 indicates a moderate-to-high level of alignment between the course and the programme outcomes.

COURSE OBJECTIVES:

The course is designed to enable students to:

- Understand the basic concepts of biostatistics, data collection, sampling and statistical representation.
- Apply measures of central tendency, dispersion, correlation and regression to biological data.
- Understand the principles of hypothesis testing and commonly used statistical tests such as t-test, chi-square test and ANOVA.
- Develop knowledge of biosafety principles, containment practices and biosafety levels for handling biological materials.
- Understand national and international biosafety guidelines, GMO regulations, risk assessment and risk management.

UNIT – I: Biostatistics - Concepts of statistics-basic principles

Variables - measurements, functions and limitation; Data -types of data, methods of collection of data, merits and demerits- tabulation and representation of data by frequency distribution diagram (Simple/Multiple/Subdivided bar diagram, Pie diagram), Graphs (Histogram, polygon, curve) Stem and leaf diagram; Sampling design – essentials of sampling – census methods - sampling methods – statistical laws – statistical error – test of reliability of sample.

UNIT – II: Measures of central tendency

Mean, median, mode and geometric mean; Measures of dispersion - range, mean deviations, standard deviation, Variance, Skewness, Kurtosis, quartile deviation - merits and demerits; coefficient of variations; Correlation - types and methods of correlation; Regression - simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression.

UNIT – III: Inferential statistics

Hypothesis - definition, types (One tailed, two tailed); Sampling distribution and errors; Statistical Tests of significance -‘t’-test, Chi-square and goodness of fit, ‘F’ test Analysis of variance (ANOVA): One-way & Two-way.

UNIT – IV: Biosafety

Introduction, biosafety issues in biotechnology-historical background; Introduction to Biological Safety Cabinets; Primary Containment for

Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals.

UNIT – V: Biosafety Guidelines

Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only)

Recent developments in biostatistical analysis, statistical software, biosafety practices, risk assessment, GMO regulations, biosecurity and emerging biosafety issues through expert lectures, seminars and webinars.

Text Books

1. Norman T. J. Bailey, 2009. Statistical methods in Biology. University press, Cambridge Rastogi, V.B. 2009. Fundamentals of Biostatistics, Anne Books, India.
2. Sateesh, M.K., 2008. Bioethics and Biosafety, I.K. International Pvt. Ltd, New Delhi, India.
3. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.

Reference Books

1. Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.K. Freeman. San Francisco.
2. Zar, J.H. 2003. Biostatistical Analysis. Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi.
3. <http://www.cbd.int/biosafety/background.shtml>
4. [http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html](http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html)

CO	COURSE OUTCOMES	K-LEVELS
CO1	Apply appropriate statistical methods to analyze and interpret biological data	K1
CO2	Understand the principles of Biostatistics and Biosafety, including data collection, Probability, and Biosafety guidelines.	K2
CO3	Recall the basic concepts, Terminology, and Biosafety levels used in Biological laboratories.	K2
CO4	Design experimental studies and implement suitable biosafety practices for handling biological materials.	K4
CO5	Evaluate statistical results and assess biosafety risks, regulations, and ethical issues in biological research.	K3
K1-Remember; K2 -Understand; K3-Apply; K4-Analyze; K5-Evaluate; K6-Create		

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy: The course demonstrates strong alignment with **Disciplinary Knowledge (PO2), Critical Thinking (PO3), Analytical Reasoning (PO4), Scientific Reasoning (PO5), Self-directed Learning (PO6), Reflective Thinking (PO7), Problem Solving (PO8), Research-related Skills (PO9), and Lifelong Learning (PO10).**

Mean Calculation:

Each PO mean is derived by calculating the average correlation score across all **5 Course Outcomes (COs)**. The **Overall Mean Score of 2.40** indicates a **moderate-to-high level of alignment** between the **Biostatistics and Biosafety course** and the **Programme Outcomes**. The course particularly supports **analytical reasoning, scientific reasoning, problem solving, research-related skills and responsible biosafety practices.**

Third Year

CORE COURSE 11

Semester VI

Code:

**IPR & BIOETHICS
(Theory)**

Credits: 4

COURSE OBJECTIVES:

The main objectives of this course are to:

- Imply the Applications of statistics in biological data
- Different analytical methods for biological data
- Microbial risk management and safety analysis

UNIT – I: Introduction to Intellectual Property Rights (IPR)

Introduction to Intellectual Property Rights (IPR)-trademarks, copyrights, designs, traditional knowledge, and geographical indications. Importance of IPR, patentable and non-patentable inventions, Biotechnology patents, WIPO, and the Indian IPR system.

