



B.Sc., BIOTECHNOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR

— 2026-2027 —

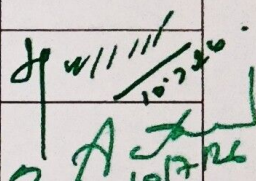
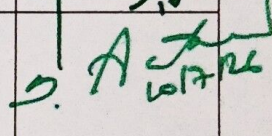
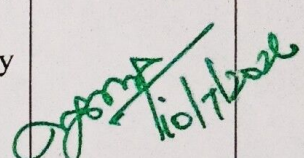
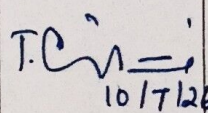
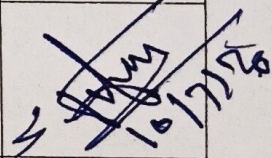
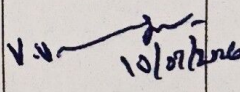
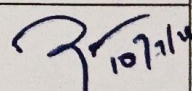
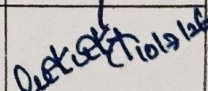
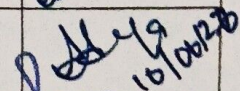
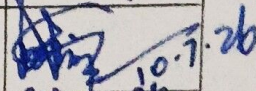
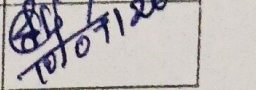


RAJAH SERFOJI GOVERNMENT COLLEGE
(Autonomous)
THANJAVUR - 613005

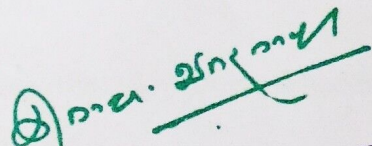
DEPARTMENT OF BIOTECHNOLOGY
RAJAH SERFOJI GOVERNMENT COLLEGE(Autonomous)
THANJAVUR-613005

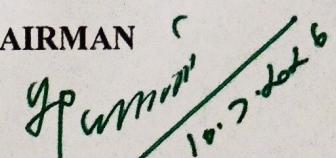
BOARD OF STUDIES MEETING

The Board of Studies (BOS) meeting in Biotechnology was conducted on **Friday (10.07.2026)** at **11.30 am** during the academic year 2026-2027 in the presence of the following board members under the chairmanship of **Dr. M. Sukumaran**.

S. No	Name	Designation	Address	Signature
1	Dr. M. Sukumaran	Chairperson	Head, Department of Biotechnology	
2	Dr. S. Achiraman	University Representative Nominee	Professor Dept of Environmental Biotechnology, Bharathidasan University, Tiruchirappalli - 620 024	
3	Dr. S. Ganesan	Subject Expert	Asst. Professor (SG) and Research Advisor PG & Research Department of Zoology and Biotechnology, A.V.V.M. Sri Pushpam College, Poondi, Thanjavur - 613 503	
4	Ms. T. Akilandeswari	Subject Expert	Head, Department of Biotechnology, AVC College (Autonomous), Mannapandal, Mayiladuthurai-609305	
5	Dr. S. Velavan	Industrialist	Harman Institute of Science Education and Research, AVP Azhagammal Nagar Thanjavur-613 005	
6	Mr. V. Veeramurugan	Meritorious alumnus	Ph.D., Research Scholar, Dept of Environmental Biotechnology, Bharathidasan University, Tiruchirappalli - 620 024	
7	Dr. J. Rajesh Singh	Faculty member	Assistant professor, Dept. of Biotechnology	
8	Dr. K. Girija	Faculty member	Guest Lecturer Dept. of Biotechnology	
9	Dr. A. Sathya	Faculty member	Guest Lecturer Dept. of Biotechnology	
10	Dr. M. Aarthi	Faculty member	Guest Lecturer Dept. of Biotechnology	
11	Dr.J.Christy Catherine	Faculty member	Guest Lecturer Dept. of Biotechnology	

The syllabi for B.Sc., Biotechnology (Major) under CBCS system were discussed and necessary corrections/ modifications were made in the paper and finalized. The finalized syllabi are approved and appended herewith.


CONTROLLER OF EXAMINATIONS
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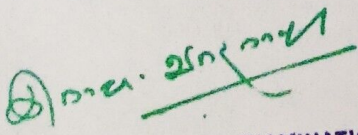
CHAIRMAN

(Dr. M. Sukumaran)
Head, Dept. of Biotechnology
Rajah Serfoji Govt. College (Auto)
Thanjavur - 613005 TamilNadu

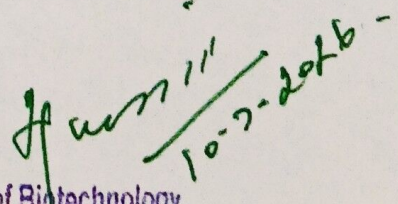
AGENDA OF THE MEETING

The meeting of the Board of Studies: Biotechnology for the Academic Year 2026-2027 was held on 10.07.2026 at 11.30 am at the Department of Biotechnology, Rajah Serfoji Government College (Autonomous), Thanjavur – 613 005.

The following agenda items had been taken up for discussion:

1. Confirmation of minutes of the previous board of studies meeting and review of the action taken report.
2. Revamping and revision of B. Sc Biotechnology syllabus in accordance with the latest curriculum framework.
3. Discussion and approval of the revised curriculum and scheme of examination of B. Sc Biotechnology Programme applicable to students admitted from the academic year 2026-2027 onwards.
4. Revision of course structure, course content and assessment pattern in alignment with NEP 2020, Outcome-Based Education (OBE), and CBCS regulations.
5. Review and approval of course outcomes (COs), Programme Outcomes (POs), Programme Specific Outcomes (PSOs).
6. Introduction of value-added components, multidisciplinary courses, skill enhancement courses, and employability-oriented topics wherever applicable.
7. Inclusion of recent advances in Biotechnology, industry-relevant content, AI and Bioinformatics and sustainability concepts in the curriculum.
8. Revision of practical courses, laboratory exercises and evaluation methods to enhance hands-on learning and research skills.
9. Approval of the question paper pattern, bloom's Taxonomy distribution and Continuous Internal Assessment (CIA) scheme.
10. Preparation and approval of the Panel of Question Paper Setters, Moderators, Practical Examiners, and External Examiners.
11. Discussion on academic collaborations with industries, research institutions and internship opportunities for students.


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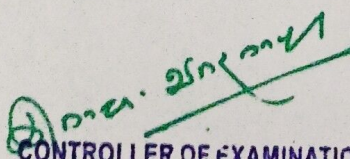

Head. Dept. of Biotechnology
Rajah Serfoji Govt. College (Auto)
Thanjavur - 613005 TamilNadu

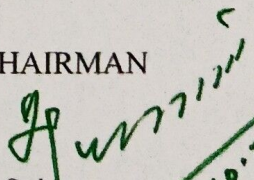
RESOLUTION FOR BOARD OF STUDIES IN BIOTECHNOLOGY

The Board of Studies (BOS) meeting in Biotechnology was conducted in the Department of Biotechnology, Rajah Serfoji Government College (Autonomous), Thanjavur on 10.07.2025 at 11.30 am. The Board members discussed the agenda and unanimously passed the following resolutions:

Discussions were made on Introduction of new paper for first year students related to instrumentation and proposed to interchange Skill Enhancement Course Learning Outcomes.

1. Discipline Specific Major Electives of the particular semesters (5th & 6th semesters of the UG) were unanimously resolved to give ratification for the introduction of the Extra Credit Courses for Advanced Learners, which will be implemented
2. from the present academic year itself.
3. The Board approved the revised syllabi of all theory and practical courses. Necessary modifications were incorporated based on the suggestions of the subject experts.
4. The prescribed textbooks and reference books were reviewed and approved. The board recommended inclusion of recent editions wherever applicable.
5. The board recommended introducing skill-oriented components such as Bioinformatics, Biomolecular concepts and applications, Industrial Training, and Internship to enhance students' practical knowledge and employability.
6. The board suggested encouraging students to undertake internships, industrial visits, mini projects, seminars and certificate courses to strengthen practical exposure.
7. To draft and approve the syllabus of B. Sc., Biotechnology from the academic year 2026-27 onwards.


CONTROLLER OF EXAMINATIONS
RAJAH SERFOJI GOVERNMENT COLLEGE (AUTONOMOUS)
THANJAVUR-613 005.

CHAIRMAN

Dr. M. Sukumaran
Head, Dept. of Biotechnology
Rajah Serfoji Govt. College (Auto)
Thanjavur - 613005 TamilNadu

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEO1: To provide a strong foundation in biotechnology by integrating the principles of biology, molecular biology, microbiology, biochemistry, genomics, recombinant DNA technology, and bioinformatics with their technological applications.

PEO2: To prepare graduates with the knowledge, practical skills, and research aptitude required for higher education, entrepreneurship, research, and employment in healthcare, agriculture, environmental, and biotechnology-based industries.

PEO3: To develop proficiency in the application of modern biotechnological tools and techniques, including molecular biology, recombinant DNA technology, genomics, and bioinformatics, for solving scientific and industrial problems.

PEO4: To equip students with state-of-the-art laboratory skills, analytical abilities, and global competencies that enable them to pursue higher studies, research, and professional careers in biotechnology and allied life science disciplines.

PEO5: To nurture effective communication, leadership, teamwork, professional ethics, and social responsibility, enabling graduates to contribute meaningfully to society and sustainable development.

PROGRAMME OUTCOMES (POS)

PO1: Demonstrate a strong foundation in biotechnology by applying the fundamental concepts of biology, molecular biology, microbiology, biochemistry, genetics, genomics, recombinant DNA technology, and bioinformatics.

PO2: Apply theoretical knowledge and practical skills to understand and solve problems in biotechnology, healthcare, agriculture, environmental science, and industrial biotechnology.

PO3: Design and conduct laboratory experiments, analyse and interpret scientific data, and apply critical thinking and scientific reasoning to address biological problems.

PO4: Develop technical competence in the use of modern laboratory techniques, scientific instruments, and computational tools relevant to biotechnology research and industrial applications.

PO5: Demonstrate professional ethics, effective communication, leadership, teamwork, and lifelong learning skills while addressing societal, environmental, health, and sustainability challenges through biotechnology.

FIRST YEAR

I SEMESTER

Part	Code	Course	Title	Hrs	Marks		Total	Credit
					IA	WE		
I	B1T1	LT	Tamil-I	6	25	75	100	3
II	B1E1	LE	English-I	6	25	75	100	3
III	B1BT1	CC1	Cell Biology	6	25	75	100	5
III	B1BT2P	CC2	Practical I – Cell Biology	3	25	75	100	3
III	B1ABT1	Allied 1	General Microbiology	4	25	75	100	4
III	B2ABT2P	Allied 2	Allied practical – General Microbiology and Bioinstrumentation	3	-	-	-	-
IV	B1VE	VE	Value Education	2	25	75	100	2
			Total	30			600	20

II SEMESTER

I	B2T2	LT	Tamil-II	6	25	75	100	3
II	B2E2	LE	English-II	6	25	75	100	3
III	B2BT3	CC3	Molecular Biology and Genetics	6	25	75	100	5
III	B2BT4P	CC4	Practical II – Molecular Biology and Genetics	3	25	75	100	3
III	B2ABT2P	Allied 2	Allied practical – General Microbiology and Bioinstrumentation	3	25	75	100	4
III	B2ABT3	Allied 3	Bioinstrumentation	4	25	75	100	4
IV	B2ES	ES	Environmental Studies	2	25	75	100	2
			Total	30			700	24

SECOND YEAR

III SEMESTER

I	B3T3	LT	Tamil-III	6	25	75	100	3
II	B3E3	LE	English-III	6	25	75	100	3
III	B3BT5	CC5	Recombinant DNA Technology	5	25	75	100	5
III	B3BT6P	CC6	Practical III – Recombinant DNA Technology	3	25	75	100	3
III	B3ABC1	Allied 4	Allied Biochemistry I	4	25	75	100	4
III	B4ABC2P	Allied 5	Allied Practical – II Biochemistry	3	-	-	-	-
IV	B3BTSE1	SEC1	Vermitechnology	2	25	75	100	2
IV	B3HW	HW	Health and Wellness	1	-	-	-	1
IV		NCC-1	Introduction to NCC (for NCC Students only)	-			100	2
			Total	30			600	21

