DHANALAKSHMI SRINIVASAN

INSTITUTE OF RESEARCH AND TECHNOLOGY

(Deemed to be University under section 3 of UGC Act, 1956.)
PERAMBALUR – 621 212, TAMIL NADU, INDIA.

SCHOOL OF ARTS AND SCIENCE

CURRICULUM AND SYLLABUS

B.Sc., BIOTECHNOLOGY

REGULATION 2026

PROGRAMME:

Vision:

To develop as a prominent center for undergraduate biotechnology education, inspiring enthusiastic young learners, innovative biotechnologists, and responsible scientists who apply biological principles to advance healthcare, agriculture, and ecological harmony through discovery and practical innovation.

Mission:

- To offer inclusive, flexible, and multidisciplinary undergraduate programs in biotechnology that integrate foundational biology, chemistry, genetics, and laboratory practices, building graduates with essential technical, analytical, and critical thinking skills for diverse career paths and lifelong learning.
- To encourage foundational research and creative inquiry in microbial biotechnology, plant and animal sciences, molecular techniques, and applied biology, addressing important challenges in health, food production, and environmental protection.
- To enhance access to quality biotechnology education for rural and underprivileged students by linking modern scientific tools with indigenous biological knowledge and traditional practices, developing relevant skills for entrepreneurial ventures and self-reliant careers.
- • To nurture ethical values, social responsibility, and global awareness through hands-on laboratory training, industry exposure, community projects, and experiential learning that connects classroom concepts with real-world biotechnological applications.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO	PROGRAM EDUCATIONAL OBJECTIVES
PEO1	To provide graduates with a strong foundation in core biotechnology concepts, laboratory techniques, and basic research methods, preparing them for entry-level roles in biotechnology industries, healthcare, agriculture, and higher studies.
PEO2	To develop scientific thinking, experimental skills, and problem-solving abilities so that graduates can understand, investigate, and apply biotechnological principles to address issues in health, agriculture, and environment.
PEO3	To foster professional ethics, effective communication, and teamwork that enable graduates to work collaboratively in scientific settings and contribute responsibly to society.
PEO4	To promote lifelong learning and adaptability, empowering graduates to keep pace with developments in biotechnology and pursue further education, research, or professional opportunities in the field.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	PROGRAM SPECIFIC OUTCOMES
PSO1	Graduates will be competent in performing basic molecular biology techniques, microbial culture methods, genetic engineering fundamentals, and biochemical assays to support applications in healthcare, agriculture, and industrial biotechnology.
PSO2	Graduates will demonstrate proficiency in laboratory safety practices, data collection, analysis, and documentation, enabling them to contribute effectively to research labs, biotech industries, and community development programs.

PROGRAM OUTCOMES (Pos)

PO	PROGRAM OUTCOMES
PO1	**PO1: Disciplinary Knowledge** Demonstrate comprehensive knowledge and understanding of the fundamental concepts, theories, principles, and applications in the chosen discipline and allied fields.
PO2	**PO2: Critical Thinking and Problem Solving** Identify, analyze, and solve complex academic, professional, and societal problems using logical reasoning, analytical skills, and evidence-based approaches.
PO3	**PO3: Research and Inquiry** Apply scientific methods, research techniques, and investigative skills to conduct studies, analyze data, interpret results, and draw meaningful conclusions.
PO4	**PO4: Creativity and Innovation** Develop innovative ideas, creative solutions, and entrepreneurial approaches to address contemporary challenges in academic, professional, and social contexts.
PO5	**PO5: Digital and Technological Competence** Utilize appropriate digital technologies, software tools, and information resources effectively and ethically for learning, research, communication, and problem-solving.
PO6	**PO6: Environment and Sustainability** Understand environmental issues and sustainable development goals and apply this knowledge to promote ecological balance and responsible resource utilization
PO7	**PO7: Ethics and Social Responsibility** Demonstrate ethical values, integrity, inclusiveness, and social responsibility while contributing positively to society and professional environments.
PO8	**PO8: Teamwork and Leadership** Work effectively as an individual and as a member or leader of diverse and multidisciplinary teams, demonstrating leadership, collaboration, and interpersonal skills.
PO9	**PO9: Communication Skills** Communicate effectively through oral, written, visual, and digital means with diverse audiences in academic, professional, and societal settings.
PO10	**PO10: Employability and Entrepreneurship** Develop professional competencies, managerial abilities, and entrepreneurial skills required for employment, higher education, and self-employment opportunities.
PO11	**PO11: Lifelong Learning** Recognize the need for continuous learning, adaptability, and self-development to meet evolving personal, professional, and societal demands in a dynamic global environment.

SEMESTER-I

Semester	Part	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
									CAT	ESE	Total
I	I	AEC	Tamil/Hindi/French-I	TA26C01/ H26C01/ F26C01	3	0	0	3	40	60	100
	II	AEC	English-I	EN26C01	3	0	0	3	40	60	100
	III	Core	Cell Biology	UBT26101	2	1	0	3	40	60	100
		Core	Lab in Cell Biology	UBT26102	0	0	4	2	40	60	100
		Core	Genetics	UBT26103	4	0	0	4	40	60	100
		MDC	MDC-1	-	2	0	2	3	40	60	100
	IV	VAC	Human Values	VAC26001	2	0	0	2	40	60	100
								20			700

SEMESTER-II

Semester	Part	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
									CAT	ESE	Total
II	I	AEC	Tamil/Hindi/French-II	TA26C02/ H26C02/ F26C02	3	0	0	3	40	60	100
	II	AEC	English-II	EN26C02	3	0	0	3	40	60	100
	III	Core	Molecular Biology & Genetic Engineering	UBT26204	2	1	0	3	40	60	100
		Core	Lab in Molecular Biology & Genetic Engineering	UBT26205	0	0	4	2	40	60	100
		Core	Bioanalytical techniques	UBT26206	4	0	0	4	40	60	100
		MDC	MDC-2	-	3	0	0	3	40	60	100
	IV	VAC	Environmental studies and sustainability	VAC26002	2	0	0	2	40	60	100
								20			700

