

Deccan Education Society's
**Kirti M. Doongursee College of Arts,
Science and Commerce
(AUTONOMOUS)**



Affiliated to
UNIVERSITY OF MUMBAI

Syllabus for
Program: **Bachelor of Science**
Course: **T.Y.B.Sc**
Subject: **Biotechnology**

Choice Based Credit System (CBCS)
with effect from
Academic Year 2025-2026

Semester	Course Code	Course Title	Vertical	Credit
V	25BTMJ511	Cell Biology	Major	2
	25BTMJ512	Genomics and Molecular Biology	Major	2
	25BTMJ513	Marine Biotechnology	Major	2
	25BTMJ514	Indian Research Institute related to Biotechnology	Major Specific IKS	2
	25BTMJP51	Practical-5 (Cell Biology + Genomics and Molecular Biology + Marine Biotechnology)	Major	2
	25BTMRC521/ 25BTMRM522/ 25BTMRL523	Chemistry-IV/ Microbiology-IV/ Life Science-IV	Minor	2
	25BTMRCP521/ 25BTMRMP522/ 25BTMRLP523	Practical (Chemistry-IV/ Microbiology-IV/ Life Science-IV)	Minor	2
	25BTAC531	Biosafety & IPR	AC/ Elective	2
	25BTACP53	Practical (Biosafety & IPR)	AC/ Elective	2
	25BTVS541	Bakery & Confectionery	VSC	2
	25BTFP5	Field Project	FP	2

Semester	Course Code	Course Title	Vertical	Credit
VI	25BTMJ611	Environmental Biotechnology-2	Major	2
	25BTMJ612	Pharmacology & Neurochemistry	Major	2
	25BTMJ613	Plant & Animal Biotechnology	Major	2
	25BTMJ614	Instrumentation Techniques	Major	2
	25BTMJP61	Practical-6 (Environmental Biotechnology + Pharmacology & Neurochemistry + Plant & Animal Biotechnology + Instrumentation Techniques)	Major	2
	25BTMRC621/ 25BTMRM622/ 25BTMRL623	Chemistry-V/ Microbiology-V/ Life Science-V	Minor	2
	25BTMRCP621/ 25BTMRMP622/ 25BTMRLP623	Practical (Chemistry-V/ Microbiology-V/ Life Science-V)	Minor	2
	25BTAC631	Agribiotechnology	AC/ Elective	2
	25BTACP63	Practical (Agribiotechnology)	AC/ Elective	2
	25BTOJT6	On-Job Training	OJT	4

PROGRAM OUTCOMES

PO	Description
A student completing Bachelor's Degree in Science Program will be able to:	
PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate program. Execute strong theoretical and practical understanding generated from the specific graduate program in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	Social competence: Display the understanding, behavioral skills needed for successful social adaptation, work in groups, exhibit thoughts and ideas effectively in writing and orally.
PO4	Research-related skills and Scientific temper: Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypotheses and inquisitiveness towards research.
PO5	Trans-disciplinary knowledge: Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	Personal and professional competence: Performing dependently and collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centered national development and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

SEMESTER V

Course Code	MAJOR-I SEM – V	Credits	Lectures /Week
25BTMJ511	Cell Biology	2	2
Course Outcomes: After successful completion of this course, students would be able to: - Identify the phases of the cell cycle, key regulators like cyclins and CDKs, and forms of intercellular signaling (autocrine, paracrine, synaptic, endocrine). - Describe how extracellular messengers (e.g., nitric oxide, calcium) and their receptors influence cell-cycle progression and apoptosis. - Analyze the impact of signaling pathways on cell-cycle checkpoints using molecular biology techniques. - Assess the effectiveness of signaling molecules (e.g., G-protein or enzyme-linked receptors) in modulating cell-cycle control and cell communication.			
Unit	Unit Name	Topics	No. of Lectures
I	Cell Cycle	Introduction: Prokaryotic and Eukaryotic cell cycle; The Early Embryonic Cell Cycle and the Role of MPF; Cell cycle in Yeasts and the Molecular Genetics of Cell-Cycle Control; Apoptosis and necrosis; Cell-Division Controls in Multicellular Animals.	15
II	Cell Signaling	General Principles of cell communication: Introduction, Forms of intercellular signaling - Autocrine, Contact dependent, Paracrine, Synaptic and Endocrine; Extracellular messengers and their receptors; Signaling via G-Protein-linked Cell-Surface Receptors; Signaling via Enzyme-linked Cell-Surface Receptors; Role of Nitric Oxide in Cell Signaling; Role of Calcium in Cell Signaling, Calcium binding proteins.	15
Textbooks: - The Cell: A Molecular Approach (4th Edition) – Geoffrey Cooper & Robert Hausman - Molecular Biology of the Cell (6th Edition) - Bruce Alberts - Cell and Molecular Biology: Concepts & Experiments (7th edition) – Gerard Karp - Molecular Cell Biology (8th Edition) – Harvey Lodish Additional References: - Biochemistry (4th Edition) – Voet & Voet			