IV SEMESTER

I	B4T4	LT	Tamil-IV	6	25	75	100	3
II	B4E4	LE	English-IV	6	25	75	100	3
III	B4BT7	CC7	Immunology	6	25	75	100	5
III	B4BT8P	CC8	Practical IV – Immunology	3	25	75	100	3
III	B4ABC2P	Allied 5	Allied Practical – I Biochemistry	3	25	75	100	4
III	B4ABC2	Allied 6	Allied Biochemistry II	4	25	75	100	4
IV	B4BTSE2	SEC2	Mushroom Technology	2	25	75	100	2
		NCC - 2	Specialized Subjects – ARMY (for NCC Students Only)	2			100	1
			Total	30			700	24

THIRD YEAR

V SEMESTER

III	B5BT9	CC9	Plant Biotechnology	5	25	75	100	5
III	B5BT10	CC10	Animal Biotechnology	5	25	75	100	5
III	B5BT11	CC11	Industrial Biotechnology	5	25	75	100	4
III	B5BT12P	CC12	Practical V – Plant, Animal and Industrial Biotechnology	5	25	75	100	4
III	BBTEC	EC1	Will be chosen from the list of Electives	5	25	75	100	4
IV	B5BTNM1	NMEC1	Life Style disease	3	25	75	100	2
IV	B5BTSE3	SEC3	Biopesticide and Biofertilizer	2	25	75	100	2
IV	B5DM	DM	Disaster Management	-	-	-	-	2
IV		Internship	Internship	-	-	-	-	2
			Total	30			700	30

VI SEMESTER

III	B6BT13	CC13	Pharmaceutical Biotechnology	6	25	75	100	5
III	B6BT14	CC14	Environmental Biotechnology	6	25	75	100	5
III	B6BT15P	CC15	Practical VI – Pharmaceutical and Environmental Biotechnology	6	25	75	100	4
III	BBTEC	EC2	Will be chosen from the List of Electives	5	25	75	100	4
IV	B6BTNM2	NMEC2	Social and Preventive Medicine	3	25	75	100	2
IV	B6BTSE4	SEC4	Organic farming	2	25	75	100	2
IV	B6GS	GS	Gender studies	2	25	75	100	2
V		EXT. Activities	Extra-Curricular Activities	-	-	-	-	1
			TOTAL	30			700	25
			GRAND TOTAL				4000	144

		PAPERS	TOTAL CREDIT	PARTWISE CREDIT	MARKS
PART-I	TAMIL	4 X 3	12	12	400
PART-II	ENGLISH	4 X 3	12	12	400
PART-III	CORE	8 X 5 = 40, 3 X 4 =12, 4 X 3 =12	64	96	1500
	ELECTIVES	2 X 4	8		200
	ALLIED	6 X 4	24		600
PART-IV	NON-MAJOR	2 X 2	4	23	200
	ES, VE	2 X 2	4		200
	SKILL BASED	4 X 2	8		400
	GS	1 X 2	2		100
	DM		2		
	INTERNSHIP		2		
	HW		1		
PART-V	EXT. ACTIVITIES		1	1	
	TOTAL PAPERS	40	144	144	4000

LIST OF ELECTIVES

S. No	Sub. Code	Title of the Paper
1.	BBTECA	Genomics and Proteomics
2.	BBTECB	Molecular Diagnostics
3.	BBTECC	Virology
4.	BBTECD	Bioenergetics and Metabolism
5.	BBTECE	Biomolecular Concepts and Applications
6.	BBTECF	Nano Biotechnology
7.	BBTECG	Forensic Biotechnology
8.	BBTECH	Enzymology
9.	BBTECI	Food Technology
10.	BBTECJ	AI and Bioinformatics

LIST OF SKILL ENHANCEMENT COURSES

S. No	Sub. Code	Title of the Paper
1.	B3BTSE1	Vermi Technology
2.	B4BTSE2	Mushroom Technology
3.	B5BTSE3	Biopesticide and Biofertilizer
4.	B6BTSE4	Organic Farming

LIST OF NON-MAJOR ELECTIVES

S. No	Sub. Code	Title of the Paper
1.	B5BTNM1	Life style disease
2.	B6BTNM2	Social and Preventive Medicine

Credits	5	Hours/Week	6	Sub Code	B1BT1	Semester	I
Medium of Instruction: English						Core Course: 1	

CC1 - CELL BIOLOGY

Learning Objectives

1. To understand the basic principles of cell biology and the diversity of cellular organization.
2. To learn the structure and functions of the plasma membrane, membrane transport systems, and cell organelles.
3. To understand chromosome structure, the cell cycle, and its regulation.
4. To acquire knowledge of the mechanisms and importance of mitosis, meiosis, apoptosis, and necrosis.
5. To understand the concepts of cell signalling, receptor function, signal transduction, and cell adhesion.

Unit I: Introduction to Cell Biology

History and scope of Cell Biology, Discovery of cells, Cell theory, Prokaryotic vs. eukaryotic cells, Plant cell vs. animal cell, Cell size, shape, and organization.

Unit II: Cell Membrane and Cell Organelles

Plasma membrane and Fluid Mosaic Model, Membrane transport (diffusion, osmosis, active transport, endocytosis, exocytosis), Cell wall, Cytoskeleton (microtubules, microfilaments, intermediate filaments), Structure and functions of: Endoplasmic reticulum (RER & SER) Golgi apparatus Ribosomes Lysosomes Peroxisomes Vacuoles Mitochondria Chloroplasts Nucleus and nucleolus.

Unit III: Chromosomes and Cell Cycle

Chromosome structure, Chromatin organization, Karyotype, Cell cycle (G₁, S, G₂, M phases), Cell cycle regulation, Cyclins and CDKs, Checkpoints.

Unit IV: Cell Division

Mitosis, Meiosis, Comparison between mitosis and meiosis, Significance of cell division, Apoptosis (programmed cell death), Necrosis (overview).

Unit V: Cell Communication

Cell signalling, Cell receptors, Signal transduction pathways (basic concepts), Cell adhesion and extracellular matrix

Books for reference:

1. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993
2. Molecular Biology Lab Fax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991
3. Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edition. Gerald Karp, Janet Iwasa Wallace Marshall.2015
4. Cell biology D E Sadava CBS Publishers & Distributors, 2009

Web Resources:

1. Swayam- Molecular biology course by Dr. Nayan K. Jain, Gujarat University
2. Swayam- Cell Biology by Dr K. Sanatombi

3. NPTEL - Molecular Cell Biology by Prof. D. Karunagaran

Course Outcomes:

- CO1:** Demonstrate an understanding of the fundamental concepts and organization of cells.
CO2: Analyse the structure and functional significance of the plasma membrane and cell organelles.
CO3: Interpret chromosome organization and the regulation of the cell cycle
CO4: Compare the mechanisms and biological significance of mitosis, meiosis, apoptosis, and necrosis.
CO5: Evaluate the role of cell signalling, signal transduction, cell adhesion, and the extracellular matrix in cellular communication.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

- Part - A:** Two Questions from each Unit (No choice) ($10 \times 2 = 20$ Marks)
Part - B: Either or Questions (One pair from each Unit) ($5 \times 5 = 25$ Marks)
Part - C: Three out of Five Questions (One from each Unit) ($3 \times 10 = 30$ Marks)

Credits	3	Hours/Week	3	Sub Code	B1BT2P	Semester	I
Medium of Instruction: English						Core Course: 2	

CC2 - Practical I - CELL BIOLOGY

1. Microscope handling
2. Observation of plant and animal cells
3. Observation of epidermal cells from onion
4. Buccal epithelial cell staining
5. Mitosis in onion root tip
6. Preparation of temporary slides
7. Cell counting using Haemocytometer
8. Measurement of cell size using micrometry
9. Demonstration of cell organelles

Credits	4	Hours/Week	4	Sub Code	B1ABT1	Semester	I
Medium of Instruction: English						Allied: 1	

Allied 1- General Microbiology

Learning Objectives

1. Introduce the history, scope and significance of microbiology and the diversity of microorganisms.
2. Explain the structure, characteristics and functions of microbial cells and viruses.
3. Develop an understanding of microbial cultivation, microscopy, staining techniques and methods of microbial control.
4. Familiarize students with the basic applications of microorganisms in biotechnology, medicine, agriculture and industry.
5. Provide a strong foundation for advanced studies in microbiology and related life science disciplines.

Unit I: History and Development of Microbiology

History and Evolution of Microbiology, Classification – Three kingdom and five kingdom classification. Microbial biodiversity: Introduction to microbial biodiversity ecological niche. Basic concepts of Eubacteria, Archaeobacteria and Eukarya. Conservation of Biodiversity.

Unit II: Microbial Cell Structure

General characteristics of cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) and acellular microorganisms - (Viruses, Viroids, Prions), Differences between prokaryotic and eukaryotic microorganisms. Structure of Bacterial cell wall, cell membrane, capsule, flagella, pili, mesosomes, chlorosomes, phycobilisomes, spores and gas vesicles. Structure of fungi (Mold and Yeast), Structure of microalgae.

Unit III: Microscopy, Staining and Microbial Cultivation

Microbiological media, composition and types: selective and differential media. Growth curve and growth kinetics. Influence of environmental factors on microbial growth. Mode of cell division, Quantitative measurement of growth. Anaerobic culture techniques.

Unit IV: Microbial Growth and Control

Microscopy – Simple, bright field, dark field, phase contrast microscope. Staining- Simple, Gram staining, Negative staining, Capsule staining, Spore staining, Flagellar staining, nuclear staining and Acid-fast staining. Sterilization techniques (physical & chemical sterilization).

Unit V: Applied Microbiology

Beneficial and harmful microbes and their role in daily life. Normal flora and Host microbe interaction.

Books for Reference

1. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology (12th Edition). McGraw-Hill.
2. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction (14th Edition). Pearson.
3. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. McGraw-Hill.

4. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual (12th Edition). Pearson.
5. Madigan, M. T., Bender, K. S., Buckley, D. H., et al. Brock Biology of Microorganisms (16th Edition). Pearson.
6. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5th Edition., McGraw Hill Publications.
7. Jeffrey C. Pommerville., Alcamo's Fundamentals of Microbiology (9th Edition). Jones & Bartlett learning 2010.

Web Resources:

1. <https://nptel.ac.in>
2. <https://epgp.inflibnet.ac.in>
3. <https://openstax.org/details/books/microbiology>

Course Outcomes

CO1: Explain the historical development of microbiology and the contributions of pioneering microbiologists.

CO2: Describe the structure, classification and characteristics of bacteria, archaea and viruses.

CO3: Apply basic microbiological techniques including microscopy, staining, microbial cultivation and preservation methods.

CO4: Explain microbial growth, sterilization, disinfection and methods used for the control of microorganisms.

CO5: Discuss the applications of microorganisms in food, agriculture, medicine, industry and biotechnology, and recognize recent advances in microbiology.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	3	Sub Code	B2ABT2P	Semester	I &II
Medium of Instruction: English						Allied: 2	

Allied practical- I- General Microbiology and Bioinstrumentation

1. Laboratory safety practices and aseptic techniques.
2. Study and operation of a compound light microscope.
3. Preparation of microbiological culture media.
4. Enumeration of microorganisms by serial dilution and colony counting.
5. Isolation of bacteria by streak plate, spread plate and pour plate techniques.
6. Cultivation and preservation of pure cultures (agar slants and glycerol stocks).
7. Staining techniques- Simple, Gram's and endospore staining.
8. Antibiotic sensitivity test by Kirby–Bauer disc diffusion method (demonstration).
9. Preparation of buffers (Phosphate buffer)
10. Calibration and operation of a pH meter.
11. Operation and applications of a colorimeter (chlorophyll estimation).
12. Operation of a Centrifuge and separation of biological samples.
13. Demonstration and operation of a Micropipette with accuracy and precision testing.
14. Introduction to submarine gel electrophoresis.

Credits	5	Hours/Week	6	Sub Code	B2BT3	Semester	II
Medium of Instruction: English						Core Course: 3	

CC3 - MOLECULAR BIOLOGY AND GENETICS

Learning Objectives

1. To understand the fundamental concepts of molecular biology, nucleic acids, and DNA replication.
2. To learn the mechanisms of gene expression and the regulation of transcription and translation.
3. To understand the principles of Mendelian inheritance and human genetics.
4. To acquire knowledge of microbial genetics, mutations, DNA repair, and genetic recombination.
5. To understand the concepts of cytogenetics and population genetics and their applications in biotechnology

Unit I: Introduction to Molecular Biology

Introduction and scope of molecular biology, DNA as genetic material, Structure of DNA (Watson and Crick model), RNA: structure and types (mRNA, tRNA, rRNA), Central Dogma of Molecular Biology, DNA replication in prokaryotes and eukaryotes.