SEMESTER-III

Semester	Part	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
									CAT	ESE	Total
III	I	AEC	Tamil/Hindi/French-III	TA26C03/ H26C03/ F26C03	3	0	0	3	40	60	100
	II	AEC	English-III	EN26C03	3	0	0	3	40	60	100
	III	Core	Immunology	UBT26307	2	1	0	3	40	60	100
		Core	Lab in Immunology	UBT26308	0	0	4	2	40	60	100
		MDC	MDC-3	-	2	0	2	3	40	60	100
		DEC	Plant Physiology	UBT26001	3	1	0	4	40	60	100
			Biofertilizer	UBT26002							
			Marine Biotechnology	UBT26003							
	IV	VAC	IKS	VAC26003	3	0	0	3	40	60	100
								21			700

SEMESTER-IV

Semester	Part	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
									CAT	ESE	Total
IV	I	AEC	Tamil/Hindi/French-IV	TA26C04/ H26C04/ F26C04	3	0	0	3	40	60	100
	II	AEC	English-IV	EN26C04	3	0	0	3	40	60	100
	III	Core	Plant and Animal Biotechnology	UBT26409	2	1	0	3	40	60	100
		Core	Lab in Plant and Animal Biotechnology	UBT26410	0	0	4	2	40	60	100
		MDC	MDC-4	-	3	0	0	3	40	60	100
		DEC	Microbial Physiology	UBT26004	3	1	0	4	40	60	100
			Bioinformatics	UBT26005							
			Food and Nutrition	UBT26006							

	IV	VAC	Ethics in AI	VAC26004	3	0	0	3	40	60	100
	V	EAA	Extra Academic Activity **(NSS,NCC,YRC…..)**					1*			
						30		21			700

SEMESTER-V

Semester	Part	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
									CAT	ESE	Total
V	III	Core	Enzymology	UBT26511	2	1	0	3	40	60	100
		Core	Lab in Enzymology	UBT26512	0	0	4	2	40	60	100
		Core	Bioprocess & Industrial Biotechnology	UBT26513	4	0	0	4	40	60	100
		DEC	Omics Technology and System Biology	UBT26007	4	0	0	4	40	60	100
			Food Technology	UBT26008							
			Agricultural Biotechnology	UBT26009							
		SEC	Drug designing	UBT26S01	3	1	0	4	40	60	100
			Scientific Communication and technical Writing	UBT26S02	3	1	0	4	40	60	100
		DEC	Biotechnology for Climate change	UBT26010	4	0	0	4	40	60	100
			Vaccine Technology	UBT26011							
			Human Genome Project	UBT26012							
	V	EE	Experiential Elective (Internship)	UBTEE01	*			2	*	*	100
								27			800

SEMESTER-VI

Semester	Part	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
									CAT	ESE	Total
VI	III	Core	Environmental Biotechnology	UBT26614	3	0	0	3	40	60	100
		Core	Lab in Environmental Biotechnology	UBT26615	0	0	4	2	40	60	100
		Core	Project	UBT26616	0	0	12	6	40	60	100
		DEC	Forensic Biotechnology	UBT26013	3	0	0	3	40	60	100

			Biosafety and Bioethics	UBT26014							
			Water Resource Management	UBT26015							
		SEC	Advanced molecular techniques and Diagnosis	UBT26S03	3	1	0	4	40	60	100
			Clinical Trial and Data Management	UBT26S04	3	1	0	4	40	60	100
	III	DEC	Food Safety and Quality control	UBT26016	4	0	0	4	40	60	100
			Animal Physiology	UBT26017							
			Computational Biology	UBT26018							
	V	VAC	Gender Studies	VAC26005	2	0	0	2	40	60	100
								28			800

Semester-wise Categorization of Courses

COURSE CATEGORY	Semester						No of Courses	Total Credits
	I	II	III	IV	V	VI		
Ability Enhancement Course	2	2	2	2	-	-	8	24
Core Courses (Theory & Practicals)	3	3	2	2	3	3	16	49
MDC–Multi Disciplinary Course	1	1	1	1	-	-	4	12
DEC–Disciplinary Elective Course	-	-	1	1	2	2	6	22
SEC–Skill Enhancement Course	-	-	-	-	2	2	4	16
VAC-Mandatory Course	1	1	1	1	-	1	5	12
EE–Experiential Elective	-	-	-	-	1	-	1	2
EAA–Extra Academic Activity	-	-	-	1	-	-	1	-
Total Courses Per Semester	7	7	7	8	8	8	**45(Courses)**	
Total Credits	20	20	21	21	27	28	**137 (Credits)**	

MDC Offered to other Department

UBT26901 - Basics in Biotechnology

UBT26902- Biotechnology in every day life

UBT26903- Tissue Culture

UBT26904- Biotechnology for Sustainable Development

DEC Offered by the Department

UBT26001 - Plant Physiology

UBT26002 - Biofertilizer

UBT26003 - Marine Biotechnology

UBT26004 - Microbial Physiology

UBT26005 - Bioinformatics

UBT26006 - Food and Nutrition

UBT26007 - Omics Technology and System Biology

UBT26008 - Food Technology

UBT26009 - Agricultural Biotechnology

UBT26010 - Biotechnology for Climate change

UBT26011 - Vaccine Technology

UBT26012 - Human Genome Project

UBT26013 - Forensic Biotechnology

UBT26014 - Biosafety and Bioethics

UBT26015 - Water Resource Management

UBT26016 - Food Safety and Quality control

UBT26017 - Animal Physiology

UBT26018 - Computational Biology

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	UBT26101	Cell Biology	Core	2	1	0	3

Pre-Requisite: Basic understanding of Biology, cell structure, and biomolecules

Co- Requisite: Basic laboratory skills and introductory Biochemistry

Progressive Course: Molecular Biology, Genetics, Biochemistry, Cell & Tissue Culture, Genetic Engineering.

Course Objectives:

1. To understand the basic concepts, diversity, and organization of cells.
2. To learn the structure and functions of cellular organelles.
3. To gain knowledge about cell cycle, mitosis, meiosis, and cellular regulation.
4. To understand cell communication, apoptosis, stem cells, cancer biology, and cell culture applications.
5. To provide a foundation for advanced studies in molecular and cellular biotechnology.