UNIT – II: Patent Filing Procedures

Introduction to process of patent filing, PCT filing, application procedures, timelines, and costs. Patent licensing, financial support, confidentiality, patent infringement, and related case studies.

UNIT – III: IPR Agreements and Treaties

Major international IPR agreements - GATT, TRIPS, WIPO, Madrid, Hague, Budapest, and PCT. Indian Patent Act, copyright, trade secrets, and IPR enforcement.

UNIT – IV: Bioethics

The principles of bioethics - ethical decision-making in biotechnology. Ethics in medical research, drug testing, informed consent, human cloning, and transgenic organisms.

UNIT – V: Biotechnology and Ethics

Ethical, legal, and social issues of biotechnology, including genetic engineering, cloning, gene therapy, GM crops, bio-piracy, and the Human Genome Project. Benefits and risks of modern biotechnology.

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

Recommended Books, References, and e-Books

1. Bioethics – by Ellen Frankel Paul, Fred D. Miller, Jeffrey Paul, Fred Dycus Miller Cambridge University Press, 2002.
2. Bioethics & Science, John A. Bryant, Linda Baggott la Velle, John F. Searle –2002.
3. Alastair V. Campbell. 2017. Bioethics. 2nd Edition-Routledge
4. M. K. Sateesh. 2020. Bioethics and Biosafety. Dreamtech Press.
5. G.B. Reddy. 2017. Intellectual Property Rights and the Law.12th Edition-Gogia Law Agency.
6. Martin. M.W. and Schinzinger. R. 2003. Ethics in engineering. 3rd Edition, Tata McGraw-Hill, New Delhi.
7. V. K. Ahuja. 2017. Law Relating to Intellectual Property Rights. 3rd Edition-Lexis Nexis.
8. Kankanala, K. C. 2007. Genetic Patent Law & Strategy. 1st Edition. Manupatra Information Solution Pvt. Ltd. Noida, India.
9. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.
10. Ramkrishna B & Anil Kumar H.S. 2017. Fundamentals: Intellectual Property Rights. 1st Edition- National Press.
11. <http://www.cbd.int/biosafety/backgrounds.html>
12. <http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>.

IPR & BIOETHICS		
S.No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
C01	Understand IPR concepts and significance.	K2
C02	Comprehend filing of innovative products for patent.	K2
C03	Know the International and Indian: IPR agreement and various treaties.	K1
C04	Understand Bioethical regulations and guidelines.	K2
C05	Explain the ethical issues of biotechnology products like GMO.	K2

MAPPING WITH PROGRAMME OUTCOMES

- **PO Mapping Strategy:** The course strongly supports PO1 (Disciplinary Knowledge), PO2 (Critical Thinking), PO5 (Modern Tool Usage), PO6 (Research Aptitude), PO8 (Ethics), PO9 (Communication Skills), and PO10 (Lifelong Learning) by providing knowledge of intellectual property rights, bioethics, biotechnology regulations, and basic bioinformatics.
- **Mean Calculation:** Each CO mean is derived by calculating the average correlation score across all 10 POs. The Overall Mean Score of 2.30 indicates a moderate-to-high level of alignment between the course and the programme outcomes.

COURSE OBJECTIVES:

The course aims to:

- Introduce students to the basic principles and scope of pharmacology.
- Explain the fundamental concepts of pharmacokinetics and pharmacodynamics.
- Familiarize students with the major classes, mechanisms and therapeutic applications of drugs.
- Introduce the role of biotechnology in drug discovery, development and production.
- Provide an overview of emerging trends in pharmacology and biotechnology-based therapeutics.

UNIT – I: Fundamentals of Pharmacology

Definition, scope and branches of pharmacology; Sources and classification of drugs; drug nomenclature; routes of administration; dosage forms; factors affecting drug action; adverse drug reactions; tolerance and dependence.