Unit II: Gene Expression

Transcription in prokaryotes and eukaryotes, RNA processing (capping, splicing, polyadenylation), Genetic code, Translation (protein synthesis), Regulation of gene expression, Lac operon and Trp operon.

Unit III: Mendelian and Human Genetics

Mendel's laws of inheritance, Monohybrid and dihybrid crosses, Incomplete dominance and codominance, Multiple alleles, Sex-linked inheritance, Pedigree analysis, Human genetic disorders.

Unit IV: Microbial Genetics

Mutation: types, causes, and repair, DNA repair mechanisms, Genetic recombination, Transformation, Transduction, Conjugation, Genetic mapping.

Unit V: Cytogenetics and Population Genetics

Karyotyping and ideogram, Numerical and structural chromosomal abnormalities, Population genetics, Hardy–Weinberg equilibrium, Gene pool and allele frequency, Genetic drift, Natural selection, Inbreeding and outbreeding, Applications of population genetics in biotechnology and evolution

Books for Reference:

1. Bruce Alberts, et al. Molecular Biology of the Cell (7th Edition). Garland Science.
2. Benjamin Lewin. Genes XII. Jones & Bartlett Learning.
3. Peter J. Russell. Genetics: A Molecular Approach (4th Edition). Pearson.
4. Daniel L. Hartl & Maryellen Ruvolo. Genetics: Analysis of Genes and Genomes. Jones & Bartlett Learning.
5. David P. Clark & Nanette J. Pazdernik. Molecular Biology (3rd Edition). Academic Press.

Web resources:

1. <https://www.ncbi.nlm.nih.gov/books/>
2. <https://www.ncbi.nlm.nih.gov/gene/>
3. <https://www.ensembl.org/>
4. <https://learn.genetics.utah.edu/>
5. <https://www.biointeractive.org/>

Course Outcomes:

CO1: Demonstrate knowledge of the molecular basis of genetic information and its replication.

CO2: Analyse the mechanisms of gene expression and the regulation of protein synthesis.

CO3: Apply the principles of classical and human genetics to interpret inheritance patterns and genetic disorders.

CO4: Evaluate the role of mutations, DNA repair, and gene transfer mechanisms in microbial genetics.

CO5: Interpret cytogenetic and population genetic concepts and assess their significance in biotechnology and evolution.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	3	Hours/Week	3	Sub Code	B2BT4P	Semester	II
Medium of Instruction: English						Core Course: 4	

CC4 - Practical II - MOLECULAR BIOLOGY AND GENETICS

1. Laboratory safety and handling of equipment's.
2. Preparation of solutions, buffers, and reagents.
3. Isolation of genomic DNA from plant tissue.
4. Isolation of genomic DNA from bacteria.
5. Estimation of DNA concentration using UV spectrophotometer (demonstration).
6. Agarose gel electrophoresis of DNA samples.
7. Observation of DNA bands using a gel documentation system (demonstration).
8. Extraction and estimation of RNA (demonstration).
9. Study of mitosis using onion root tip.
10. Meiotic stages of grass hopper testes/ Flower bud
11. Giant chromosomes from Chironomus larvae/ Drosophila salivary glands
12. Preparation of a human karyotype using beads.
13. Monohybrid and dihybrid genetic problems.
14. Pedigree chart analysis of inherited traits

Credits	4	Hours/Week	4	Sub Code	B2ABT3	Semester	II
Medium of Instruction: English						Allied: 3	

Allied 3-BIOINSTRUMENTATION

Learning Objectives

1. Introduce the principles and applications of commonly used bioanalytical instruments.
2. Develop an understanding of microscopy, centrifugation and spectroscopic techniques.
3. Familiarize students with chromatographic and electrophoretic separation methods.
4. Explain the basic principles of molecular biology instruments used in biotechnology.
5. Provide knowledge of advanced analytical instruments used in research and diagnostics.

Unit I: Introduction to Bioinstrumentation

Principles and importance of bioinstrumentation. Basic laboratory measurements, accuracy, precision and calibration. Laboratory safety and good laboratory practices (GLP).

Unit II: Microscopy and Centrifugation

Principles and applications of fluorescence microscope, electron microscope (SEM and TEM), confocal microscope and atomic force microscope. Principles, types and applications of centrifuges.

Unit III: Spectroscopy and Chromatography

Principles and applications of UV-Visible spectrophotometry, colorimetry and fluorimetry. Introduction to chromatography: Paper, TLC, Column, Ion-exchange, Gel filtration, Affinity chromatography and HPLC.

Unit IV: Electrophoresis and Molecular Techniques

Principles and applications of agarose gel and SDS-PAGE. Introduction to PCR, Real-Time PCR, ELISA and Blotting techniques (Southern, Northern and Western blotting).

Unit V: Advanced Bioinstrumentation

Introduction to Flow Cytometry, DNA Sequencing, Mass Spectrometry and Biosensors. Applications of bioinstrumentation in clinical diagnosis, biotechnology, pharmaceuticals and research.

Books for Reference

1. Wilson, K., & Walker, J. (2022). Principles and Techniques of Biochemistry and Molecular Biology (9th Edition). Cambridge University Press.
2. Sawhney, S. K., & Singh, R. (2015). Introductory Practical Biochemistry. Narosa Publishing House.
3. Upadhyay, A., Upadhyay, K., & Nath, N. (2019). Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House.
4. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). Principles of Instrumental Analysis (7th Edition). Cengage Learning.
5. Pattabhi, V., & Gautham, N. (2017). Biophysics. Narosa Publishing House.

Web resources:

1. https://nptel.ac.in/?utm_source=chatgpt.com

2. https://openstax.org/details/books/biology-2e?utm_source=chatgpt.com
3. https://epgp.inflibnet.ac.in?utm_source=chatgpt.com

Course Outcomes

CO1: Explain the principles and working of common laboratory instruments used in biotechnology.

CO2: Describe the applications of microscopy, centrifugation and spectroscopic techniques.

CO3: Differentiate various chromatographic and electrophoretic techniques used for biomolecule separation.

CO4: Explain the principles and applications of PCR, ELISA and blotting techniques.

CO5: Discuss the role of advanced bioinstrumentation in biotechnology research, healthcare and industrial applications.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	5	Hours/Week	5	Sub Code	B3BT5	Semester	III
Medium of Instruction: English						Core Course: 5	

CC5 – Recombinant DNA Technology

Learning Objectives

1. To understand the molecular tools and enzymes used in recombinant DNA technology and gene cloning.
2. To learn the characteristics and applications of different cloning and expression vectors.
3. To understand the various gene transfer techniques used in genetic engineering.
4. To acquire knowledge of gene cloning, recombinant screening, PCR, and blotting techniques.
5. To understand the construction of genomic and cDNA libraries, DNA sequencing methods, and the applications of recombinant DNA technology.

Unit I: Molecular tools for gene cloning

Nucleases: exonucleases and endonucleases, restriction enzymes (Type I, II, III, IV & V). Polymerases: DNA pol I, Klenow fragments, reverse transcriptase, Taq & pfu polymerases. Ligases: *E. coli* DNA ligase, T4 RNA ligase. Topoisomerases: Type I (A, B) & Type II (A, B). End modifying enzymes: Terminal transferases, T4 polynucleotide kinase, alkaline phosphatases.

Unit II: Cloning Vectors

Introduction and properties - plasmids, bacteriophage, phagemids, cosmids, BAC, YAC, shuttle vectors and expression vectors.

Unit III: Gene Transfer Techniques

Transfer of DNA into Cells - transformation, CaCl₂ mediated, Ultra-sonication, Electroporation, Micro-injection, Macro-injection, Particle bombardment system and Liposome mediated gene transfer.

Unit IV: Gene Cloning and Screening

Cloning methods: Cloning in *E. coli*, Selection and screening of recombinants. DNA amplification- PCR. Blotting techniques - Southern, Western and Northern blot.

Unit V: Genomic Libraries and Applications

Construction of genomic libraries and cDNA library, DNA sequencing methods - chemical degradation, chain termination. Application of Recombinant DNA technology in medicine, industry, agriculture and r-DNA technology - merits and demerits.

Books for Reference:

1. Brown T.A, 2015. Gene Cloning and DNA Analysis: An Introduction, 7th edition, Wiley - Blackwell.
2. R. W. Old & S. B. Primrose, Principles of Gene Manipulation, Fifth Edition, Blackwell Science.
3. Genetic Engineering Principles and Methods by Setlow. Jane K. (Volume 24).
4. Monika Jain (2012), Recombinant DNA Technology, (I edition). Alpha Science International ISBN-13: 978-1842656679.

Web Resources:

1. <https://www.britannica.com/recombinant-DNA-technology>
2. <https://www.le.ac.uk/recombinant-dna-and-genetic-techniques>
3. <https://www.ncbi.nlm.nih.gov>

Course Outcomes:

CO1: Classify the molecular tools employed in gene cloning and recombinant DNA technology.

CO2: Differentiate various cloning vectors and their applications in molecular biology.

CO3: Illustrate the principles and applications of gene transfer techniques.

CO4: Integrate molecular techniques for gene cloning, DNA amplification, and recombinant screening.

CO5: Appraise the applications of recombinant DNA technology in medicine, agriculture, and industry.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	3	Hours/Week	3	Sub Code	B3BT6P	Semester	III
Medium of Instruction: English						Core Course: 6	

CC6 - Practical III- Recombinant DNA Technology

1. Isolation of plasmid DNA from *Escherichia coli*.
2. Isolation of genomic DNA from Animal tissue
3. Restriction enzyme digestion of Lambda (λ) DNA (demonstration).
4. Ligation of DNA fragments using T4 DNA ligase (demonstration).
5. Preparation of competent *E. coli* cells.
6. Transformation of competent *E. coli* using the CaCl_2 method.
7. Selection and screening of transformants using antibiotic selection and blue-white screening (demonstration).
8. Polymerase Chain Reaction (PCR) and analysis of PCR products by agarose gel electrophoresis.

Credits	5	Hours/Week	6	Sub Code	B4BT7	Semester	IV
Medium of Instruction: English						Core Course: 7	

CC7 - IMMUNOLOGY

Learning Objectives

1. To understand the fundamental concepts of immunology, the immune system, and the development of immune cells.
2. To learn the structure, functions, and interactions of antigens and antibodies, and the production of monoclonal antibodies.
3. To understand the role of immune mediators, vaccines, and immunization in protective immunity.
4. To acquire knowledge of immune disorders, histocompatibility, and organ transplantation.
5. To understand the principles and applications of immunological techniques used in diagnosis and research.

Unit I: Fundamentals of Immunology

Introduction and scope of Immunology, Cells of the immune system, Primary and secondary lymphoid organs, Innate and adaptive immunity, Haematopoiesis and development of B and T lymphocytes.

Unit II: Antigens, Antibodies and Antibody Production

Antigens: Structure and types, Antibodies: Structure, classes and functions, Monoclonal antibodies production and their applications.

Unit III: Immune Mediators and Vaccines

Complement system, Cytokines and chemokines, Vaccines: Types and production, Immunization and vaccination schedules, Applications of vaccines.

Unit IV: Immune Disorders and Histocompatibility

Hypersensitivity reactions, Autoimmune diseases, Immunodeficiency disorders, Major Histocompatibility Complex (MHC), HLA typing and organ transplantation

Unit V: Immunological Techniques and Applications

Antigen-antibody interactions, Immunodiffusion, Immunoelectrophoresis, ELISA, Immunofluorescence, Antibody purification, Applications of immunological techniques in diagnosis and research.

Books for Reference:

1. Thomas J. Kindt, Barbara A. Osborne and Richard A Goldsby, 2006. Kuby Immunology. 6th edition, W. H. Freeman and Company.
2. Kannan, I., 2010. Immunology. MJP Publishers, Chennai
3. Nandini Shetty, 1996, Immunology: introductory textbook – I. New Age International, New Delhi.
4. Abbas, A.K., A.H.L., Libman and S. Pillai, 2010. Cellular and Molecular Immunology, 6th Edition. Saunders Elsevier Publications, Philadelphia
5. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Riott's Essential Immunology, 12th edition, Wiley- Blackwell. USA.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/books/NBK279395/>
2. <https://med.stanford.edu/immunol/phd-program/ebook.html>
3. <https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/>
4. [Immunology - an overview | Science Direct Topics](#)

Course Outcomes:

CO1: Classify the components of the immune system and distinguish between innate and adaptive immune responses.

CO2: Analyse the structure and functions of antigens, antibodies, and antigen–antibody interactions in immune responses.

CO3: Evaluate the role of complement proteins, cytokines, vaccines, and immunization in disease prevention.