Course Outcomes:

CO1: Recall the basic concepts of cell structure, cell theory, and biomolecules (K1)

CO2: Explain the structure and functions of cell organelles (K2)

CO3: Explain the cell cycle, mitosis, and meiosis (K2)

CO4: Apply the concepts of cell communication and cell culture (K3)

CO5: Apply basic cell biology techniques in biotechnology and research (K3)

Unit-I	Cell as the Basic Unit of Life	9 Hrs.

Discovery and diversity of cells, development of cell theory, structure and organization of prokaryotic and eukaryotic cells, comparative structure of plant and animal cells, membrane architecture with special reference to unit membrane model and fluid mosaic model, and biomacromolecules and bio micromolecules and their primary functions in the cell.

Unit-II	Cell Organelles and Cellular Organization	9 Hrs.

Structure and functions of cell wall, plasma membrane and cytoplasm; nucleus and chromosomes; endoplasmic reticulum, ribosomes and Golgi apparatus; mitochondria and chloroplasts; lysosomes and vacuoles; peroxisomes, glyoxysomes and other microbodies; centrosome and centrioles; cilia and flagella; cytoskeleton and its components.

Unit-III	Cell Cycle and Cell Division	9 Hrs.
Cell cycle and its phases, cell cycle checkpoints, cell division, mitosis and meiosis, significance of mitosis and meiosis, cellular differentiation, regulation of cell cycle and abnormalities associated with cell division		
Unit-IV	**Cell Communication and Cell Death**	**9 Hrs.**
Cell junctions and extracellular matrix, cell adhesion and cell-to-cell communication, signal transduction pathways, G-protein coupled receptors, cell growth and proliferation, apoptosis and necrosis, stem cells and their characteristics, cellular ageing and senescence, overview of cancer cells and their distinguishing features, and basic principles and applications of cell culture.		
Unit-V	**Cell Biology Techniques and Applications**	**9 Hrs.**
Principles and applications of cell culture, types of cell cultures, aseptic (sterile) techniques, preparation and composition of culture media, cell counting methods and viability assays, chromosome organization and karyotyping, basic principles of flow cytometry and fluorescence microscopy, and applications of cell biology in biotechnology, medicine, agriculture, and biomedical research.		

Text Book(s):

1. Devasena, T. (2012). *Cell Biology*. Oxford University Press, New Delhi.
2. Karp, G. (2019). *Cell and Molecular Biology: Concepts and Experiments*, 9th Edition. Wiley, New York.
3. De Robertis, E.D.P. and De Robertis, E.M.F. (2017). *Cell and Molecular Biology*, 8th Edition. Lippincott Williams & Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2019). *The Cell: A Molecular Approach*, 8th Edition. Oxford University Press.
5. Alberts, B., Johnson, A., Lewis, J., et al. (2022). *Essential Cell Biology*, 6th Edition. W.W. Norton & Company.

Reference Book(s):

1. Alberts, B., Johnson, A., Lewis, J., et al. (2022). *Molecular Biology of the Cell*, 7th Edition. W.W. Norton & Company.
2. Lodish, H., Berk, A., Kaiser, C.A., et al. (2021). *Molecular Cell Biology*, 9th Edition. W.H. Freeman.
3. Karp, G. (2019). *Cell and Molecular Biology: Concepts and Experiments*, 9th Edition. Wiley.
4. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. (2016). *The World of the Cell*, 9th Edition. Pearson Education.
5. Pollard, T.D., Earnshaw, W.C. and Lippincott-Schwartz, J. (2017). *Cell Biology*, 3rd Edition. Elsevier.

e Resources:

1. NCBI Bookshelf –https://www.ncbi.nlm.nih.gov/books/
2. NPTEL Online Courses –https://nptel.ac.in
3. OpenStax Biology - https://openstax.org/details/books/biology-2e
4. Nature Education –https://www.nature.com/scitable
5. Khan Academy –https://www.khanacademy.org/science/biology

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course	Hours	Credit
I	UBT26101	Cell Biology	3	3

Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	–	1	–	–	–	1	–	1	3	2	1.54
CO2	3	2	2	1	2	–	1	–	1	–	1	3	2	1.69
CO3	3	3	2	1	2	–	1	1	1	–	1	3	2	1.85
CO4	3	3	3	2	2	1	2	1	2	1	2	3	3	2.15
CO5	3	3	3	2	3	2	2	2	2	1	2	3	3	2.38
Mean	3.00	2.60	2.20	1.20	2.00	0.60	1.20	0.80	1.40	0.40	1.40	3.00	2.40	1.92

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	UBT26102	Lab in Cell Biology	Core	0	0	4	2

Pre-Requisite: Basic knowledge of biology and familiarity with laboratory safety and scientific observation.

Co- Requisite: Concurrent study of Cell Biology.

Progressive Course: Genetics, Molecular Biology, Biochemistry, Microbiology, Immunology, and Genetic Engineering.

Course Objectives:

1. To familiarize students with laboratory safety procedures, good laboratory practices, and maintenance of laboratory equipment.
2. To develop skills in the operation and handling of a compound light microscope for biological observations.
3. To enable students to prepare, stain, and examine various biological specimens using standard laboratory techniques.
4. To study the structure, organization, and division of cells through observations of mitosis, meiosis, and cellular components.
5. To understand fundamental cellular processes, reproduction, embryonic development, and techniques for organelle isolation.

Course Outcomes:

CO1: Demonstrate safe laboratory practices and proficient use of basic laboratory equipment and microscopes. (K3)

CO2: Prepare, stain, and identify different cell types and tissues through microscopic examination. (K3)

CO3: Distinguish the stages of mitosis and meiosis and explain their significance in cell division .(K2)

CO4: Compare plant and animal cells and interpret cellular processes such as plasmolysis and deplasmolysis. (K2)

CO5: Describe reproductive cells, embryonic developmental stages, and the principles of cell fractionation and differential centrifugation. (K2)

LIST OF EXPERIMENTS:

1. Laboratory safety, GLP, GMP and maintenance of laboratory equipment.
2. Observation of stages of mitosis by onion root tip squash technique.
3. Observation of stages of meiosis using grasshopper testis/flower bud squash (Demonstration/Permanent slides).
4. Preparation and staining of human blood smear and identification of blood cells.
5. Preparation and staining of buccal smear and identification of squamous epithelial cells.
6. Isolation and comparative study of plant and animal cells.
7. Study of plasmolysis and deplasmolysis in plant cells.
8. Observation of sperm, ovum and developmental stages of chick embryo (24 h, 48 h, 72 h and 96 h) using permanent slides.
9. Cell fractionation and identification of cell organelles by differential centrifugation (Demonstration).
10. Determination of cell viability by Trypan Blue exclusion method.