UNIT – II: Pharmacokinetics

Basic concepts of ADME; drug absorption, distribution, metabolism and excretion; bioavailability; plasma protein binding; Phase I and Phase II drug metabolism; drug excretion; half-life and clearance.

UNIT – III: Pharmacodynamics

Drug receptors and drug-receptor interactions; agonists and antagonists; dose-response relationship; potency and efficacy; therapeutic index; basic mechanisms of drug action and signal transduction.

UNIT – IV: Drugs and Therapeutic Applications

Classification, basic mechanisms and therapeutic applications of drugs - nervous, cardiovascular and gastrointestinal systems; analgesics, antipyretics, anti-inflammatory, antimicrobial, antiviral and anticancer drugs.

UNIT – V: Biotechnology in Drug Development

Drug discovery and development; drug targets and screening; recombinant therapeutics; therapeutic proteins; monoclonal antibodies; vaccines; biosimilars; introduction to pharmacogenomics.

UNIT – VI: Emerging Trends in Pharmacology

Novel and targeted drug delivery; nanomedicine; gene and cell therapy; RNA therapeutics; personalized medicine; computational drug discovery; AI in pharmacology; pharmacovigilance.

Text Books

1. Katzung, B.G., Vanderah, T.W. (2021). Basic & Clinical Pharmacology. 15th Edition. McGraw Hill.
2. Ritter, J.M., Flower, R.J., Henderson, G., Loke, Y.K., MacEwan, D. and Rang, H.P. (2023). Rang & Dale's Pharmacology. 10th Edition. Elsevier.
3. Whalen, K. (2021). Lippincott Illustrated Reviews: Pharmacology. 8th Edition. Wolters Kluwer.
4. Brunton, L.L., Hilal-Dandan, R. and Knollmann, B.C. (Eds.) (2023). Goodman & Gilman's The Pharmacological Basis of Therapeutics. 14th Edition. McGraw Hill.

Reference Books

1. Golan, D.E., Armstrong, E.J. and Armstrong, A.W. (2022). Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy. 5th Edition. Wolters Kluwer.
2. Preston, C.L. (Ed.) (2024). Stockley's Drug Interactions. 13th Edition. Pharmaceutical Press.
3. Silverman, R.B. and Holladay, M.W. (2021). The Organic Chemistry of Drug Design and Drug Action. 3rd Edition. Academic Press.
4. Crommelin, D.J.A., Sindelar, R.D. and Meibohm, B. (Eds.) (2024). Pharmaceutical Biotechnology: Fundamentals and Applications. 5th Edition. Springer.
5. Mandal, S.C., Mandal, M. and Das, A.K. (2021). Pharmacology and Pharmacotherapeutics. 2nd Edition. Academic Publishers.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts, terminology and scope of pharmacology.

CO2: Describe the basic principles of drug absorption, distribution, metabolism and excretion.

CO3: Explain drug-receptor interactions, dose-response relationships and basic mechanisms of drug action.

CO4: Identify major classes of drugs and describe their basic mechanisms and therapeutic applications.

CO5: Explain the applications of biotechnology in drug discovery, development and production.

CO6: Recognize emerging biotechnology-based approaches and modern trends in pharmacology.

MAPPING WITH PROGRAMME OUTCOMES

PO Mapping Strategy:

The course strongly supports **PO1 (Disciplinary Knowledge)**, **PO2 (Critical Thinking)**, **PO3 (Problem Solving)**, **PO4 (Research Aptitude)**, **PO5 (Modern Tool Usage)**, **PO7 (Environment and Sustainability)**, **PO8 (Health Awareness)**, and **PO9 (Entrepreneurial Skills)** by providing knowledge of pharmacological principles, drug action, therapeutic applications, drug discovery, biotechnology-based therapeutics, pharmacogenomics, nanomedicine, AI-based drug discovery and pharmacovigilance.

Mean Calculation: Each CO mean is derived by calculating the average correlation score across all **10 POs** using the correlation scale **3 – Strong, 2 – Moderate, 1 – Low, 0 – No correlation**. The **Overall Mean Score of 2.11** indicates a **moderate-to-high level of alignment** between the Pharmacology course and the programme outcomes.