Course Code	MAJOR-II SEM – V		Credits	Lectures /Week
25BTMJ512	Genomics & Molecular Biology		2	2
Course Outcomes: After successful completion of this course, students would be able to: - Recall genetic engineering methods used for plant and animal cells, and their role in gene delivery and expression. - Describe the processes involved in creating transgenic animals and plants. - Apply knowledge of genetic manipulation for improving seed quality proteins and generating transgenic traits. - Assess the impact of genetically engineered plants and animals on agriculture, biomedical research, and conservation efforts.				
Unit	Unit Name	Topics	No. of Lectures	
I	Genetic Engineering of Plants	Genetic engineering of plants: Methodology; Plant transformation with the Ti plasmid of <i>A.tumefaciens</i> , Ti plasmid derived vector system; Transgenic plants: Physical methods of transferring genes to plants: electroporation, microprojectile bombardment, liposome mediated, protoplast fusion; Vectors for plant cells; Improvement of seed quality protein.	15	
II	Transgenic Animals	Transgenic mice: methodology- retroviral method, DNA microinjection, ES method; Genetic manipulation with <i>cre-loxP</i> ; Vectors for animal cells; Transgenic animals recombination system; Cloning livestock by nuclear transfer; Green Fluorescent Protein; Transgenic fish.	15	
Textbooks: - Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology (3rd Edition) -Glick B.R., Pasternak J.J., Patten C.L. - Biotechnology (3rd Edition)- S.S. Purohit. - Principles of Gene Manipulation (7th Edition) - Primrose S.B., Twyman R.M.				
Additional References: - Genomes (3rd Edition) -T.A. Brown. - Biotechnology- B.D. Singh.				

Course Code	MAJOR-III SEM – V	Credits	Lectures /Week
25BTMJ513	Marine Biotechnology	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Recall key marine ecosystems and marine-derived bioactives along with their applications in nutraceuticals & cosmetics.
- Describe the roles of marine extremozymes, probiotics in enhancing health and cosmetic properties and biological functions and delivery systems of marine-derived ingredients in cosmetics and functional foods.
- Utilize bioprospecting techniques to isolate microorganisms and bioactive compounds from marine environments and use marine-derived bioactives in creating cosmeceuticals with biological properties.
- Evaluate the ecological and functional roles of marine ecosystems in providing resources for biotechnology.

Unit	Unit Name	Topics	No. of Lectures
I	Introduction to Marine Biotechnology and Marine Ecosystem	Introduction to Marine Biotechnology, The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal & deep sea ecosystems. Hydrothermal vents. Bioprospecting, Marine Microbial Habitats and Their Biotechnologically relevant Microorganisms - Methods for Microbial Bioprospecting in Marine Environments. Approved Marine Drugs as Pharmaceuticals Marine Extremozymes and Their Significance, Current Use of Marine Microbial Enzymes.	15
II	Marine nutraceuticals, Functional foods and cosmetics	Marine Nutraceuticals : Marine Bioactives as Potential Nutraceuticals, Functional Carbohydrates, Polyunsaturated Fatty Acids Carotenoids, Soluble Calcium, Fish Collagen and Gelatin, Marine Probiotics Marine Functional Foods: Marine-Derived Ingredients with Biological Properties Functional Foods Incorporating Marine-Derived Ingredients. Cosmetics from Marine Sources: Cosmetics: Definition and Regulations, Cosmeceuticals , Target Organs and Cosmetics Delivery Systems , Components of Cosmetics, Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals , Treatments Based on Marine Resources , Products Based on Marine Resources.	15

Textbooks:

- Kim, S.K Springer Handbook on Marine Biotechnology ; Springer : Berlin Germany ; Heidelberg, Germany 2015
- Nollet , Leo M L Marine organisms : Extraction and analysis of Bioactive compounds CRC Press_Taylor and Francis (2017)

Additional References:

- R.S.K Barnes , R.N Hughes (auth) : An Introduction to Marine Ecology Third edition

Course Code	MAJOR-IV SEM – V	Credits	Lectures /Week
25BTMJ514	Indian Research Institutes related to Biotechnology	2	2
Course Outcomes: After successful completion of this course, students would be able to: - Recall the major contributions of Indian Scientists and identify significant organizations like DBT, BIRAC, CSIR, ICAR, ICMR, and DST, and their roles in advancing biotechnology in India. - Discuss the impact of innovations by Indian scientists and significance of schemes like BIRAC's BIG and DST's SERB in fostering biotech innovation. - Apply knowledge of DBT or BIRAC schemes to draft funding proposals for biotech innovations. - Compare the roles of organizations like CSIR, ICAR, and ICMR in promoting biotech applications across agriculture, healthcare, and industry.			
Unit	Unit Name	Topics	No. of Lectures
I	Contribution of Indian Scientists in Biotechnology	Role of Indian Scientists in Global Biotechnology: Dr. M. S.Swaminathan: Green Revolution and Agricultural Biotechnology; Dr. H. G. Khorana: DNA Synthesis & Genetic Code Research (Nobel Laureate); Dr. G. N. Ramachandran: Protein Structure and Molecular Biology; Dr. Yellapragada Subbarow: Discovery of ATP, Folic Acid, & Antibiotics) Contributions to Vaccine Development (e.g., COVID-19 Vaccines by Bharat Biotech & Serum Institute); Case studies on successful biotech startups (e.g., Bharat Biotech, Biocon); Mini project on biotech innovation funded by BIRAC; Virtual tours of DBT-funded institutions/incubator; Hands-on training or proposal writing for DBT or BIRAC schemes.	15
II	Biotechnology Institutions & Government Initiatives	Department of Biotechnology (DBT) – vision, mandate, achievements Biotechnology Industry Research Assistance Council (BIRAC) – innovation funding, schemes like BIG Council of Scientific and Industrial Research (CSIR) – biotech-based labs and networks; Indian Council of Agricultural Research (ICAR) – biotechnology in agriculture; Indian Council of Medical Research (ICMR) – biomedical biotech initiatives; Ministry of Science & Technology – policy roles and interdisciplinary support; Department of Science and Technology (DST) – SERB, FIST, and TARE programs; Information on National Institute [(NII) New Delhi, (NCCS) Pune, (IGIB) Delhi, (CDFD) Hyderabad, (NIBMG) Kalyani, (ILS) Bhubaneswar, (RGCB) Kerala, (NABI), Mohali, (THSTI), Faridabad.	15

Textbooks:

- https://dbtindia.gov.in/sites/default/files/World%27s%20First%20DNA%20Vaccine_The%20Scientific%20Journey.pdf
- <https://pmc.ncbi.nlm.nih.gov/articles/PMC3061398/>
- <https://www.nobelprize.org/prizes/medicine/1968/khorana/facts/>
- <https://pubmed.ncbi.nlm.nih.gov/39310515/#:~:text=His%20discoveries%2C%20including%20the%20elucidati, on, oncology%2C%20and%20infectious%20disease%20treatment.>
- <https://www.britannica.com/biography/M-S-Swaminathan?>

Additional References:

- <https://www.birac.nic.in/>
- https://archive.biocon.com/biocon_invrelation_com_history.asp
- https://www.bharatbiotech.com/history_milestones.html
- <https://nptel.ac.in/> (For virtual learning)
- <https://dbtindia.gov.in/>
- <https://icar.org.in/>
- <https://icar.org.in/>
- <https://www.indiascienceandtechnology.gov.in/organisations/ministry-and-departments/indian-council-medical-research-icmr>