Reference Book(s):

1. Karp, G. (2021). *Cell and Molecular Biology: Concepts and Experiments* (9th Edition). Wiley.
2. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular Biology of the Cell* (7th Edition). Garland Science.
3. Freshney, R. I. (2016). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications* (7th Edition). Wiley-Blackwell.
4. Verma, P. S., & Agarwal, V. K. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand Publishing.
5. Chaitanya, K. V. (2013). *Cell and Molecular Biology: A Laboratory Manual*. PHI Learning.

e Resources:

1. American Society for Microbiology (ASM) Protocols https://asm.org
2. Microbiology Societyhttps://microbiologysociety.org
3. NCBI Bookshelf – Practical Microbiology Resources https://www.ncbi.nlm.nih.gov/books/
4. OpenStax Microbiology https://openstax.org/details/books/microbiology
5. JoVE Science Education Database – Microbiology Experiments https://www.jove.com/science-education/microbiology

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course	Hours	Credit
I	UBT26102	Lab in Cell Biology	4	2

Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	2	-	2	2	2	1	1	1	1	3	3	2.14
CO2	3	3	2	2	2	2	1	1	2	1	1	3	3	2.10
CO3	3	3	2	2	1	-	-	-	1	-	2	3	2	1.96
CO4	3	3	3	2	2	1	-	1	2	2	1	3	3	2.15
CO5	3	3	3	2	2	1	1	1	2	1	2	3	3	2.15
Mean	2.83	2.83	2.50	2.0	1.83	1.50	1.18	1.00	1.83	1.5	1.33	3.0	2.83	2.11

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	UBT26103	Genetics	Core	4	0	0	4

Pre-Requisite: Basic knowledge of cell biology, biomolecules and principles of heredity.

Co- Requisite: Cell Biology and Biomolecules.

Progressive Course: Molecular Biology, Genomics, Genetic Engineering

Course Objectives:

1. To provide a comprehensive understanding of the principles of heredity and variation.
2. To explain chromosomal organization and patterns of inheritance.
3. To introduce gene interactions, linkage and recombination mechanisms.
4. To familiarize students with mutations, chromosomal abnormalities and population genetics.
5. To provide a foundation for advanced studies in molecular genetics and genetic engineering.

Course Outcomes:

CO1: Explain the basic principles of heredity and Mendelian inheritance. (K2)

CO2:. Describe chromosome structure, cell division and chromosomal abnormalities. (K2)

CO3: Analyze linkage, recombination and sex-linked inheritance patterns. (K3)

CO4: Understand mutation mechanisms and principles of population genetics. (K2)

CO5: Apply genetic concepts to human disorders and biotechnological applications. (K3)

Unit-I	Introduction to Genetics and Mendelian Principles	12 Hrs.

History and scope of genetics. - Contributions of Mendel. - Mendelian laws of inheritance. -Monohybrid and dihybrid crosses - Test cross and back cross - Incomplete dominance, codominance and multiple alleles- Lethal genes and pleiotropy. Gene interactions and epistasis - Pedigree analysis.

Unit-II	Chromosomes and Organization	12 Hrs.

Introduction to chromosome organization and structure; chromosome morphology- chromonema, chromatids, centromere and telomere; euchromatin and heterochromatin: characteristics and functions; nucleosome model and chromatin organization; karyotype, idiogram and chromosome classification; special types of chromosomes polytene and lampbrush chromosomes; chromosome mapping (genetic and

cytogenetic mapping); chromosomal variations—deletion, duplication, inversion, translocation, aneuploidy and polyploidy.		
Unit-III	**Linkage, Recombination and Sex Determination**	**12 Hrs.**
Linkage and crossing over- Types of linkage - Chromosome mapping and recombination frequency- Interference and coincidence - Sex determination mechanisms in humans, Drosophila and birds- Sex-linked inheritance - Cytoplasmic inheritance- Extra-chromosomal inheritance.		
Unit-IV	**Mutation and Population Genetics**	**12 Hrs.**
Gene mutations and chromosomal mutations- Physical and chemical mutagens-Hardy-Weinberg equilibrium - Gene and genotype frequencies - Factors affecting gene frequencies- Genetic drift, migration and natural selection- Genetic polymorphism.		
Unit-V	**Human Genetics and Applied Genetics**	**12 Hrs.**
Human chromosomes and karyotyping- Blood groups and inheritance- Inborn errors of metabolism- Genetic disorders: Down syndrome, Turner syndrome, Klinefelter syndrome, sickle cell anemia and hemophilia- Genetic counseling- Applications of genetics in medicine, agriculture and biotechnology.		

Text Book(s):

1. Verma, P.S. and Agarwal, V.K. (2022). Genetics. S. Chand Publishing, New Delhi.
2. Gupta, P.K. (2023). Genetics. Rastogi Publications, Meerut.
3. Arora, M.P. and Sandhu, P.S. (2021). Genetics. Himalaya Publishing House, Mumbai.
4. Pierce, B.A. (2023). Genetics: A Conceptual Approach (8th Ed.). W.H. Freeman.
5. Singh, B.D. (2022). Fundamentals of Genetics (4th Ed.). Kalyani Publishers, Ludhiana, India.