CO4: Interpret the mechanisms of hypersensitivity, autoimmunity, immunodeficiency, and histocompatibility in clinical immunology.

CO5: Demonstrate the principles and applications of immunological techniques for disease diagnosis and biomedical research.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	3	Hours/Week	3	Sub Code	B4BT8P	Semester	IV
Medium of Instruction: English						Core Course: 8	

CC8 - PRACTICAL IV - IMMUNOLOGY

1. Identification of immune cells and lymphoid organs using charts/permanent slides.
2. Preparation of blood smear and differential leukocyte identification.
3. Separation of Serum and Plasma.
4. ABO and Rh blood group determination.
5. WBC counting
6. RBC counting
7. Antigen–antibody reactions: Slide agglutination test.
8. Latex agglutination test.
9. WIDAL slide test
10. Single Radial Immunodiffusion
11. ELISA – Demonstration
12. Pregnancy test
13. ASO test
14. CRP Test
15. VDRL - Demonstration

Credits	5	Hours/Week	5	Sub Code	B5BT9	Semester	V
Medium of Instruction: English						Core Course: 9	

CC9 - PLANT BIOTECHNOLOGY

Learning Objectives:

1. Explore the history of Biotechnology and state the importance of organization of plant genome.
2. Be acquainted with the molecular basis of action of plant hormones and gene expression
3. Illustrate about various culture medium preparations, haploid, triploid plant production and its applications
4. Enumerate various recombinant techniques and gene probes and molecular markers identification.
5. Exploit symbiotic organisms as a vector for gene transfer to produce transgenic plants Develop molecular technique skills for crop improvement

Unit I: Introduction to Plant Biotechnology

History and scope of plant biotechnology, Conservation of plants using biotechnology, Concepts of totipotency, Plant genome organization, Structure of a representative plant gene, Gene families in plants, Chloroplast and mitochondrial genomes.

Unit II: Plant Growth Regulators and Gene Expression

Auxins, cytokinin and gibberellins: molecular mechanism, Phytochrome and photomorphogenesis, Absciscic acid (ABA) and stress response, Stress-induced gene expression, Ethylene and fruit ripening

Unit III: Plant Tissue Culture Techniques

Media composition (MS media), Micropropagation techniques, direct and indirect organogenesis, soma clonal variation, somatic embryogenesis, haploid and triploid, Protoplast isolation, fusion and culture, hybrid and cybrid production, Synthetic seed production, Secondary metabolite production.

Unit IV: Plant Genetic Engineering

Agrobacterium and crown gall disease, T-DNA transfer mechanism, Ti and Ri plasmid vectors, Plant viral vectors, Symbiotic nitrogen fixation, Rhizobium and nif genes

Unit V: Applications of Plant Biotechnology

Crop improvement, herbicide, insect and virus resistance plants, Transgenic plants, plant vaccines, genetically modified food - future perspectives and ecological impact of transgenic plants.

Books for Reference:

1. Adrian Slater., Plant Biotechnology, Oxford University press, 2008.
2. Chawla, H.S., "Introduction to Plant Biotechnology", 3rd Edition, Science Publishers, 2009.
3. Stewart Jr., C.N., "Plant Biotechnology and Genetics: Principles, Techniques and Applications" Wiley-Interscience, 2008.
4. Narayanaswamy S. 1994. Plant cell and tissue culture. Tata McGraw Hill Publishing Company limited, New Delhi.
5. Ignacimuthu. 1996. Applied Plant Biotechnology. Tata McGraw – Hill.

Web Resources:

1. <https://nptel.ac.in/courses/102103016>
2. <https://science.umd.edu/classroom/bsci124/lec41.html>
3. <https://www.nifa.usda.gov/grants/programs/biotechnology-programs/plant-biotechnology>

Course Outcomes:

CO1: Acquire comprehensive knowledge of the principles and scope of plant biotechnology.

CO2: Interpret the role of plant growth regulators, genome organization, and gene expression in plant development.

CO3: Perform and relate plant tissue culture techniques for propagation, conservation, and metabolite production.

CO4: Demonstrate knowledge of plant genetic engineering strategies and gene transfer systems used in crop improvement.

CO5: Analyse the applications of transgenic plants and genetically modified crops with reference to agricultural productivity, biosafety, and environmental sustainability.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	5	Hours/Week	5	Sub Code	B5BT10	Semester	V
Medium of Instruction: English						Core Course: 10	

CC10 - ANIMAL BIOTECHNOLOGY

Learning Objectives:

1. Understand the basic concepts of Animal cell culture and cell laboratory
2. Describe the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines
3. Discuss the strategies for gene transfer and gene expressions with their applications
4. Be acquainted with genetic modification and stem cell technology in production of transgenic animals.
5. Learn the Assisted reproductive technology and its applications

Unit I: Animal Cell Culture

History and principles of animal cell culture, Pluripotency, Cell culture media and its components, Serum-containing and serum-free media, Preparation of media for cell lines, Essential equipment for animal cell culture

Unit II: Cell Culture Techniques

CO₂ Incubator, Inverted microscope, Cryostorage containers. Primary and secondary culture, organ culture and cell lines, Feeder layers, Cell separation, synchronization and counting, Cryopreservation and cell banking, Apoptosis, cell viability and cytotoxicity test.

Unit III: Genetic Engineering of Animal Cells

Cell transfection methods, Viral vectors and physical methods, HAT selection and selectable markers, Gene targeting, gene silencing and gene knockout

Unit IV: Applications for Animal Biotechnology

Recombinant protein production, Stem cells and their applications, Cell culture products Transgenic animals

Unit V: Assisted reproductive technology

Embryo collection and preservation, semen banking, Artificial insemination (AI), In vitro fertilization (IVF), Intracytoplasmic sperm injection (ICSI)

Books for Reference:

1. K. Srivastava *et al.*, 2009, Animal Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Jenkins, N. (ed). 1999 Animal cell Biotechnology: Methods and protocols. Humana press, New Jersey.
3. B.C. Currell *et al.*, 1994, In vitro Cultivation of Animal Cells (Biotol), Butterworth-Heinemann Ltd.
4. R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications.

Web Resources:

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=350>
2. <http://thebiologynotes.com/embryo-transfer/>

3. <https://people.ucalgary.ca/~browder/transgenic.html>

Course Outcomes:

CO1: Demonstrates a strong foundation in animal cell culture principles, culture media, and laboratory practices.

CO2: Performs and interprets various animal cell culture techniques, including cell preservation and banking methods.

CO3: Utilizes genetic engineering approaches for the modification and analysis of animal cells.

CO4: Integrates animal biotechnology concepts in recombinant protein production, stem cell technology, and transgenic animal development.

CO5: Applies reproductive biotechnology techniques for embryo manipulation, gamete preservation, and assisted reproductive technologies.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	B5BT11	Semester	V
Medium of Instruction: English						Core Course: 11	

CC11 - INDUSTRIAL BIOTECHNOLOGY

Learning Objectives

1. To understand the fundamental concepts, industrial microorganisms and media used in industrial biotechnology.
2. To learn the principles of fermentation technology, bioprocess engineering and bioreactor operation.
3. To acquire knowledge of downstream processing techniques for the recovery and purification of bioproducts.
4. To understand the industrial production of metabolites, enzymes, single-cell protein and probiotics.
5. To recognize the applications of industrial biotechnology in food, pharmaceuticals, agriculture, bioenergy and environmental management.

Unit I: Introduction to Industrial Biotechnology

History, scope and importance of industrial biotechnology, industrially important microorganisms (bacteria, fungi, yeast and algae), Isolation, screening and preservation of industrial microorganisms, Strain improvement methods (mutation and recombinant DNA technology), Industrial media: composition, formulation and sterilization.

Unit II: Fermentation Technology and Bioprocess Engineering

Principles and types of fermentation (batch, fed-batch and continuous), Fermenter design, construction and types, Bioprocess parameters: pH, temperature, aeration, agitation and foam control, Scale-up of fermentation processes, Bioreactor monitoring and process optimization.

Unit III: Downstream Processing

Recovery and purification of fermentation products, Cell disruption techniques, Filtration, centrifugation and sedimentation, Solvent extraction, precipitation and membrane separation, Chromatographic techniques in bioproduct purification, Drying, Crystallization, Formulation and Packaging of Bioproducts.

Unit IV: Industrial Production of Bioproducts

Production of primary metabolites (ethanol, citric acid, amino acids), Production of secondary metabolites (antibiotics, pigments and vitamins), Industrial enzymes: amylase, protease, cellulase and lipase, Single Cell Protein (SCP) and probiotics.

Unit V: Applications of Industrial Biotechnology

Food biotechnology (bread, cheese, yogurt, vinegar and beverages), Recombinant products: insulin, vaccines and therapeutic proteins, Biofertilizers and biopesticides, Biofuels (bioethanol, biodiesel and biogas), Wastewater treatment and bioremediation.

Books for Reference:

1. Stanbury, P. F., Whitaker, A. & Hall, S. J. Principles of Fermentation Technology (3rd Edition). Elsevier.

2. Crueger, W. & Crueger, A. Biotechnology: A Textbook of Industrial Microbiology. Panima Publishing.
3. Casida, L. E. Industrial Microbiology. New Age International.
4. Shuler, M. L. & Kargi, F. Bioprocess Engineering: Basic Concepts (3rd Edition). Pearson
5. Prescott, Harley & Klein. Microbiology (Industrial Microbiology chapters). McGraw-Hill.

Web resources:

1. <https://www.ncbi.nlm.nih.gov/books/>
2. <https://www.ncbi.nlm.nih.gov/guide/training-tutorials/>
3. <https://www.fao.org/biotechnology/en/>
4. <https://www.fao.org/biotechnology/en/>
5. <http://www.fbae.org/>

Course Outcomes:

CO1: Demonstrate knowledge of industrial biotechnology and industrial microorganisms.
CO2: Apply the principles of fermentation technology and bioprocess engineering.
CO3: Perform downstream processing techniques for bioproduct recovery and purification.
CO4: Interpret the industrial production of metabolites, enzymes and microbial products.
CO5: Integrate industrial biotechnology for applications in food, healthcare, agriculture, energy and environmental management.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)
Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)
Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	B5BT12P	Semester	V
Medium of Instruction: English						Core Course: 12	

CC12 -PRACTICAL -V- PLANT, ANIMAL AND INDUSTRIAL BIOTECHNOLOGY

Plant Biotechnology Practical

1. Preparation of MS (Murashige and Skoog) medium.
2. Sterilization techniques and aseptic handling.
3. Callus induction from plant explants.
4. Micropropagation using shoot tip/nodal explants.
5. Isolation of protoplasts
6. Preparation of synthetic seeds
7. Visit to a plant tissue culture laboratory

Animal Biotechnology Practical

1. Laboratory safety and aseptic techniques.
2. Preparation of animal cell culture media.
3. Sterilization of glassware and media.
4. Handling and maintenance of cell cultures (demonstration).
5. Cell viability test (MTT assay).
6. Cryopreservation (demonstration).
7. Visit to an animal cell culture laboratory

Industrial Biotechnology Practical

1. Isolation of industrially important microorganisms.
2. Production of wine from grape.
3. Production of citric acid using *Aspergillus niger*.
4. Enzyme production (Amylase) and assay.
5. Downstream processing (demonstration) and industrial visit.

Credits	5	Hours/Week	6	Sub Code	B6BT13	Semester	VI
Medium of Instruction: English						Core Course: 13	

CC13 - PHARMACEUTICAL BIOTECHNOLOGY

Learning Objectives

1. To understand the concepts, scope and drug development process in pharmaceutical biotechnology.
2. To acquire knowledge of biopharmaceutical production, formulation and drug delivery systems.
3. To learn the production and applications of major biopharmaceutical products.
4. To understand drug safety, toxicity and the management of drug-related complications.
5. To recognize pharmaceutical regulations, industrial practices and career opportunities in pharmaceutical biotechnology.

Unit I: Introduction to Pharmaceutical Biotechnology

Objectives and scope, Generic and Bigeneric drugs, Drug discovery and development, Preclinical and clinical trials, Pharmacokinetics and pharmacodynamics, Drug approval, patenting and marketing.

Unit II: Biopharmaceutical Production

Recombinant protein production, Nucleic acid-based therapies, Biopharmaceuticals, Pharmaceutical regulations, Formulation and drug delivery, Pharmacognosy.

Unit III: Biopharmaceutical Products

Recombinant therapeutic proteins, Hormones and blood factors, Erythropoietin and colony-stimulating factors, Interferons and antimicrobial peptides, cancer biologics.