Course Code	PRACTICAL-5	Credits	Lectures/Week
25BTMJ51	Cell Biology + Genomics and Molecular Biology + Marine Biotechnology	2	4
Course Outcomes: After successful completion of this course, students would be able to: - Identify the steps involved in the transformation of <i>E. coli</i>, genomic DNA extraction from animal cells, and bacterial gene expression. - Describe the methods for antioxidant assays (DPPH), extraction of marine metabolites, and separation of alkaloids by TLC. - Apply western blotting to study signaling proteins in response to stimuli. - Discuss the relevance of signaling proteins in health and disease, as highlighted in the case study on cell signaling disorders.			
Topics - Transformation in E.coli. - Genomic DNA Extraction: Animal cells. - Bacterial gene expression (Kit may be used). - Detection of Signaling proteins in response to stimuli by western blotting (Demonstration) - Case Study: Cell Signaling Disorders and Their Impact on Health. - Visit to nearby coastal areas or marine research centers. - Study of any 2 marine bacteria or algae (Macro and micro). - DPPH assay for antioxidants extracted from marine algae. - Extraction of carotenoids from marine algae / Bacteria / Fungi - Extraction and estimation of Gelatin from Fish. - Extraction of Collagen from Fish and estimation of Collagen by Bradford method. - Extraction of alkaloids from marine organisms and their separation by TLC.			

Course Code	MINOR-I SEM – V	Credits	Lectures /Week
25BTMRC521	Chemistry - IV	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Identify the tertiary and quaternary structures of proteins, mechanisms of protein folding and carbohydrate biosynthetic pathways.
- Describe the protein interactions, regulation, energetics, and metabolic disorders associated with carbohydrate biosynthetic pathways.
- Examine the role of metabolic intermediates in modulating protein activity, particularly during energy generation.
- Evaluate the regulation of carbohydrate pathways and their impact on protein functions and cellular energetics.

Unit	Unit Name	Topics	No. of Lectures
I	Protein Biochemistry	Protein structure: Protein Tertiary and Quaternary Structures; Protein Denaturation and Folding; Protein Function: Reversible Binding of a Protein to a Ligand: Oxygen-Binding Proteins; Complementary Interactions between Proteins and Ligands: Immunoglobulins; Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors; Protein purification.	15
II	Carbohydrate Biosynthesis, Electron Transport System and Energy Rich Compounds	Carbohydrate Biosynthesis Carbohydrate biosynthesis and its regulation: Peptidoglycan in Bacteria; Starch and sucrose in Plants; Glycogen in Animals; Biosynthesis and regulation of Cholesterol, Atherosclerosis. Electron Transport System : Electron Transport and Oxidative Phosphorylation. Inhibitors of ETS. Energy Rich Compounds : ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, etc.	15

Textbooks:

- Lehninger's Biochemistry, Nelson Cox
- Biochemistry (4th edition) - Voet and Voet.
- Biochemistry (4th edition) - Satyanarayana and Chakrapani

Additional References:

- Harper's Illustrated Biochemistry, Murray

Course Code	PRACTICAL OF MINOR-I	Credits	Lectures/ Week
25BTMRCP521	Practical - Chemistry-IV	2	2
Course Outcomes: After successful completion of this course, students would be able to: ● Recall the principles and procedures of biochemical estimation methods and protein purification methods. ● Explain the significance of protein stability and viscosity determination in understanding molecular integrity. ● Perform experiments to estimate protein concentration, starch, glycogen, and glucose using specific biochemical methods. ● Assess the relationship between carbohydrate biosynthesis disorders and their impact on metabolic efficiency.			
Topics: 1. Estimation of Protein by Bradford method. 2. Ammonium sulfate fractionation of Proteins. 3. Estimation of Starch by Anthrone method. 4. Estimation of Glycogen by Phenol sulfuric acid method. 5. Determination of viscosity. 6. Determination of Protein stability 7. Estimation of glucose by DNSA method. 8. Case study on disorders related to carbohydrate biosynthesis and ETC. 9. Cholesterol estimation colorimetric method 10. Demonstration: Protein folding experiment 11. Demonstration: Refolding and annealing proteins using Bio informations 12. Demonstration: Mitochondrial respiration			

Course Code	MINOR-II SEM – V	Credits	Lectures/ Week
25BTMRM522	Microbiology - IV	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Identify the structural and functional characteristics of viruses and fungi, including viral classifications (Baltimore and ICTV) and fungal taxonomy systems (Bessey and Ainsworth).
- Understand viral cultivation, purification, and assays to study their biological properties and interactions with host cells and use fungal models to examine their growth patterns.
- Describe the interactions between viruses and host cells during lytic and lysogenic cycles, and the impact of environmental factors on fungal growth and reproduction.
- Critically analyze the impact of viral cytocidal infections and fungal bioremediation on ecosystems and human health.