Reference Book(s):

1. Snustad, D.P. and Simmons, M.J. (2019). Principles of Genetics, 7th Edition. Wiley India Pvt. Ltd., New Delhi.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A. (2018). Concepts of Genetics, 12th Edition. Pearson India Education Services Pvt. Ltd., Noida.
3. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2016). Principles of Genetics, 8th Edition. Wiley India Pvt. Ltd., New Delhi.
4. Griffiths, A.J.F. et al. (2020). Introduction to Genetic Analysis, 12th Edition. W.H. Freeman and Macmillan Learning.

e Resources:

1. NCBI Bookshelf NCBI Bookshelf – Genetics 101
2. Open Textbook Library – Chromosomes, Genes, and Traits (2024) Chromosomes, Genes, and Traits: An Introduction to Genetics
3. Open Textbook Library – Introduction to Genetics Introduction to Genetics
4. Cell Biology, Genetics and Biochemistry for Pre-Clinical Students Cell Biology, Genetics and Biochemistry for Pre-Clinical Students
5. Genetics, Agriculture and Biotechnology Genetics, Agriculture and Biotechnology

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course	Hours	Credit
I	UBT26!03	Genetics	4	4

Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	-	2	-	2	-	1	3	2	1.81
CO2	3	2	2	2	2	-	2	-	1	-	1	3	2	2.10
CO3	3	3	2	2	2	-	1	1	2	-	1	3	2	1.62
CO4	3	3	3	2	2	2	2	1	1	-	2	3	2	2.00
CO5	3	3	3	2	3	2	2	2	2	1	2	3	3	2.38
Mean	3.00	2.60	2.20	2.0	2.00	0.80	1.80	0.80	1.85	1	1.40	3.00	2.20	2.10

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
1	UBT26901	Basics in Biotechnology	MDC	2	0	2	3

Pre-Requisite: Basic knowledge of Biology and Chemistry

Co-Requisite: Microbiology

Progressive Course: Molecular Biology, Genetic Engineering, Immunology, Industrial Microbiology and Bioinformatics.

Course Objectives:

1. To introduce the basic concepts and applications of biotechnology.
2. To provide knowledge of cells, biomolecules and molecular processes.
3. To familiarize students with plant tissue culture and animal cell culture techniques.
4. To understand the role of microorganisms in industrial and environmental biotechnology.
5. To create awareness about recent developments and ethical issues in biotechnology.

Course Outcomes:

CO1: Explain the basic concepts and scope of biotechnology. (K1)

CO2: Describe cell structure and molecular processes. (K2)

CO3: Understand the principles and applications of plant biotechnology (K2)

CO4: Explain animal cell culture and stem cell technology. (K2)

CO5: Discuss microbial biotechnology and its applications. (K3)

Unit-I	**Introduction to Biotechnology**	**9 Hrs.**

Definition, history and scope of biotechnology. Branches of biotechnology. Applications in agriculture, medicine, industry and environment. Structure and functions of carbohydrates, proteins, lipids and nucleic acids. Enzymes and their importance.

Unit-II	**Cell Biology and Molecular Biology**	**9 Hrs.**

Structure of prokaryotic and eukaryotic cells. Cell organelles and their functions. Cell division – mitosis and meiosis. Structure and functions of DNA and RNA. Central dogma of molecular biology. Introduction to recombinant DNA technology and PCR.

Unit-III	**Plant Biotechnology**	**9 Hrs.**

Introduction to plant biotechnology. Concept of plant tissue culture and totipotency. Culture media and aseptic techniques. Callus culture and micropropagation. Production of disease-free plants. Transgenic plants and their applications

Unit-IV	Animal Biotechnology and Stem Cells	9 Hrs.
Introduction to animal biotechnology. Principles of animal cell culture and culture media. Types of cell cultures. Applications of animal cell culture. Stem cells – types and characteristics. Applications of stem cells in medicine and tissue engineering. Ethical aspects of stem cell research		
Unit-V	**Microbial Biotechnology and Applications**	**9 Hrs.**
Role of microorganisms in biotechnology. Fermentation and bioreactors. Production of antibiotics, enzymes and vaccines. Single Cell Protein (SCP). Environmental biotechnology and bioremediation. Biofertilizers and biopesticides. Biosafety and bioethics.		

Text Book(s):

1. Dubey, R.C. (2022). A Textbook of Biotechnology (6th Ed.). S. Chand Publishing, New Delhi.
2. Purohit, S.S. (2018). Biotechnology: Fundamentals and Applications. Agrobios (India), Jodhpur.
3. Kumaresan, V. (2015). Biotechnology. Saras Publications, Nagercoil.

Reference Book(s):

1. Satyanarayana, U. (2022). Biotechnology. Books and Allied (P) Ltd., Kolkata.
2. Verma, A.S. and Singh, A. (2014). Animal Biotechnology. Academic Press.
3. Bhojwani, S.S. and Razdan, M.K. (2013). Plant Tissue Culture: Theory and Practice. Elsevier.
4. Freshney, R.I. (2021). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell.
5. Lanza, R., Atala, A. and Gearhart, J. (2014). Essentials of Stem Cell Biology. Academic Press.

e Resources:

1. OpenStax Biology 2e –https://openstax.org/details/books/biology-2e
2. Khan Academy –https://www.khanacademy.org/science/biology
3. NPTEL –https://nptel.ac.in/courses/102106081
4. Nature Education (Scitable) –https://www.nature.com/scitable
5. Microbiology Society Educational Resources-https://microbiologysociety.org

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course					Hours		Credit		
I	UBT26901			Basics in Biotechnology					2+2		3		
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	–	2	–	2	1	–	1	–	3	2	1.46
CO2	3	3	2	1	2	2	3	2	–	1	–	3	3	1.92
CO3	3	3	2	2	3	1	2	1	–	1	–	3	3	1.85
CO4	2	3	2	2	2	3	3	3	2	2	1	2	2	2.23
CO5	3	3	3	2	3	2	3	2	1	2	2	3	3	2.46
Mean	2.8	2.8	2.0	1.4	2.4	1.6	2.6	1.8	0.6	1.4	0.6	2.8	2.6	2.00

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	UBT26204	Molecular Biology & Genetic Engineering	Core	2	1	0	3

Pre-Requisite: Basic knowledge of Cell Biology, Biochemistry and Genetics.

Co- Requisite: Molecular Biology and Genetic Engineering Practical.

Progressive Course: Molecular Biotechnology, Genomics, Bioinformatics, Genetic Engineering Laboratory, Industrial Biotechnology and Advanced Molecular Biology.