Course Objectives:

- To understand the fundamental concepts and distinction between Quality Assurance (QA) and Quality Control (QC).
- To learn Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), and documentation standards.
- To study analytical assay validation and quality testing parameters for biotechnology products.
- To acquire knowledge of national and international regulatory bodies and biosafety guidelines.
- To understand intellectual property rights, patent procedures, and product dossier filing.

UNIT – I: Introduction to QA, QC and Quality Standards

Definitions and concepts of QA and QC; Differences between QA and QC. Total Quality Management (TQM). Quality Control tools and control charts. Quality system standards: overview of ISO 9001 and ISO 17025. Standard Operating Procedures (SOPs): preparation, review, and control.

UNIT – II: Good Practices (GxP) and Laboratory Documentation

Good Manufacturing Practices (GMP): building layout, personnel hygiene, air handling units (HVAC), water for injection (WFI). Good Laboratory Practices (GLP): principles, equipment calibration, protocol adherence. Documentation: Batch Manufacturing Records (BMR), Batch Release Records (BRR), logbooks, audit trails, and data integrity (ALCOA principles).

UNIT – III: Analytical Quality Control and Assay Validation

Sampling procedures: raw materials, in-process samples, and finished biologicals. Method validation parameters (ICH Q2 guidelines): specificity, linearity, precision, accuracy, LOD, LOQ, and robustness. QC testing of biologicals: sterility testing, endotoxin (LAL) testing, bioburden, and stability testing (ICH guidelines).

UNIT – IV: Biosafety Regulations and Statutory Authorities

Biosafety concepts: recombinant DNA guidelines and risk groups (RG 1-4). Biosafety containment levels (BSL-1 to BSL-4). Regulatory framework in India: Institutional Biosafety Committee (IBSC), Review Committee on

Genetic Manipulation (RCGM), Genetic Engineering Appraisal Committee (GEAC), and CDSCO. Global regulatory agencies: USFDA, EMA, WHO pre-qualification.

UNIT – V: Regulatory Dossier, Clinical Trials, and IPR

Drug development lifecycle: preclinical testing to clinical trials (Phase I to IV). Investigational New Drug (IND) and New Drug Application (NDA) overview. Common Technical Document (CTD) format. Intellectual Property Rights (IPR): patents, trademarks, copyrights, trade secrets; patent criteria and patent filing stages.

UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessment only)

Draft a Standard Operating Procedure (SOP) for an autoclave or laminar airflow bench, perform a sample IBSC proposal review exercise, and prepare a comparative chart of USFDA vs CDSCO regulatory filing steps.

Recommended Books, References, and e-Books

1. Quality Assurance in Biotechnology, G. Sharma, CBS Publishers, 2021.
2. Pharmaceutical Quality Assurance, M.A. Potdar, Nirali Prakashan, 2020.
3. Regulatory Affairs in the Pharmaceutical Industry, Javed Ali, Academic Press, 2022.
4. Biosafety and Bioethics, Rajmohan Joshi, Isha Books, 2019.

Course Outcomes:

QA, QC and Regulatory Affairs in Biotechnology		
Course Outcomes (with Knowledge Level):		
C01	Differentiate QA and QC concepts, ISO standards, and SOP documentation systems.	[K1, K2]
C02	Apply GMP and GLP regulations, audit trails, and BMR record-keeping standards.	[K3]
C03	Explain analytical assay validation criteria and quality testing methods for biologicals	[K2, K4]
C04	Evaluate biosafety guidelines and statutory clearance pathways (RCGM, GEAC, CDSCO).	[K4, K5]
C05	Analyze clinical trial phases, CTD regulatory submissions, and patent filing processes.	[K4]

MAPPING WITH PROGRAMME OUTCOMES (Pos)

PO Mapping Strategy: The course demonstrates strong alignment with **Disciplinary Knowledge (PO1), Problem Solving (PO3), Research Aptitude (PO4), Ethics and Professionalism (PO6), Environmental Sustainability (PO7), and Lifelong Learning (PO10).**

Mean Calculation: The **Overall Mean Score of 1.96** indicates a moderate-to-high level of alignment between the course outcomes and the programme outcomes, reflecting the course's contribution to biodiversity conservation, ecological awareness, and sustainable development.