Unit IV: Drug Safety

Drug toxicity analysis, Common side effects of drugs and managements, Drugs of abuse, Prevention and management of drug-related complications.

Unit V: Pharmaceutical Industry and Career Opportunities

National and international drug regulatory agencies, Pharmaceutical and biotechnology industries, opportunities in pharmaceutical biotechnology

Books for Reference:

1. Chandrakant Kokate and Pramod H.J 1st Edition (2011), Text Book of Pharmaceutical Biotechnology, Elsevier.
2. Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd (Eds.) (2019), Pharmaceutical Biotechnology: Fundamentals and Applications, Springer.
3. Ashish Dixit, Pawan Tiwari and Vivekanand Kishan Chatap (2015), Textbook of Pharmaceutical Biotechnology, Studium Press (India) Pvt. Ltd.
4. Gary Walsh (2003), Biopharmaceuticals; biochemistry and Biotechnology, John Wiley & Sons Ltd.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5178364/>
2. https://www.patentdocs.org/biotech_news/
3. <https://www.pharmamanufacturing.com/>
4. <https://nptel.ac.in/courses/102/103/102103013/>

Course Outcomes:

CO1: Demonstrate knowledge of pharmaceutical biotechnology and drug development.
CO2: Apply the principles of biopharmaceutical production and drug formulation.
CO3: Interpret the production and therapeutic applications of biopharmaceutical products.
CO4: Evaluate drug safety, toxicity and adverse drug reactions.
CO5: Integrate pharmaceutical biotechnology concepts with industrial practices and career opportunities.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	5	Hours/Week	6	Sub Code	B6BT14	Semester	VI
Medium of Instruction: English						Core Course: 14	

CC14 - ENVIRONMENTAL BIOTECHNOLOGY

Learning Objectives

1. To understand ecosystem structure, ecological interactions and biogeochemical cycles.
2. To acquire knowledge of environmental pollution, its impacts and monitoring strategies.
3. To learn waste management practices and microbial approaches for environmental remediation.
4. To understand the principles and applications of bioremediation and phytoremediation.
5. To recognize the role of genetic engineering in environmental protection and sustainable development.

Unit I: Ecosystem and Biogeochemical Cycles

Ecosystem structure and function, Food chain, food web and trophic levels, Energy flow and ecological pyramids, Carbon, Nitrogen, Sulfur and phosphorus cycles.

Unit II: Environmental Pollution

Types, sources and effects of pollution (Air, water, soil, noise, thermal and radioactive pollution) Greenhouse effect, ozone depletion, global warming and acid rain, Bioaccumulation and biomagnification, biological control, environmental impact assessment and monitoring.

Unit III: Waste Management and Bioremediation

Biosorption and bioaccumulation, Composting of organic wastes, Microbial treatment of oil spills, Aerobic and anaerobic wastewater treatment.

Unit IV: Bioremediation and Phytoremediation

In situ and *ex situ* bioremediation, Phytoremediation, Microbial degradation of pesticides and xenobiotics, Bioleaching and rhizosphere interactions.

Unit V: Genetic Engineering in Environmental Biotechnology

Genetically engineered microorganisms for environmental applications, Transgenic plants and microbes in agriculture, Bioremediation using genetically engineered organisms, Biosafety, environmental hazards and regulatory policies

Books for Reference:

1. Scragg, A. H. (2005). *Environmental Biotechnology* (2nd Edition). Oxford University Press.
2. Rittmann, B. E., & McCarty, P. L. (2020). *Environmental Biotechnology: Principles and Applications*. McGraw-Hill Education.
3. Jördening, H. J., & Winter, J. (2005). *Environmental Biotechnology: Concepts and Applications*. Wiley-VCH.
4. Vallero, D. A. (2019). *Environmental Biotechnology: A Biosystems Approach* (2nd Edition). Elsevier.
5. Bhattacharyya, B. C., & Banerjee, R. (2007). *Environmental Biotechnology*. Oxford University Press.

Web sources:

1. <https://nptel.ac.in>
2. <https://ocw.mit.edu>
3. <https://www.epa.gov>
4. <https://www.unep.org>

Course Outcomes:

CO1: Demonstrate knowledge of ecosystem functions and biogeochemical cycles.

CO2: Assess different types of environmental pollution and their ecological impacts.

CO3: Apply biological methods for waste management and environmental remediation.

CO4: Interpret the applications of bioremediation, phytoremediation and bioleaching.

CO5: Integrate genetic engineering approaches for environmental management while considering biosafety and regulatory aspects

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	6	Sub Code	B6BT15P	Semester	VI
Medium of Instruction: English						Core Course: 15	

CC15 – PRACTICAL - VI - PHARMACEUTICAL AND ENVIRONMENTAL BIOTECHNOLOGY

Pharmaceutical Biotechnology

1. Preparation and sterilization of microbiological media.
2. Isolation and maintenance of industrially important microorganisms.
3. Antibiotic sensitivity test (Kirby–Bauer disc diffusion method).
4. Determination of Minimum Inhibitory Concentration (MIC) by serial dilution (demonstration).
5. Sterility testing of pharmaceutical preparations.
6. Production of antibiotics by microbial fermentation (demonstration).
7. Demonstration of vaccine production and recombinant insulin technology (charts/models).
8. Visit to a pharmaceutical industry, hospital microbiology laboratory, or research institute with submission of a report.

Environmental Biotechnology

9. Collection and microbiological analysis of water samples.
10. Determination of pH, turbidity, and Total Dissolved Solids (TDS) of water.
11. Estimation of Dissolved Oxygen (DO).
12. Estimation of Biochemical Oxygen Demand (BOD).
13. Estimation of Chemical Oxygen Demand (COD).
14. Determination of water hardness and alkalinity.
15. Isolation of pollutant-degrading microorganisms from soil by enrichment culture.
16. Preparation of biofertilizers (Rhizobium/Azotobacter) or biopesticides (demonstration).

Visit to a wastewater treatment plant/biogas plant/effluent treatment plant and submission of a report.

Credits	4	Hours/Week	5	Sub Code	BBTECA	Semester	-
Medium of Instruction: English						Elective Course: 1	

ELECTIVE COURSE – 1 - GENOMICS AND PROTEOMICS

Learning Objectives

1. To understand the fundamental concepts of genomics and proteomics.
2. To acquire knowledge of genome organization, sequencing technologies and bioinformatics resources.
3. To develop an understanding of protein structure, function and proteomic techniques.
4. To familiarize with advanced tools used in genomics and proteomics research.
5. To recognize the applications of genomics and proteomics in healthcare, agriculture and biotechnology.

Unit I: Introduction to Genomics- Genome

Definition, organization and complexity, Prokaryotic and eukaryotic genomes, Structural and functional genomics, Genome mapping (genetic and physical mapping), DNA sequencing methods (Sanger and Next Generation Sequencing – basics), Genome databases and genome browsers.

Unit II: Comparative and Functional Genomics

Comparative genomics and genome evolution Gene prediction and genome annotation, Transcriptomics and RNA sequencing (RNA-Seq), Gene expression profiling, Single Nucleotide Polymorphisms (SNPs), Applications of genomics in agriculture, medicine and biotechnology.

Unit III: Introduction to Proteomics

Proteome and proteomics: concepts and significance, Protein extraction and purification techniques, Protein separation methods: SDS-PAGE, Native PAGE, Two-Dimensional Gel Electrophoresis (2-DE), Protein quantification methods, Protein databases.

Unit IV: Advanced Proteomics

Mass spectrometry: MALDI-TOF and ESI-MS (principle and applications), Protein identification and characterization, Protein sequencing, Protein structure prediction, Protein-protein interactions (Yeast Two-Hybrid, Co-immunoprecipitation), post-translational modifications.

Unit V: Applications of Genomics and Proteomics

Pharmacogenomics, Personalized medicine, Clinical and diagnostic proteomics, Biomarker discovery, Cancer genomics and proteomics, Microbial, plant and animal genomics, Applications in drug discovery, vaccine development and precision agriculture, Ethical, legal and social issues (ELSI) in genomics and proteomics.

Books for Reference:

1. Principles of Gene Manipulation and Genomics – Sandy B. Primrose & Richard Twyman.
2. Genomes – T. A. Brown.
3. Introduction to Proteomics: Tools for the New Biology – Daniel C. Liebler.
4. Discovering Genomics, Proteomics and Bioinformatics – A. Malcolm Campbell & Laurie J. Heyer.
5. Principles of Proteomics – Richard Twyman.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/>
2. <https://www.ensembl.org/>
3. <https://www.uniprot.org/>
4. <https://www.ebi.ac.uk/>
5. <https://www.rcsb.org/>

Course Outcomes:

CO1: Demonstrate knowledge of genome organization, mapping and sequencing technologies.

CO2: Apply genomic and transcriptomic approaches for biological data analysis.

CO3: Perform protein separation, identification and characterization using proteomic techniques.

CO4: Interpret protein interactions and post-translational modifications using appropriate analytical methods.

CO5: Evaluate the applications of genomics and proteomics in medicine, agriculture, biotechnology and precision healthcare.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECB	Semester	-
Medium of Instruction: English						Elective Course: 2	

ELECTIVE COURSE – 2 - MOLECULAR DIAGNOSTICS

Learning Objectives

1. To understand the principles and scope of molecular diagnostics.
2. To acquire knowledge of molecular diagnostic techniques and laboratory practices.
3. To develop skills in molecular analysis of infectious and genetic diseases.
4. To familiarize with advanced diagnostic technologies and quality assurance.
5. To recognize the clinical and research applications of molecular diagnostics.

UNIT I: Introduction to Molecular Diagnostics

Principles and scope of molecular diagnostics; Biomarkers and molecular basis of disease; Sample collection, handling and nucleic acid isolation; DNA and RNA extraction methods; Quality control and biosafety in diagnostic laboratories.

UNIT II: Molecular Diagnostic Techniques

Polymerase Chain Reaction (PCR): Principle, types and applications; Real-Time PCR (qPCR); Reverse Transcription PCR (RT-PCR); Digital PCR (Introduction); Gel electrophoresis and nucleic acid visualization.

UNIT III: Advanced Molecular Diagnostic Methods

DNA sequencing: Sanger and Next Generation Sequencing (NGS); DNA fingerprinting; Restriction Fragment Length Polymorphism (RFLP); SKY; DNA microarray; Fluorescence In Situ Hybridization (FISH).

UNIT IV: Clinical Applications of Molecular Diagnostics

Molecular diagnosis of infectious diseases; Molecular diagnosis of genetic disorders; Cancer diagnostics and biomarkers; Prenatal and neonatal diagnosis; Pharmacogenomics and personalized medicine.

UNIT V: Emerging Trends and Applications

CRISPR-based molecular diagnostics; Point-of-care molecular diagnostics; Biosensors in molecular diagnostics; Companion diagnostics; Quality assurance and accreditation in molecular diagnostic laboratories; Ethical, legal and regulatory aspects of molecular diagnostics.

Books for Reference:

1. Molecular Diagnostics: Fundamentals, Methods and Clinical Applications – Lela Buckingham.
2. Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory – William B. Coleman and Gregory J. Tsongalis.
3. Molecular Biology of the Cell – Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter.
4. Principles of Gene Manipulation and Genomics – Sandy B. Primrose and Richard Twyman.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/>
2. <https://www.cdc.gov/>

3. <https://www.who.int/>
4. <https://www.ebi.ac.uk/>
5. <https://www.fda.gov/>

Course Outcomes:

CO1: Demonstrate knowledge of molecular diagnostic principles and laboratory procedures.

CO2: Apply molecular techniques for disease detection and genetic analysis.

CO3: Analyse diagnostic results using molecular biology tools.

CO4: Integrate advanced molecular technologies in clinical diagnostics.

CO5: Evaluate the role of molecular diagnostics in personalized medicine and healthcare.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECC	Semester	-
Medium of Instruction: English						Elective Course: 3	

ELECTIVE COURSE- 3 -VIROLOGY

Learning Objectives

1. To understand the fundamental concepts of virology and virus classification.
2. To acquire knowledge of viral replication and cultivation methods.
3. To develop an understanding of viral diseases and diagnostic techniques.
4. To familiarize with host–virus interactions and antiviral strategies.
5. To recognize the applications of virology in medicine, agriculture and biotechnology.

UNIT I: Introduction to Virology

History and scope of virology; General characteristics of viruses; Classification and nomenclature of viruses; Structure of animal, plant and bacterial viruses; Viral morphology and genome organization.

UNIT II: Virus Replication and Cultivation

Virus replication cycle; Viral adsorption, penetration, uncoating, biosynthesis, assembly and release; Cultivation of viruses in laboratory animals, embryonated eggs and cell culture; Virus assay methods.