Course Objectives:

1. To provide a comprehensive understanding of the molecular basis of gene structure, organization and expression.
2. To impart knowledge on DNA replication, transcription, translation and regulation of gene expression in prokaryotes and eukaryotes.
3. To familiarize students with recombinant DNA technology and molecular cloning techniques.
4. To introduce modern molecular biology tools including PCR, DNA sequencing and genome editing technologies.
5. To develop an understanding of the applications of genetic engineering in medicine, agriculture, industry and environmental biotechnology.

Course Outcomes:

CO1: Recall the structure and functions of nucleic acids and explain genome organization in prokaryotes and eukaryotes. (K1)

CO2: Explain the mechanisms of DNA replication, transcription, translation and regulation of gene expression. (K2)

CO3: Explain the principles of recombinant DNA technology and molecular cloning techniques. (K2)

CO4: Apply molecular biology techniques such as PCR, DNA sequencing and gene cloning in biotechnology. (K3)

CO5: Apply the principles of genetic engineering in medicine, agriculture and industry with awareness of biosafety and bioethics. (K3)

Unit-I	**Nucleic Acids and Genome Organization**	**9 Hrs.**

Historical development of molecular biology. DNA as the genetic material (Griffith, Avery-MacLeod-McCarty, Hershey and Chase experiments). Structure and types of DNA and RNA. Genome organization in prokaryotes and eukaryotes. DNA supercoiling.

Unit-II	**DNA Replication and Gene Expression**	**9 Hrs.**

DNA replication in prokaryotes and eukaryotes. Enzymes involved in replication. DNA mutations and repair. Transcription and RNA processing (capping, polyadenylation and splicing). Genetic code and translation.		
Unit-III	**Regulation of Gene Expression**	**9 Hrs.**
Regulation of gene expression in prokaryotes (lac and trp operons). Basic concepts of eukaryotic gene regulation. RNA interference (RNAi). Transposable elements and their significance.		
Unit-IV	**Recombinant DNA Technology**	**9 Hrs.**
Restriction enzymes and DNA ligase. Cloning vectors (plasmids and bacteriophages). Gene cloning. Polymerase Chain Reaction (PCR). DNA sequencing (Sanger method). Transformation and selection of recombinant clones.		
Unit-V	**Genetic Engineering and Applications**	**9 Hrs.**
Principles of genetic engineering. Recombinant proteins and vaccines. Genetically Modified Organisms (GMOs). Gene therapy. CRISPR-Cas9 (basic concepts). DNA fingerprinting. Biosafety and bioethics.		

Text Book(s):

1. Clark, D.P., Pazdernik, N.J. and McGehee, M.R. (2019). *Molecular Biology*, 3rd Edition. Elsevier.
2. Brown, T.A. (2021). *Gene Cloning and DNA Analysis: An Introduction*, 8th Edition. Wiley-Blackwell.
3. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2022). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*, 6th Edition. ASM Press.
4. Weaver, R.F. (2021). *Molecular Biology*, 7th Edition. McGraw-Hill Education.
5. Verma, P.S. and Agarwal, V.K. (2021). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand Publishing.

Reference Book(s):

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2014). *Molecular Biology of the Gene*, 7th Edition. Pearson.
2. Alberts, B. et al. (2022). *Molecular Biology of the Cell*, 7th Edition. Garland Science.
3. Brown, T.A. (2017). *Genomes 4*, 4th Edition. Garland Science.
4. Lewin, B. et al. (2017). *Lewin's Genes XII*. Jones & Bartlett Learning.
5. Primrose, S.B. and Twyman, R.M. (2021). *Principles of Gene Manipulation and Genomics*, 8th Edition. Wiley-Blackwell.

e Resources:

1. NCBI Bookshelf – https://www.ncbi.nlm.nih.gov/books/
2. NCBI Gene Database – https://www.ncbi.nlm.nih.gov/gene
3. Nature Education (Scitable) – https://www.nature.com/scitable
4. EMBL-EBI Training – https://www.ebi.ac.uk/training/
5. NPTEL – https://nptel.ac.in

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course	Hours	Credit
II	UBT26204	Molecular Biology & Genetic Engineering	3	3

Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	-	-	-	-	-	-	-	-	1	3	2	2.2
CO2	3	3	2	-	-	-	-	-	-	-	1	3	2	2.3
CO3	2	3	3	2	2	-	-	-	-	-	-	3	3	2.6
CO4	2	2	3	3	3	-	-	-	-	-	-	3	3	2..7
CO5	2	2	3	2	3	2	2	2	-	-	2	3	3	2.3
Mean	2.4	2.4	2.8	2.3	2.7	2.0	2.0	2.0	-	-	1.3	3.0	2.6	2.42

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	UBT26205	Lab in Molecular Biology & Genetic Engineering	Core	0	0	4	2

Pre-Requisite: Basic knowledge of Cell Biology, Biochemistry and Genetics.

Co- Requisite: Molecular Biology & Genetic Engineering (Theory)

Progressive Course: Advanced Molecular Biology Laboratory, Recombinant DNA Technology, Genomics, Bioinformatics, Molecular Diagnostics and Industrial Biotechnology.

Course Objectives:

1. To develop basic laboratory skills in molecular biology techniques.
2. To train students in isolation and analysis of nucleic acids.
3. To provide hands-on experience in agarose gel electrophoresis and PCR techniques.
4. To familiarize students with recombinant DNA technology through practical exercises and demonstrations.
5. To enable students to interpret experimental results while following laboratory safety and ethical practices.

Course Outcomes:

CO1: Demonstrate good laboratory practices and proper handling of molecular biology equipment and reagents. (K2)

CO2: Perform genomic DNA isolation and assess DNA quality using agarose gel electrophoresis. (K3)

CO3: Prepare and perform basic molecular biology experiments including restriction digestion and PCR setup. (K3)

CO4: Analyze molecular biology experimental results and interpret electrophoretic banding patterns. (K4)

CO5: Apply biosafety and ethical practices during molecular biology laboratory work (K3)

LIST OF EXPERIMENTS:

1. Calibration and proper use of micropipettes; preparation of TE and TAE/TBE buffers.
2. Isolation of genomic DNA from plant tissue.
3. Isolation of plasmid DNA from bacterial culture (Mini-preparation).
4. Qualitative analysis of DNA by agarose gel electrophoresis.
5. Restriction digestion of DNA and analysis of restriction fragments.
6. Polymerase Chain Reaction (PCR) – Preparation of reaction mixture.
7. Analysis of PCR products by agarose gel electrophoresis.
8. Competent cell preparation and bacterial transformation.
9. Selection and screening of recombinant bacterial colonies.
10. Transformation of competent *E. coli* with plasmid DNA.