Unit	Unit Name	Topics	No. of Lectures
I	Virology	Introduction to viruses-Position in biological spectrum; Virus properties, General structure of viruses, Baltimore and ICTV Classification and Taxonomy; Cultivation of viruses and purification of viruses, Viral assays, Cytocidal infections and cell damage Reproduction of ds DNA phages (T even phages- lytic cycle), Lambda Phage- Lysogenic cycle; Reproduction of ss RNA (Polio or influenza virus), Retrovirus (HIV) Reproduction of plant virus (TMV) Viroids and Prions.	15
II	Mycology	Fungal Taxonomy: A comparative account of outline systems of classification of fungi proposed by Bessey and Ainsworth. Fungal Cytology: Microscopic structure of fungal cell, Chemical composition and functional attributes of fungal septa and cell wall. Fungal Diversity: i) Freshwater fungi ii) Marine fungi iii) Coprophilous fungi iv) Aero-fungi Environmental factors influencing fungal growth: i) Humidity ii) Temperature Fungal bioremediation.	15

Textbooks:

- Understanding Viruses by Teri Shors.
- Fundamental Virology, 4th ed. (2001). D.M. Knipe and P.M. Howley.
- Principles of Virology: (2000). by S.J. Flint et al., ASM Press.
- Basic Virology, (1999). By Waginer and Hewlett, Black Well Science Publishing.
- Introductory Mycology" by C.J. Alexopoulos, Charles W. Mims, and M. Blackwell
- "The Fungi" by Sarah C. Watkinson, Lynne Boddy, and Nicholas Money
- "Fungal Biology" by J.W. Deacon
- "Cell Biology of Fungi" edited by Richard J. Howard and Neil A.R. Gow
- "Biodiversity of Fungi: Inventory and Monitoring Methods" by Mercedes S. Foster, Gerald F. Bills, and others
- "Fungal Ecology" by John Dighton
- "Fungi in Bioremediation" edited by Geoffrey M. Gadd

Additional References:

- Microbiology: An introduction (12th edition) - Gerard Tortora, Berdell Funke, Christine Case
- Prescott's Microbiology.

Course Code	PRACTICAL OF MINOR-II	Credits	Lectures/ Week
25BTMRMP522	Practical - Microbiology-IV	2	2
Course Outcomes: After successful completion of this course, students would be able to: ● Recognize the components involved in measuring fungal growth (biomass method) and assessing chlorophyll levels in healthy versus virus-infected leaves. ● Learn to collect, preserve the virus samples and detect the viruses by using biological, serological and molecular methods, good microbiological and laboratory practices used in the clinical laboratories. ● Utilize methods for viral cultivation and study their interactions with hosts, including embryonated egg inoculations. ● Compare fungal growth patterns under different environmental conditions, such as varying temperatures and nitrogen sources.			
Topics: 1. Isolation of soil fungi from different locations (garden loam, agricultural soil, salt marsh, rhizosphere) by Warcup method and identification of fungi. 2. Study of effect of incubation temperatures on fungal growth (15°C, 30°C & 60°C). 3. Isolation of fungal pathogens from infected leaves / wood/ phylloplane 4. Measurement of fungal growth by biomass (mycelial dry weight) method. 5. To study the effect of different nitrogen sources on fungal growth in terms of biomass. 6. Isolation of freshwater fungi by baiting technique. 7. Preparation of slants by Sub-culturing of fungal culture from pour plate culture /slide culture. 8. Study of Seed Surface Mycoflora by Dry Seed Agar Plate technique .& Micrometry: Measurement of spores of fungal pathogens. 9. Determination of chlorophylls in healthy and virus infected leaves. 10. Demonstration experiment: Cultivation of viruses in embryonated eggs: different routes of inoculation. 11. Cancer Biology: (Field visit and 2 page report in the journal) 12. Assignment on Virology – Research Paper.			

Course Code	MINOR-III SEM – V	Credits	Lectures /Week
25BTMRL523	Life Science - IV	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Identify the basic structure, function, and disorders associated with hormones from different glands and recall key stages of embryonic development.
- Explain hormone secretion, transport, and biochemical roles in physiological processes like growth, metabolism, and reproduction.
- Analyze hormonal regulatory pathways influencing developmental processes in model organisms.
- Compare hormonal interactions across different endocrine glands and their impact on developmental processes.