UNIT III: Viral Diseases and Diagnosis

Human viral diseases- HIV and Hepatitis B; Plant viral diseases- CaMV, TMV; Animal viral diseases-SV40, Adeno virus; Bacteriophages and their applications; Laboratory diagnosis of viral infections; Serological and molecular diagnostic techniques.

UNIT IV: Host–Virus Interaction and Immunity

Host immune response to viral infections; Viral pathogenesis; Mechanisms of viral persistence and latency; Antiviral agents and drug resistance; Vaccines and immunization against viral diseases.

UNIT V: Applied and Advanced Virology

Emerging and re-emerging viral diseases; Oncogenic viruses; Gene therapy and viral vectors; Biosafety and biosecurity in virology laboratories; Applications of virology in medicine, agriculture and biotechnology.

Books for Reference:

1. Principles of Virology – S. J. Flint, V. R. Racaniello, G. F. Rall and A. M. Skalka.
2. Medical Virology – Dimmock, Easton and Leppard.
3. Fields Virology – David M. Knipe and Peter M. Howley.
4. Introduction to Modern Virology – N. J. Dimmock, A. J. Easton and K. N. Leppard.
5. Basic Virology – Edward K. Wagner and Martinez J. Hewlett.

Web Resources:

1. <https://www.cdc.gov/>
2. <https://www.who.int/>
3. <https://www.ncbi.nlm.nih.gov/>
4. <https://www.ictv.global/>
5. <https://www.virology.ws/>

Course Outcomes:

CO1: Demonstrate knowledge of virus structure, classification and replication.

CO2: Apply laboratory methods for virus cultivation and identification.

CO3: Analyse viral diseases and diagnostic approaches.

CO4: Interpret host immune responses and antiviral mechanisms.

CO5: Evaluate the applications of virology in healthcare and biotechnology.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECD	Semester	-
Medium of Instruction: English						Elective Course: 4	

ELECTIVE COURSE - 4- BIOENERGETICS AND METABOLISM

Learning Objectives

1. To understand the principles of bioenergetics and energy metabolism.
2. To acquire knowledge of carbohydrates, lipid and protein metabolism.
3. To develop an understanding of oxidative phosphorylation and ATP synthesis.
4. To familiarize with metabolic regulation under physiological conditions.
5. To recognize the significance of metabolism in health, disease and biotechnology.

UNIT I: Fundamentals of Bioenergetics

Laws of thermodynamics; Free energy, enthalpy and entropy; High-energy compounds; ATP as the energy currency of the cell; Biological oxidation–reduction reactions; Electron carriers and bioenergetic principles.

UNIT II: Carbohydrate Metabolism

Glycolysis; Citric Acid Cycle (TCA Cycle); Pentose Phosphate Pathway; Glycogenesis; Glycogenolysis; Gluconeogenesis; Regulation of carbohydrate metabolism.

UNIT III: Lipid and Amino Acid Metabolism

β -Oxidation of fatty acids; Fatty acid biosynthesis; Ketone body metabolism; Amino acid metabolism; Transamination; Deamination; Urea cycle; Integration of lipid and protein metabolism.

UNIT IV: Electron Transport Chain and Oxidative Phosphorylation

Structure and organization of the mitochondrial electron transport chain; Oxidative phosphorylation; Chemiosmotic theory; ATP synthesis; Mitochondrial bioenergetics; Regulation of oxidative phosphorylation.

UNIT V: Metabolic Integration and Regulation

Integration of carbohydrate, lipid and protein metabolism; Hormonal regulation of metabolism; Metabolic adaptations during fasting and starvation; Metabolic disorders; Bioenergetics in health and disease; Applications of metabolism in biotechnology.

Books for Reference:

1. Lehninger Principles of Biochemistry – David L. Nelson and Michael M. Cox.
2. Biochemistry – Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr. and Lubert Stryer.
3. Harper's Illustrated Biochemistry – Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly and P. Anthony Weil.
4. Biochemistry – Donald Voet, Judith G. Voet and Charlotte W. Pratt.
5. Biochemistry – U. Satyanarayana and U. Chakrapani.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/>
2. <https://www.khanacademy.org/>
3. <https://www.ebi.ac.uk/>
4. <https://www.biochemj.org/>
5. <https://www.fao.org/>

Course Outcomes:

CO1: Demonstrate knowledge of bioenergetic principles and metabolic pathways.

CO2: Apply concepts of carbohydrate, lipid and amino acid metabolism.

CO3: Analyse energy production through oxidative phosphorylation.

CO4: Interpret metabolic regulation during normal and altered physiological states.

CO5: Evaluate metabolic processes in health, disease and biotechnology.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECE	Semester	-
Medium of Instruction: English						Elective Course: 5	

ELECTIVE COURSE – 5 - BIOMOLECULAR CONCEPTS AND APPLICATIONS

Learning Objectives

1. To understand the structure, properties and functions of biomolecules.
2. To learn the basic concepts of DNA, RNA and protein synthesis.
3. To understand the fundamentals of protein engineering and recombinant proteins.
4. To learn the basic methods of recombinant DNA, PCR and protein expression.
5. To become familiar with CRISPR, gene therapy, mRNA vaccines and cell-free protein synthesis.

UNIT I: Introduction to Biomolecules

Introduction to Biomolecular Engineering. Importance and applications. Biomolecules: Carbohydrates, Proteins, Lipids and Nucleic acids (DNA and RNA).

UNIT II: DNA, RNA and Protein Synthesis

Structure of DNA and RNA. Central Dogma (DNA → RNA → Protein). Transcription and Translation. Protein synthesis (basic concept). Plasmids and their role in protein expression.

UNIT III: Protein Engineering

Introduction to protein engineering. Objectives and importance. Rational design and directed evolution (basic concepts). Recombinant proteins. Applications in medicine and industry. Recombinant human insulin as an example.

UNIT IV: Genetic and Molecular Engineering

Introduction to genetic engineering. Recombinant DNA technology. Primer design (basic concept). PCR. Restriction enzymes. DNA ligase. *Escherichia coli* as a host for recombinant protein expression.

UNIT V: Modern Biomolecular Engineering and Synthetic Biology

CRISPR-Cas9, guide RNA, Cas9 and PAM sequence (basic concepts). Gene therapy. mRNA vaccines and COVID-19 vaccines. Introduction to synthetic biology. Cell-free protein synthesis (basic concept). Applications of synthetic biology.

Books for Reference:

1. Biomolecular Engineering – Peter Dunnill, Michael D. Lilly and F. Mark Wang
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten
3. Principles of Gene Manipulation and Genomics – Sandy B. Primrose and Richard Twyman
4. Introduction to Protein Structure – Carl Branden and John Tooze
5. Biochemistry – David L. Nelson and Michael M. Cox.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/>
2. <https://www.ebi.ac.uk/>

3. <https://www.uniprot.org/>
4. <https://www.rcsb.org/>
5. <https://www.nature.com/subjects/biomolecular-engineering>

Course Outcomes:

CO1: Explain the structure and functions of major biomolecules.

CO2: Describe the central dogma and the basic mechanisms of DNA replication, transcription and translation.

CO3: Understand the basic principles of protein engineering and recombinant protein production.

CO4: Explain the concepts of genetic engineering, PCR, recombinant DNA technology and CRISPR-Cas9.

CO5: Describe the applications of biomolecular engineering and synthetic biology in medicine, agriculture and industry.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECF	Semester	-
Medium of Instruction: English						Elective Course: 6	

ELECTIVE COURSE – 6 - NANO BIOTECHNOLOGY

Learning Objectives

1. To understand the classification, synthesis and properties of nanomaterials used in biotechnology.
2. To acquire knowledge of biological methods for nanoparticle synthesis and characterization techniques.
3. To examine the role of nanobiotechnology in drug delivery, diagnostics and tissue engineering.
4. To explore the applications of nanotechnology in agriculture, environmental remediation and food technology.
5. To recognize the industrial applications, biosafety, nanotoxicology and regulatory aspects of nanobiotechnology.

UNIT I: Introduction to Nanobiotechnology

Introduction to nanotechnology and nanobiotechnology; Classification and properties of nanomaterials; Nanoparticles and nanostructures; Methods of nanoparticle synthesis; Characterization of nanomaterials.

UNIT II: Biological Synthesis and Characterization of Nanomaterials

Green synthesis of nanoparticles using microorganisms and plants; Microbial and plant-mediated nanoparticle synthesis; Characterization techniques: UV–Visible spectroscopy, X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), FTIR and Dynamic Light Scattering (DLS).

UNIT III: Nanobiotechnology in Medicine

Drug delivery systems; Targeted drug delivery; Nano diagnostics; Biosensors; Nanoparticles in cancer diagnosis and therapy; Tissue engineering and regenerative medicine.

UNIT IV: Agricultural and Environmental Nanobiotechnology

Applications of nanotechnology in agriculture; Nano fertilizers and nano pesticides; Environmental remediation; Water purification; Nanomaterials in food technology; Safety aspects of nanomaterials.

UNIT V: Industrial Applications and Safety

Industrial applications of nanobiotechnology; Nanomaterials in biotechnology and pharmaceuticals; Nanotoxicology; Biosafety and bioethics; Regulatory aspects and prospects of nanobiotechnology.

Books for Reference:

1. Nanobiotechnology: Concepts, Applications and Perspectives – Christof M. Niemeyer and Chad A. Mirkin.
2. Introduction to Nanotechnology – Charles P. Poole Jr. and Frank J. Owens.
3. Nanobiotechnology – C. M. Niemeyer and C. A. Mirkin.
4. Nanobiotechnology: Principles and Applications – Tuan Vo-Dinh.

5. Nanotechnology: Principles and Practices – Sulabha K. Kulkarni.

Web Resources:

1. <https://www.nano.gov/>
2. <https://www.nature.com/subjects/nanobiotechnology>
3. <https://www.ebi.ac.uk/>
4. <https://www.ncbi.nlm.nih.gov/>
5. <https://www.ncbi.nlm.nih.gov/>

Course Outcomes:

CO1: Explain the concepts and classification of nanomaterials used in biological systems.

CO2: Perform biological synthesis and characterization of nanoparticles using suitable techniques.

CO3: Utilize nanobiotechnology for biomedical applications including targeted drug delivery and diagnostics.

CO4: Assess the applications of nanotechnology in agriculture and environmental management.

CO5: Interpret the safety, ethical and industrial aspects of nanobiotechnology.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECG	Semester	-
Medium of Instruction: English						Elective Course: 7	

ELECTIVE COURSE – 7 - FORENSIC BIOTECHNOLOGY

Learning Objectives

1. To understand the principles of forensic biotechnology and biological evidence management.
2. To acquire knowledge of DNA profiling and molecular techniques used in forensic investigations.
3. To study forensic serology and molecular approaches for human identification.
4. To explore the applications of forensic biotechnology in criminal investigations and wildlife forensics.
5. To recognize recent advances, bioinformatics applications and ethical issues in forensic biotechnology.

UNIT I: Introduction to Forensic Biotechnology

Introduction to forensic science and forensic biotechnology; Scope and applications; Crime scene investigation; Collection, preservation and transportation of biological evidence; Chain of custody; Laboratory safety and quality assurance.

UNIT II: DNA Profiling and Molecular Techniques

DNA extraction from forensic samples; DNA quantification; Polymerase Chain Reaction (PCR); Short Tandem Repeats (STRs); DNA fingerprinting; Gel electrophoresis; DNA databases and their applications.

UNIT III: Forensic Serology and Human Identification

Blood group analysis; Bloodstain pattern analysis; Semen, saliva and hair analysis; Mitochondrial DNA analysis; Y-chromosome markers; Human identification and kinship analysis.

UNIT IV: Applications of Forensic Biotechnology

Forensic investigation of homicide, sexual assault and paternity disputes; Wildlife forensics; Microbial forensics; Forensic toxicology (Introduction); Disaster victim identification.

UNIT V: Recent Advances and Ethical Issues

Next Generation Sequencing (NGS) in forensics; Forensic genomics; Bioinformatics in forensic science; Quality assurance and accreditation of forensic laboratories; Ethical, legal and regulatory aspects of forensic biotechnology.

Books for Reference:

1. Forensic DNA Typing – John M. Butler.
2. Fundamentals of Forensic DNA Typing – John M. Butler.
3. Forensic Biotechnology – Mohammed Y. El-Naggar.
4. Forensic Biology – Richard Li.
5. Forensic Science: An Introduction to Scientific and Investigative Techniques – Stuart H. James and Jon J. Nordby.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/>
2. <https://www.fbi.gov/>
3. <https://www.interpol.int/>
4. <https://www.nist.gov/>
5. <https://www.cdc.gov/>

Course Outcomes:

CO1: Demonstrate knowledge of forensic biotechnology and crime scene evidence handling.