Reference Book(s):

1. Brown TA. Gene Cloning and DNA Analysis: An Introduction. Wiley-Blackwell.
2. Sambrook J & Russell DW. Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press.
3. Glick BR & Pasternak JJ. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
4. Primrose SB & Twyman RM. Principles of Gene Manipulation and Genomics. Wiley-Blackwell.
5. Green MR & Sambrook J. Molecular Cloning: A Laboratory Manual (4th Edition).

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course					Hours		Credit		
II	UBT26205			Lab in Molecular biology & Genetic Engineering					4		2		
Course Outcomes (COs)	**Programme Outcomes (POs)**										**Programme Specific Outcomes (PSOs)**		**Mean Score of COs**
	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	
CO1	3	2	2	1	3	2	1	3	2	2	2	3	3	2.23
CO2	3	3	3	2	3	1	1	2	2	2	2	3	3	2.31
CO3	3	3	3	3	3	1	1	2	2	2	2	3	3	2.46
CO4	3	3	3	3	2	2	1	2	2	2	3	3	3	2.46
CO5	3	3	3	3	3	3	2	3	2	2	3	3	3	2.77
Mean	3.0	2.8	2.8	2.4	2.8	1.8	1.2	2.4	2.0	2.0	2.4	3.0	3.0	2.45

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	UBT26206	Bioanalytical Techniques	Core	4	0	0	4

Pre-Requisite: Basic knowledge of Cell Biology, Biochemistry, Chemistry, and Microbiology.

Co- Requisite: Bioanalytical Techniques Laboratory

Progressive Course: Molecular Biology, Immunology, Genetic Engineering, Bioinformatics, Bioprocess Technology

Course Objectives:

1. To introduce the principles and applications of commonly used bioanalytical techniques in biological and biomedical sciences.
2. To develop an understanding of chromatographic, electrophoretic, spectroscopic, and microscopic techniques used in biotechnology.
3. To explain the principles and applications of immunological and molecular analytical techniques.
4. To familiarize students with analytical instrumentation, data interpretation, and quality assurance practices.
5. To prepare students to apply bioanalytical techniques in research, diagnostics, pharmaceutical, food, and biotechnology industries.

Course Outcomes:

CO1: Explain the principles, instrumentation, and applications of major bioanalytical techniques. (K2)

CO2: Describe the working principles of spectroscopic, microscopic, chromatographic, and electrophoretic techniques. (K2)

CO3: Interpret analytical data generated using molecular and immunological techniques. (K3)

CO4: Apply appropriate bioanalytical methods for biological research, diagnostics, and industrial applications while adhering to quality standards. (K3)

CO5: Evaluate and select suitable bioanalytical techniques for solving problems in biotechnology, pharmaceutical sciences, and biomedical research. (K3)

Unit-I	Introduction to Bioanalytical Techniques	12 Hrs.

Introduction to bioanalytical techniques; laboratory safety and Good Laboratory Practices (GLP); sampling methods; preparation of biological samples; principles of measurement; calibration and standardization; accuracy, precision, sensitivity, specificity, validation of analytical methods; data recording and interpretation.

Unit-II	Spectroscopic and Microscopic Techniques	12 Hrs.
Principles, instrumentation, and applications of UV-Visible spectrophotometry, fluorescence spectroscopy, infrared (IR) spectroscopy, atomic absorption spectroscopy (AAS); principles and applications of light microscopy, phase-contrast microscopy, fluorescence microscopy, confocal microscopy, scanning electron microscopy (SEM), and transmission electron microscopy (TEM).		
Unit-III	**Separation Techniques**	**12 Hrs.**
Principles and applications of centrifugation; differential and density gradient centrifugation; electrophoresis - agarose gel, SDS-PAGE and native PAGE; chromatography - paper chromatography, thin-layer chromatography (TLC), ion-exchange chromatography, gel filtration chromatography, affinity chromatography, High Performance Liquid Chromatography (HPLC), and Gas Chromatography (GC).		
Unit-IV	**Molecular and Immunological Techniques**	**12 Hrs.**
Polymerase Chain Reaction (PCR) and its applications; Real-Time PCR (qPCR); DNA sequencing (Sanger and Next-Generation Sequencing – overview); blotting techniques (Southern, Northern, and Western blotting); ELISA, immunodiffusion, immunoelectrophoresis, immunofluorescence, flow cytometry, and biosensors.		
Unit-V	**Advanced Bioanalytical Techniques and Applications**	**12 Hrs.**
Mass spectrometry (MALDI-TOF, LC-MS/MS); Nuclear Magnetic Resonance (NMR) spectroscopy (basic principles); X-ray crystallography (overview); analytical techniques in proteomics and metabolomics; laboratory automation; quality control and quality assurance		

Text Book(s):

1. Wilson, K. and Walker, J. (2023). Principles and Techniques of Biochemistry and Molecular Biology (9th Ed.). Cambridge University Press.
2. Skoog, D.A., Holler, F.J. and Crouch, S.R. (2021). Principles of Instrumental Analysis (7th Ed.). Cengage Learning.
3. Boyer, R. (2020). Biochemistry Laboratory: Modern Theory and Techniques (3rd Ed.). Pearson Education.
4. Upadhyay, A., Upadhyay, K. and Nath, N. (2022). Biophysical Chemistry: Principles and Techniques (5th Ed.). Himalaya Publishing House.
5. Plummer, D.T. (2017). An Introduction to Practical Biochemistry (6th Ed.). McGraw-Hill Education.

Reference Book(s):

1. Wilson, K., & Walker, J. (2022). Principles and Techniques of Biochemistry and Molecular Biology (9th ed.). Cambridge University Press.
2. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). Principles of Instrumental Analysis (7th ed.). Cengage Learning.
3. Keith Wilson & John Walker. Practical Biochemistry: Principles and Techniques. Cambridge University Press.
4. Boyer, R. (2019). Biochemistry Laboratory: Modern Theory and Techniques (3rd ed.). Pearson.
5. Upadhyay, A., Upadhyay, K., & Nath, N. (2017). Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House.