Unit	Unit Name	Topics	No. of Lectures
I	Endocrinology	Basic of Group I and II hormones; Structure, storage, release, transport, biochemical functions and disorders associated with hormones secreted by Hypothalamus; Anterior Pituitary gland - GH, stimulating hormones; Posterior Pituitary gland – oxytocin and vasopressin; Thyroid gland – Thyroxine, calcitonin; Parathyroid gland – PTH; Adrenal medulla – epinephrine and norepinephrine; Adrenal cortex – Glucocorticoids; Pancreas – insulin and glucagon; Female Gonads– estrogen and progesterone; Male gonads– testosterone; Placenta – HcG.	15
II	Developmental Biology	Overview of how the modern era of developmental biology emerged through multidisciplinary approaches; Stages of development- zygote, blastula, gastrula, neurula cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map; Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development Pattern formation- axis specification, positional identification (regional specification), Morphogenetic movements, Model organisms in Developmental biology.	15

Textbooks:

- Biochemistry (4th edition) - Voet and Voet.
- Biochemistry (4th edition) - Satyanarayana and Chakrapani
- Developmental Biology (9th edition)- Scott Gilbert
- Developmental biology- Veer Bala Rastogi
- Concept of Developmental biology- Dr. Amrita Singh.

Additional References:

- Essential Developmental Biology (2nd Edition) – J.M.W. Slack

Course Code	PRACTICAL OF MINOR-III	Credits	Lectures/ Week
25BTMRLP523	Practical – Life Science-IV	2	2
Course Outcomes: After successful completion of this course, students would be able to: ● Identify the stages of embryonic development (zygote, blastula, gastrula) in frog embryos and the techniques used for fate mapping of chick embryos. ● Describe the impact of hormones like auxin and gibberellin on seed germination and plant growth. ● Perform fate mapping of chick embryos to trace the developmental destiny of cells. ● Evaluate experimental findings on blood glucose levels in relation to metabolic conditions.			
Topics: 1. Chick embryo candling and inoculation methods (Demonstration experiment). 2. To study different embryonic stages (zygote, blastula, gastrula) in frog embryos. 3. Fate mapping of chick embryo. 4. Blood glucose estimation. 5. Study of effect of hormone - auxin and gibberellin on seed germination 6. Detection of hormones using ELISA (Demonstration). 7. Assignment on Hormonal disorders.			

Course Code	APPLIED COMPONENT	Credits	Lectures/ Week
25BTAC531	Biosafety & IPR	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Recall the principles of biosafety, including biological risk assessment and hazardous characteristics of agents and procedures.
- Discuss the importance of microbiological assays and regulatory testing in ensuring product safety and quality.
- Describe the significance of biodiversity legislation, traditional knowledge, and the international conventions governing IPR.
- Critically review the effectiveness of biosafety equipment, contamination detection methods, and intellectual property protection in fostering innovation and safety.

Unit	Unit Name	Topics	No. of Lectures
I	Biosafety	Introduction to Biosafety Biological Risk Assessment, Hazardous Characteristics of an Agent; Genetically modified agent hazards; Hazardous Characteristics of Laboratory Procedures; Potential Hazards Associated with Work Practices; Safety Equipment and Facility Safeguards; Pathogenic risk and management. Detection and testing of contaminants Microbial Contamination in food and pharma products; Some common microbial contaminants; Microbiological Assays for pharmaceutical products- Antibiotic assay, Vitamin B12 assay; Regulatory Microbiological testing in pharmaceuticals.	15
II	Intellectual Property Rights (IPR)	Introduction to IPR; Types of IPR - patents, trademarks, trade secrets, copyright & related IPR rights, industrial design, traditional knowledge, geographical indications; Biodiversity importance and legislation; International convention and treaties- WTO, TRIPs, WIPO, EPO; Plant variety protection and farmers rights act.	15

Textbooks:

- Kshitij Kumar Singh (auth.) - Biotechnology and Intellectual Property Rights- Legal and Social Implications-Springer India (2015)
- Goel, D., & Parashar, S. (2013). IPR, Biosafety and Bioethics. Pearson Education India.
- Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 6th edition Oxford Black Scientific Publishers.
- Biosafety in Microbiological and Biomedical Laboratories - 5th Edition, L. Casey Chosewood Deborah E. Wilson U.S. Department of Health and Human Services Centers for Disease Control and Prevention National Institutes of Health.