CO2: Apply DNA profiling techniques in forensic investigations.

CO3: Analyse biological samples for human identification and kinship analysis.

CO4: Integrate forensic biotechnology in criminal, wildlife and disaster investigations.

CO5: Evaluate recent technologies and regulatory aspects of forensic biotechnology.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECH	Semester	-
Medium of Instruction: English						Elective Course: 8	

ELECTIVE COURSE – 8 - ENZYMOLOGY

Learning Objectives

1. To understand enzyme classification, structure, cofactors and catalytic properties.
2. To acquire knowledge of enzyme kinetics, inhibition and mechanisms of enzyme action.
3. To study enzyme extraction, purification, assay methods and immobilization techniques.
4. To explore industrial, clinical and diagnostic applications of enzymes.
5. To recognize advanced concepts including allosteric enzymes, ribozymes and enzyme engineering.

UNIT I: Introduction to Enzymology

Introduction to enzymes; Nomenclature and classification of enzymes; Chemical nature and properties of enzymes; Cofactors, coenzymes and prosthetic groups; Active site and specificity of enzymes.

UNIT II: Enzyme Kinetics and Mechanism of Action

Michaelis–Menten kinetics; Factors affecting enzyme activity; Lineweaver–Burk plot; Enzyme inhibition; Mechanism of enzyme action; Regulation of enzyme activity.

UNIT III: Enzyme Isolation and Immobilization

Sources of enzymes; Enzyme extraction and purification; Enzyme assay methods; Immobilization of enzymes; Immobilized enzyme systems; Industrial significance of immobilized enzymes.

UNIT IV: Industrial and Clinical Enzymology

Industrial applications of enzymes; Enzymes in food, pharmaceutical, textile and detergent industries; Clinical enzymes as diagnostic markers; Therapeutic enzymes; Biosensors and enzyme-based diagnostics.

UNIT V: Advanced Enzymology

Allosteric enzymes; Isoenzymes; Ribozymes; Enzyme engineering; Protein engineering of enzymes; Recent advances and future prospects in enzymology.

Books for Reference:

1. Fundamentals of Enzymology – Nicholas C. Price and Lewis Stevens.
2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry – Trevor Palmer and Philip L. Bonner.
3. Lehninger Principles of Biochemistry – David L. Nelson and Michael M. Cox.
4. Biochemistry – Donald Voet, Judith G. Voet and Charlotte W. Pratt.
5. Biochemistry – U. Satyanarayana and U. Chakrapani.

Web Resources:

1. <https://www.brenda-enzymes.org/>
2. <https://www.expasy.org/>
3. <https://www.ncbi.nlm.nih.gov/>
4. <https://www.ebi.ac.uk/>

5. <https://www.khanacademy.org/>

Course Outcomes:

CO1: Demonstrate knowledge of enzyme structure, classification and catalytic mechanisms.

CO2: Interpret enzyme kinetics and factors influencing enzyme activity.

CO3: Perform enzyme isolation, purification and immobilization techniques.

CO4: Utilize enzymes in industrial, clinical and diagnostic applications.

CO5: Assess recent developments in enzyme engineering and modern enzymology.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECI	Semester	-
Medium of Instruction: English						Elective Course: 9	

ELECTIVE COURSE – 9 - FOOD BIOTECHNOLOGY

Learning Objectives

1. To understand the principles of food science, food groups and food preparation methods.
2. To acquire knowledge of nutritional composition and processing of pulses and beverages.
3. To study the nutritional quality and processing of meat, poultry and fish products.
4. To explore the role of biotechnology in functional foods and nutritional enhancement.
5. To recognize food quality control measures and the significance of food additives.

UNIT I: Food Science Principles

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

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

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

Biotechnology in Functional Foods Role of biotechnology in the development of functional foods. Overview of prebiotics, probiotics, and symbiotic. Importance of dietary lipids, vitamins, and minerals in promoting human health, Biofortified crops

UNIT V: Food Quality and Additives

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.

Books for Reference:

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.

Web Resources:

1. <https://www.fssai.gov.in/>
2. <https://www.fao.org>

3. <https://www.who.int/>
4. <https://www.cfsan.fda.gov/>
5. <https://www.ifst.org/>

Course Outcomes:

CO1: Explain the principles of food science and nutritional classification of foods.

CO2: Analyse the nutritional value and processing of plant-based food products.

CO3: Evaluate the quality and preparation of animal-derived foods.

CO4: Apply biotechnology concepts in the development of functional foods.

CO5: Assess food quality standards, additives and food safety practices.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	4	Hours/Week	5	Sub Code	BBTECJ	Semester	-
Medium of Instruction: English						Elective Course: 10	

ELECTIVE COURSE – 10 - AI AND BIOINFORMATICS

Learning Objectives

1. To understand the fundamentals of artificial intelligence, bioinformatics and biological databases.
2. To acquire knowledge of sequence analysis, genome annotation and phylogenetic analysis.
3. To study machine learning approaches and AI applications in genomics, proteomics and drug discovery.
4. To explore computational biology tools for molecular docking, systems biology and precision medicine.
5. To recognize emerging technologies, ethical issues and prospects of AI in life sciences.

UNIT I: Introduction to Artificial Intelligence and Bioinformatics

Introduction to Artificial Intelligence (AI); History and scope of AI in life sciences; Introduction to bioinformatics; Biological databases; Sequence databases; Structure databases; Data retrieval and biological information resources.

UNIT II: Biological Data Analysis

Sequence alignment; Pairwise and multiple sequence alignment; BLAST; Phylogenetic analysis; Genome and proteome databases; Gene prediction; Functional annotation.

UNIT III: AI Applications in Bioinformatics

Machine learning concepts; Supervised and unsupervised learning; AI applications in genomics, proteomics and drug discovery; Pattern recognition in biological data; Protein structure prediction; Biological network analysis.

UNIT IV: Computational Biology and Drug Discovery

Molecular docking; Virtual screening; Molecular dynamics (Introduction); Computer-aided drug design; Systems biology; Precision medicine; Biomedical data analysis.

UNIT V: Emerging Trends and Ethical Issues

Deep learning in bioinformatics; Big data in life sciences; Cloud computing in bioinformatics; AI in healthcare and biotechnology; Ethical, legal and social issues; Future prospects of AI and bioinformatics.

Books for Reference:

1. Bioinformatics: Sequence and Genome Analysis – David W. Mount.
2. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Andreas D. Baxevanis and B. F. Francis Ouellette.
3. Introduction to Bioinformatics – Arthur M. Lesk.
4. Artificial Intelligence: A Modern Approach – Stuart J. Russell and Peter Norvig.
5. Bioinformatics and Functional Genomics – Jonathan Pevsner.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/>
2. <https://www.ebi.ac.uk/>
3. <https://blast.ncbi.nlm.nih.gov/>
4. <https://www.uniprot.org/>
5. <https://alphafold.ebi.ac.uk/>

Course Outcomes:

CO1: Demonstrate knowledge of AI concepts and bioinformatics resources.

CO2: Apply bioinformatics tools for sequence and genome analysis.

CO3: Utilize artificial intelligence techniques for biological data interpretation.

CO4: Integrate computational approaches in drug discovery and biomedical research.

CO5: Evaluate emerging trends and ethical considerations in AI-enabled biotechnology.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	2	Hours/Week	2	Sub Code	B3BTSE1	Semester	III
Medium of Instruction: English						Skill Enhancement course:1	

SEC 1 – VERMI TECHNOLOGY

Learning Objectives

1. To understand the biological characteristics of earthworms used in vermi technology.
2. To acquire skills in vermiculture and compost preparation techniques.
3. To evaluate factors influencing vermicompost production.
4. To design small-scale and commercial vermicomposting systems.
5. To encourage sustainable waste management through Vermi technology.

Unit I: Fundamentals of Vermi technology

Introduction to Vermi technology, types and characteristics of earthworms, and their role in soil fertility. Biology, collection, preservation, and identification of suitable earthworm species. Flow chart and principles of Vermi technology.

Unit II: Earthworm Culturing and Composting Materials

Methods of earthworm culture including pot and wooden box techniques. Propagation and factors affecting earthworm growth. Vermicomposting materials and their preliminary treatment.

Unit III: Vermicompost Production and Harvesting

Preparation, maintenance, and harvesting of vermicompost. Maturity indicators, quality evaluation, storage, and applications of vermicompost. Uses of Vermi wash and vermicompost in sustainable agriculture.

Unit IV: Small-Scale Vermicomposting Techniques

Indoor dual-bin, bed, pit, heap, expandable worm tower, and hanging basket methods. Preparation and maintenance of small-scale vermicomposting units. Physical, chemical, and biological properties of vermicompost.

Unit V: Large-Scale Vermicomposting and Commercial Production

Large-scale vermicomposting methods including outdoor dual-bin, raised cage, dual pit, commercial model, and trickling filter systems. Commercial production, marketing, and entrepreneurship. Future prospects of Vermi technology in sustainable agriculture.

Books for Reference:

1. The Earthworm book, Ismail, S.A., other India Press, Goa
2. Somani, L.L. 2008. Vermicomposting and vermiwash. Agrotech Publishing Academy, Udaipur.
3. Talashilkar and Dosani, 2005. Earthworm in Agriculture. Agrobios (India), Jodhpur.
4. Ranganathan, L.S. 2006. Vermibiotechnology from soil health to human health – Agrobios, India.

Web Resources:

1. <https://icar.org.in/>
2. <https://tnau.ac.in/>
3. <https://www.fao.org/>
4. <https://cpcb.nic.in/>
5. <https://nbaindia.org/>

Course Outcomes

- CO1:** Characterize earthworm species suitable for vermicomposting.
- CO2:** Produce vermicompost using scientific cultivation methods.
- CO3:** Evaluate the quality and properties of vermicompost.
- CO4:** Design vermicomposting units for domestic and commercial applications.
- CO5:** Encourage sustainable agricultural practices using vermi technology.

Question Paper Pattern

(Time: 3 Hours)

(Marks: 75)

Part - A: 5 out of 7 questions, at least one question from each unit (5x 6 = 30 marks)

Part - B: One question from each unit (3 x 15 = 45 Marks)

Credits	2	Hours/Week	2	Sub Code	B4BTSE2	Semester	IV
Medium of Instruction: English						Skill Enhancement course:2	

SEC 2 - MUSHROOM TECHNOLOGY

Learning Objectives

1. To identify the diversity and economic importance of edible mushrooms.
2. To acquire practical knowledge of mushroom cultivation techniques.
3. To demonstrate post-harvest handling and preservation methods.
4. To improve value addition and quality management of mushroom products.
5. To establish entrepreneurial competence in mushroom production

Unit I: Introduction to Mushrooms

History of mushroom cultivation, Scope and importance of mushroom industry, Classification of edible and poisonous mushrooms, Morphology and life cycle of mushrooms, Nutritional and medicinal value of mushrooms

Unit II: Mushroom Cultivation

Cultivated mushroom species (Button, Oyster, Milky, Paddy straw, Shiitake), Spawn production, Substrate preparation Composting, Spawning and incubation, Environmental conditions (temperature, humidity, light, ventilation), Crop management

Unit III: Harvesting and Post-Harvest Technology

Harvesting techniques, Cleaning, grading and packaging, Storage and preservation, Value-added mushroom products, Marketing and economics

Unit IV: Harvesting and Post-Harvest Technology

Harvesting techniques, Cleaning, grading and packaging, Storage and preservation, Value-added mushroom products, Marketing and economics.

Unit V: Entrepreneurship

Mushroom farm establishment, Cost–benefit analysis Small-scale mushroom industry, Government schemes, Commercial mushroom production and business opportunities.

Books for Reference:

1. Mushroom Cultivation Technology – B.C. Suman
2. Mushrooms: Cultivation, Nutritional Value, Medicinal Effect and Environmental Impact – Shu-Ting Chang & Philip G. Miles
3. Growing Gourmet and Medicinal Mushrooms – Paul Stamets
4. The Mushroom Cultivator: A Practical Guide to Growing Mushrooms at Home – Paul Stamets & J.S. Chilton
5. Mushroom Cultivation in India – B.C. Suman & V.P. Sharma.

Web Resources:

1. <https://dmrsolan.res.in/>
2. <https://icar.org.in/>
3. <https://tnau.ac.in>
4. <https://nhb.gov.in/>
5. <https://www.fao.org/>

Course Outcomes

CO1: Distinguish edible and poisonous mushroom species.