E-Resources

1. Virtual Labs (Ministry of Education) – https://www.vlab.co.in
2. SWAYAM – https://swayam.gov.in
3. NPTEL – https://nptel.ac.in
4. EMBL-EBI Training – https://www.ebi.ac.uk/training
5. HHMI BioInteractive – https://www.biointeractive.org

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course	Hours	Credit
II	UBT26206	Bioanalytical Techniques	4	4

Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	2	1	2	1	2	2	1	1	2	3	3	1.92
CO2	3	3	2	2	3	1	2	2	2	1	2	3	3	2.23
CO3	3	3	3	2	3	2	2	2	2	2	2	3	3	2.46
CO4	3	3	3	3	3	2	2	2	2	2	2	3	3	2.62
CO5	3	3	3	3	3	3	2	3	2	2	3	3	3	3.00
Mean	3.00	2.80	2.60	2.20	2.80	1.80	2.00	2.20	1.80	1.60	2.20	3.00	3.00	2.50

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	UBT26902	Biotechnology in everyday life	MDC	3	0	0	3

Pre-Requisite: Basic knowledge of Biology and Chemistry

Co- Requisite: Fundamentals of Cell Biology and General Chemistry.

Progressive Course: Cell Biology, Genetics, Microbiology, Biochemistry, Molecular Biology, and Applied Biotechnology.

Course Objectives:

1. To introduce the basic concepts of biotechnology and its role in daily life.
2. To create awareness of biotechnology applications in health, agriculture, food, and the environment.
3. To familiarize students with emerging biotechnological products and ethical issues.
4. To promote scientific understanding of biotechnology-related societal challenges.
5. To provide insight into recent advances and future trends in biotechnology and their impact on society.

Course Outcomes:

CO1: Explain the basic principles and scope of biotechnology. (K2)

CO2: Identify biotechnology applications in healthcare and food production. (K1)

CO3: Describe the role of biotechnology in agriculture and environmental protection. (K2)

CO4: Discuss ethical, safety, and societal issues related to biotechnology. (K2)

CO5: Evaluate the impact of biotechnology on everyday life. (K3)

Unit-I	**Introduction to Biotechnology**	**9 Hrs.**

Definition and scope of biotechnology – Historical development – Branches of biotechnology – Basic concepts of cells, DNA, genes, and microorganisms – Biotechnology in daily life – Biotechnology industries and careers.

Unit-II	**Biotechnology in Health Care**	**9 Hrs.**

Vaccines and immunization – Antibiotics and medicines – Diagnostic kits – Recombinant insulin and therapeutic proteins – Biotechnology in disease prevention – Personalized medicine (overview).

Unit-III	**Biotechnology in Food and Agriculture**	**9 Hrs.**

Traditional fermented foods – Probiotics and nutraceuticals – Genetically modified crops: concepts and examples – Biofertilizers and biopesticides – Improving crop productivity and food security.

Unit-IV	Environmental Biotechnology	9 Hrs.
Wastewater treatment – Bioremediation – Composting and bioenergy – Role of microorganisms in environmental management – Biotechnology for sustainable development.		
Unit-V	**Biotechnology and Society**	**9 Hrs.**
Ethical issues in biotechnology – Biosafety and regulations – Biotechnology in consumer products – Future trends: gene editing, synthetic biology, and precision agriculture (overview) – Public perception of biotechnology.		

Text Book(s):

1. Gupta, P.K. (2021). *Elements of Biotechnology*, 3rd Edition, Rastogi Publications, Meerut.
2. Dubey, R.C. (2022). *A Textbook of Biotechnology*, 6th Revised Edition, S. Chand & Company Ltd., New Delhi.
3. Satyanarayana, U. (2021). *Biotechnology*, Books and Allied (P) Ltd., Kolkata.
4. Thieman, W.J. and Palladino, M.A. (2020). *Introduction to Biotechnology*, 4th Edition, Pearson Education, New York.
5. Clark, D.P. and Pazdernik, N.J. (2022). *Biotechnology: Applying the Genetic Revolution*, 3rd Edition, Academic Press, London.

Reference Book(s):

1. Primrose, S.B. and Twyman, R.M. (2019). *Principles of Gene Manipulation and Biotechnology*, 8th Edition, Wiley-Blackwell, Oxford.
2. Glick, B.R., Patten, C.L. and Pasternak, J.J. (2021). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*, 6th Edition, ASM Press, Washington, D.C.
3. Brown, T.A. (2020). *Gene Cloning and DNA Analysis: An Introduction*, 8th Edition, Wiley-Blackwell, Oxford.
4. Campbell, N.A., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V. and Orr, R.B. (2021). *Campbell Biology*, 12th Edition, Pearson Education.
5. Smith, J.E. (2018). *Biotechnology*, 5th Edition, Cambridge University Press, Cambridge.

e Resources:

1. National Centre for Biotechnology Information (NCBI) – https://www.ncbi.nlm.nih.gov
2. National Centre for Biotechnology Information (NCBI) – https://www.ncbi.nlm.nih.gov
3. Biotechnology Innovation Organization (BIO) – https://www.bio.org
4. Department of Biotechnology (DBT), Government of India – https://dbtindia.gov.in

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course					Hours				Credit
II	UBT26902			Biotechnology in everyday life					3				3
Course Outcomes (COs)	**Programme Outcomes (POs)**											**Programme Specific Outcomes (PSOs)**		**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	
CO1	3	2	1	–	2	–	2	1	–	1	–	3	2	1.46
CO2	3	3	2	1	2	2	3	2	–	1	–	3	3	1.92
CO3	3	3	2	2	3	1	2	1	–	1	–	3	3	1.85
CO4	2	3	2	2	2	3	3	3	2	2	1	2	2	2.23
CO5	3	3	3	2	3	2	3	2	1	2	2	3	3	2.46
Mean	2.8	2.8	2.0	1.4	2.4	1.6	2.6	1.8	0.6	1.4	0.6	2.8	2.6	2.00