Course Code	PRACTICAL- APPLIED COMPONENT	Credits	Lectures/ Week
25BTACP51	Practical – Biosafety & IPR	2	2
Course Outcomes: After successful completion of this course, students would be able to: ● Explain the principles behind calibration of instruments like pH meters, weighing balances, micropipettes, and colorimeters. ● Perform microbiological contamination assays, such as antibiotic and Vitamin B12 tests, on food and pharmaceutical samples. ● Prepare Standard Operating Procedures (SOPs) for laboratory instruments. ● Evaluate case studies based on patents, highlighting the challenges and implications of intellectual property disputes.			
Topics: 1. Validation of micropipette, measuring cylinders, colorimeters 2. Calibration of pH meter and weighing balance 3. Vitamin B12 bioassay. 4. Testing for adulterants in food; ex. Starch in milk 5. SOP making for any 2 major laboratory instruments 6. Sterility testing of injectables 7. Case Studies based on Patent. 8. Assignment on geographical indications.			

Course Code	VOCATIONAL SKILL COURSE SEM – V	Credits	Lectures/ Week
25BTVS541	Bakery & Confectionery	2	4
Course Outcomes: After successful completion of this course, students would be able to: • List the basic parameters for sugar crystallization and cake baking methods. • Explain the role of lactic acid bacteria and yeast in the fermentation of bakery products, including their isolation and identification. • Prepare fermented products like sourdough and sauerkraut using standard microbial culture techniques. • Analyze the impact of manufacturing parameters on the quality of biscuits, cakes, and bread.			
Topics: 1. Study of different bakery and confectionery products available in Indian markets. 2. Identification and study of organisms used in the Bakery industry. 3. Isolation and Identification of types of Lactic acid bacteria present in different bakery products. 4. Isolation and Identification of the types of yeast present in different bakery products. 5. Study and cultivation of the yeast starter cultures used in making bread and their commercial application. 6. Estimation of shelf life of Bakery products and confectionery under specific storage conditions. 7. Study the manufacturing parameters for bakery products - Biscuits , Cakes and Bread. 8. Estimation of Gluten content from flour samples : Wheat , Jowar and Bajra. 9. Evaluation of yeast pre-fermentations : Biga, poolish, pate fermentee and Sponge. 10. Preparation of Sourdough. 11. Study the parameters involved in crystallisation of sugar. 12. Cake baking methods.			

SEMESTER VI

Course Code	MAJOR-I SEM – VI		Credits	Lectures / Week
25BTMJ611	Environmental Biotechnology		2	2
Course Outcomes:				
After successful completion of this course, students would be able to:				
- Identify key aerobic and anaerobic biological treatment methods employed in industrial effluent and wastewater treatment. - Apply multiple tube fermentation or biosensor-based techniques for bacteriological examination of wastewater. - Explain waste treatment techniques and the use of biosensors in pollution monitoring. - Analyze how pollutants impact biotreatment processes and the biodegradability of persistent compounds.				
Unit	Unit Name	Topics		No. of Lectures
I	Industrial Effluent Treatment	Biological processes for industrial effluent treatment: Aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (any two) Biological filters, RBC, FBR; Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB; Solid waste treatment; Pollution indicators & biosensors; biodegradation of xenobiotics-persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation; Use of immobilized enzymes or microbial cells for treatment.		15
II	Wastewater Treatment	Wastewater treatment- introduction, biological treatment, impact of pollutants on biotreatment, use of packaged organisms and genetically engineered organisms in waste treatment; Wastewater Monitoring - Estimation of BOD, COD, TSS, TVS, TDS, ash content, lignin, cellulose, hemicellulose; Bacteriological examination of wastewater: Multiple tube fermentation method, MPN, other methods (nucleic acid based, biosensor based, Immunological-based methods etc.)		15

Textbooks:

- Environmental Biotechnology- Alan Scragg
- Environmental Biotechnology (Basic concepts and applications)-Indu Shekhar Thakur
- Environmental Biotechnology, Bimal C. Bhattacharya, Rintu Banerjee, Oxford University Press
- Environmental Biotechnology (Industrial pollution management) - S.D. Jogdand

Additional References:

- Textbook of Environmental Biotechnology, Pramod Kumar, Vipin Kumar, Woodhead Publishing India PVT Ltd.
- Gavrilescu, Maria. (2010). Environmental Biotechnology: Achievements, Opportunities and Challenges.