CO2: Cultivate mushrooms under suitable environmental conditions.

CO3: Process and preserve mushroom products using standard methods.

CO4: Enhance product quality through appropriate post-harvest practices.

CO5: Establish small-scale mushroom production enterprises.

Question Paper Pattern

(Time: 3 Hours)

(Marks: 75)

Part - A: 5 out of 7 questions, at least one question from each unit (5x 6 = 30 marks)

Part - B: One question from each unit (3 x 15 = 45 Marks)

Credits	2	Hours/Week	2	Sub Code	B5BTSE3	Semester	V
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SEC 3 - BIOPESTICIDE AND BIOFERTILIZER

Learning Objectives

1. To recognize the importance of biopesticides and biofertilizers in sustainable agriculture.
2. To investigate beneficial microorganisms associated with crop productivity.
3. To formulate concepts of biological pest control and nutrient management.
4. To optimize production and quality control of microbial products.
5. To encourage eco-friendly agricultural technologies for sustainable farming.

Unit I: Fundamentals of Biofertilizers and Biopesticides

Introduction to sustainable agriculture, organic farming, and biological inputs. Types of biofertilizers and biopesticides, soil microbiology, rhizosphere, and plant–microbe interactions. Advantages and limitations of biofertilizers and biopesticides.

Unit II: Biopesticides

Classification and applications of bacterial, fungal, viral, and botanical biopesticides. Important biopesticides including *Bacillus thuringiensis* (Bt), *Pseudomonas fluorescens*, *Trichoderma* spp., *Beauveria bassiana*, *Metarhizium anisopliae*, and Nuclear Polyhedrosis Virus (NPV). Mode of action and role in sustainable crop protection.

Unit III: Biofertilizers

Types and applications of nitrogen-fixing, phosphate-solubilizing, and potassium-solubilizing microorganisms. *Rhizobium*, *Azotobacter*, *Azospirillum*, *Frankia*, cyanobacteria, *Azolla–Anabaena*, mycorrhiza, and Plant Growth-Promoting Rhizobacteria (PGPR). Role of biofertilizers in sustainable agriculture.

Unit IV: Organic Farming and Certification

Organic crop production practices, certification process, and standards in India. Certification agencies including AGMARK, FSSAI, Halal, and PGS. Quality assurance and certification of organic products.

Unit V: Recent Advances and Future Perspectives

Recent advances in nano-biofertilizers, nano-biopesticides, microbial consortia, and precision agriculture. Integrated Nutrient Management (INM), Integrated Pest Management (IPM), and climate-smart agriculture. Commercial production, government regulations, and future prospects.

Books for Reference:

1. H.C. Lakshmana & A. Channabasava – Biofertilizers and Biopesticides (Pointer Publishers).
2. N.S. Subba Rao – Biofertilizers in Agriculture and Forestry (Scientific Publishers).
3. G. Rangaswami & D.J. Bagyaraj – Agricultural Microbiology (PHI Learning).
4. R.C. Dubey – A Textbook of Biotechnology (S. Chand).
5. K.G. Mukerji, B.P. Chamola & J. Singh (Eds.) – Biocontrol of Plant Diseases (CRC Press/Springer).

Web Resources:

1. <https://www.icar.org.in>
2. <https://www.iari.res.in>
3. <https://ncipm.icar.gov.in>

4. <https://www.fao.org>
5. <https://www.cabi.org>

Course Outcomes

CO1: Select suitable microbial products for agricultural applications.

CO2: Produce quality biopesticides and biofertilizers using standard techniques.

CO3: Apply biological inputs for crop protection and soil fertility improvement.

CO4: Maintain quality standards during production and storage.

CO5: Assess recent innovations in sustainable agricultural biotechnology.

Question Paper Pattern

(Time: 3 Hours)

(Marks: 75)

Part - A: 5 out of 7 questions, at least one question from each unit (5x 6 = 30 marks)

Part - B: One question from each unit (3 x 15 = 45 Marks)

Credits	2	Hours/Week	2	Sub Code	B6BTSE4	Semester	VI
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SEC 4 - ORGANIC FARMING

Learning Objectives

1. To appreciate the importance of organic farming for sustainable agriculture.
2. To cultivate knowledge of organic manures and biofertilizers.
3. To implement eco-friendly methods for pest, weed, and disease management.
4. To examine certification standards and quality assurance in organic farming.
5. To strengthen entrepreneurial skills related to organic agriculture

Unit I: Fundamentals of Organic Farming

Introduction, principles, and importance of organic farming for sustainable development. Promotion of organic agriculture in India and concepts of the organic ecosystem. Scope and benefits of organic farming.

Unit II: Organic Manures and Biofertilizers

Preparation and management of farmyard manure, farm compost, and town compost. Concentrated organic manures and biofertilizers. Role of organic inputs in sustainable agriculture.

Unit III: Organic Crop Protection

Management of insect pests, weeds, and diseases in organic farming. Identification of common symptoms and preventive measures. Eco-friendly crop protection practices.

Unit IV: Organic Crop Production and Certification

Organic crop production practices and certification standards in India. Certification process and agencies such as AGMARK, FSSAI, Halal, and PGS. Quality assurance in organic farming.

Unit V: Organic Product Processing and Marketing

Storage, processing, packaging, labelling, marketing, and export of organic products. Economic value of organic farming and entrepreneurship opportunities. Role of micro-enterprises, SHGs, and MSMEs.

Books for Reference:

1. Maliwal, P. L., 2019. Principles of Organic Farming: Text book. Scientific Publisher
2. Baradkar, D.D., 2021. Organic Farming Systems, Sakal Media Pvt. Ltd.
3. Annadurai, K. and Palaniappan, S. P., 2018. Organic Farming: Theory And Practice, Scientific Publishers.
4. Reddy, S.R., 2017. Principles of Organic Farming, Kalyani Publishers.

Web Resources:

1. <https://www.fao.org/organicag/>
2. <https://nconf.dac.gov.in>
3. <https://icar.org.in>
4. <https://www.fibl.org>
5. <https://apeda.gov.in/apedawebsite/organic/index.html>

Course Outcomes:

CO1: Adopt sustainable organic farming practices.

CO2: Prepare organic nutrient formulations for crop production.

CO3: Apply biological methods for crop protection.

CO4: Follow certification procedures for organic products.

CO5: Promote value addition and marketing of organic produce.

Question Paper Pattern

(Time: 3 Hours)

(Marks: 75)

Part - A: 5 out of 7 questions, at least one question from each unit (5x 6 = 30 marks)

Part - B: One question from each unit (3 x 15 = 45 Marks)

Credits	2	Hours/Week	3	Sub Code	B5BTNM1	Semester	V
Medium of Instruction: English					Non-Major Elective Course: 1		

NME1 - LIFESTYLE DISEASES

Learning Objectives

1. To familiarize learners with the biological and environmental determinants of lifestyle diseases.
2. To analyse the molecular and physiological mechanisms underlying major non-communicable diseases.
3. To interpret the influence of nutrition, physical activity, and behavioural factors on disease progression.
4. To formulate preventive and therapeutic strategies for the management of lifestyle disorders.
5. To integrate emerging technologies and public health approaches for improving quality of life.

UNIT I: Introduction to Lifestyle Diseases

Definition and concept of lifestyle diseases, Healthy and unhealthy lifestyle habits, Risk factors: unhealthy diet, physical inactivity, smoking, alcohol, stress prevention through healthy living.

UNIT II: Common Lifestyle Diseases

Obesity, Diabetes mellitus, Hypertension, Cardiovascular diseases, respiratory diseases (related to smoking), Cancer (overview).

UNIT III: Nutrition and Physical Fitness

Balanced diet and food groups, Importance of exercise and physical activity, Weight management, Sleep and mental well-being, Yoga and meditation for health.

UNIT IV: Prevention and Early Detection

Regular health check-ups, Vaccination and preventive healthcare, Screening for diabetes, hypertension, and cancer Stress management techniques, Healthy habits for different age groups.

UNIT V: Lifestyle Modification and Public Health

Health education and awareness, Government initiatives for prevention of non-communicable diseases, Digital health and fitness applications, Role of family and community in disease prevention. Future trends in lifestyle disease management.

Books for Reference:

1. James M. Rippe. Lifestyle Medicine. CRC Press
2. David L. Katz. Nutrition in Clinical Practice. Lippincott Williams & Wilkins.
3. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy & Hester H. Vorster. Introduction to Human Nutrition. Wiley-Blackwell.
4. Frank B. Hu. Obesity Epidemiology. Oxford University Press.
5. World Health Organization. Preventing Chronic Diseases: A Vital Investment.

Web Resources

1. <https://www.who.int>
2. <https://www.cdc.gov/chronicdisease>
3. <https://www.nin.res.in>
4. <https://www.nhp.gov.in>
5. <https://www.fssai.gov.in>

Course Outcomes

CO1: Correlate genetic, metabolic, and environmental factors with the development of lifestyle diseases.

CO2: Differentiate the pathophysiological mechanisms and clinical features of major non-communicable diseases.

CO3: Apply nutritional and lifestyle interventions for disease prevention and health promotion.

CO4: Assess diagnostic approaches and evidence-based management strategies for chronic disorders.

CO5: Integrate preventive healthcare practices with recent advances in lifestyle disease management.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)

Credits	2	Hours/Week	3	Sub Code	B6BTNM2	Semester	VI
Medium of Instruction: English					Non-Major Elective Course: 2		

NME 2 - SOCIAL AND PREVENTIVE MEDICINE

Learning Objectives

1. To acquaint learners with the principles and scope of social and preventive medicine in public health.
2. To examine the epidemiology, transmission, and prevention of communicable and non-communicable diseases.
3. To evaluate environmental, occupational, and nutritional factors influencing community health.
4. To strengthen knowledge of national health programmes and disease surveillance systems.
5. To promote evidence-based public health practices for improving individual and community well-being.

UNIT I: Principles of Social and Preventive Medicine

Concept, scope and objectives of social and preventive medicine – Determinants of health – Health indicators – Epidemiology: measures of disease frequency, epidemiological methods and study designs – Natural history of disease – Levels of disease prevention – Screening and surveillance

UNIT II: Communicable and Non-Communicable Diseases

Epidemiology, transmission, prevention and control of communicable diseases (Tuberculosis, Malaria, Dengue, HIV/AIDS, Hepatitis and COVID-19) – non-communicable diseases: diabetes, hypertension, cardiovascular diseases, cancer and obesity – Emerging and re-emerging infectious diseases.

UNIT III: Environmental, Occupational and Nutritional Health

Water, air and soil pollution – Waste management – Environmental sanitation – Occupational hazards and occupational diseases – Food hygiene and food safety – Balanced nutrition – Nutritional deficiency disorders – Public health nutrition

UNIT IV: Maternal, Child and Community Health

Maternal and child health services – Reproductive health – Family welfare programmes – Immunization schedules – Adolescent health – Geriatric healthcare – School health services – Primary healthcare system and community participation.

UNIT V: National Health Programmes and Recent Advances

National Health Mission (NHM) – National Programme for Prevention and Control of Non-Communicable Diseases (NP-NCD) – Universal Immunization Programme (UIP) – Integrated Disease Surveillance Programme (IDSP) – Health education – Digital health and telemedicine – Recent advances in preventive medicine.

Books for Reference:

1. Park, K. Park's Textbook of Preventive and Social Medicine. Banarsidas Bhanot Publishers.
2. Leon Gordis. Epidemiology. Elsevier.
3. Maxcy-Rosenau-Last. Public Health and Preventive Medicine. McGraw-Hill.
4. Wallace, R. B. Maxcy-Rosenau-Last Public Health and Preventive Medicine. McGraw-Hill.

5. Oxford University Press. Oxford Handbook of Public Health Practice.

Web Resources

1. <https://www.who.int>
2. <https://www.mohfw.gov.in>
3. <https://www.nhp.gov.in>
4. <https://www.cdc.gov>
5. <https://www.nhm.gov.in>

Course Outcomes

CO1: Interpret the concepts and principles of social and preventive medicine in healthcare delivery.

CO2: Analyse epidemiological data for the prevention and control of communicable and non-communicable diseases.

CO3: Apply public health measures to improve environmental sanitation, nutrition, and occupational health.

CO4: Assess the implementation of national health programmes and immunization strategies for disease prevention.

CO5: Integrate health education, surveillance, and community-based interventions for effective public health management.

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)

Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)

Part - C: Three out of Five Questions (One from each Unit) (3x10 = 30 Marks)