Course Code	MAJOR-II SEM – VI	Credits	Lectures/ Week
25BTMJ612	Basic Pharmacology & Neurochemistry	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Understand the key concepts of pharmacology and neurochemistry.
- Explain the mode of action of pharmacological agents, routes of administration, and factors affecting drug distribution as well as propagation of nerve impulses and the role of neurotoxins and neurotransmitters.
- Describe pharmacokinetics (absorption, bioavailability, distribution) and pharmacodynamics (dose-response relationships, therapeutic index) of CNS-acting drugs and their effects on brain function.
- Apply knowledge of neurochemical pathways to propose pharmacological strategies for modulating neuronal activity.

Unit	Unit Name	Topics	No. of Lectures
I	General Principles of Pharmacology	Definition and scope of pharmaceutical Biotechnology; Mode of action of pharmacological agents, Route of administration; Absorption and Bioavailability of drug; factors influencing drug distribution; dose-response relationship: therapeutic index, ED, LD; Potency and Intrinsic Activity; Physiological barriers to drug distribution. Pharmacokinetics: Drug Concentration–Time Profiles And Basic Pharmacokinetic Parameters; Additional Pharmacokinetic Parameters; Pharmacokinetics Of Single Versus Multiple Dosing; Nonlinear Pharmacokinetics.	15
II	Neurochemistry	Anatomy and functioning of the brain; Neuronal pathways; Propagation of nerve impulses; Neuronal excitation and inhibition; Synapses and gap junctions; Action of Neurotoxins and neurotransmitters.	15

Textbooks:

- Modern Pharmacology with clinical Applications Craig,C.R, Stitzel,R.E 5th edition
- Pharmaceutical Biotechnology: Fundamentals and Applications, CRC Press, 2007.
- Principles of anatomy and physiology (14th edition) - Gerard Tortora
- Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
- Biochemistry Metzler, D.E Elsevier; 2nd edition vol 1-2

Additional References:

- Pharmaceutical Biotechnology: Fundamentals and Applications, Springer.
- Clinical Pharmacology Bennet,PN,Brown,M.J, Sharma,P 11th edition; Elsevier
- Patrick Waller and Mira Harrison- Woolrych An Introduction to Pharmacovigilance, Second Edition

Course Code	MAJOR-III SEM – VI	Credits	Lectures/ Week
25BTMJ613	Plant & Animal Biotechnology	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Recall key concepts of tissue culture and cell culture in plant and animal studies.
- Understand the principles of media preparation in plant tissue culture and animal cell culture.
- Apply the fundamental techniques in plant tissue culture and animal tissue cultures.
- Identify major breakthroughs and applications of biotechnology in agriculture and healthcare.

Unit	Unit Name	Topics	No. of Lectures
I	Plant Tissue Culture	History of Plant tissue culture; Media preparation- Significance of Macronutrients, micronutrients, PGR, Trace elements, Carbon source, Fe- EDTA; Different types of medium- MS medium, Gamborg medium, B5 Medium (Basal Media); Techniques in PTC with applications- Totipotency, Callus culture, Cell suspension culture, Protoplast culture, Micropropagation, Somaclonal variation, Somatic hybridization and somatic embryogenesis; Cryopreservation.	15

II	Animal Cell Culture	Physicochemical Properties of Animal Cell Culture Media; Components of Media; Types of Culture Medium; Cell culture types and their properties; Equipment used in Animal Cell Culture; Morphological Differences in Mammalian Cell culture system; Subculture; Techniques for Detachment of Cells; Maintenance of Cell Line; Applications of Animal Cell Culture Technology.	15
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Textbooks:

- Introduction to Plant Biotechnology (3rd Edition) –H.S. Chawla
- Plant Tissue culture (2nd edition) -M.K. Razdaan
- Culture of animal cells: a manual of basic technique and specialized applications (6th edition)– Ian Freshney
- Textbook of Animal Biotechnology- B.Singh

Additional References:

- Advanced Biotechnology (1st edition) -RC Dubey
- A textbook of Biotechnology- RC Dubey

Course Code	MAJOR-IV SEM – VI	Credits	Lectures/ Week
25BTMJ614	Instrumentation Techniques	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Identify the basic principles, instrumentation, and key components of spectroscopy, centrifugation, electrophoresis, and chromatography techniques.
- Describe how factors like sample type, experimental setup, and environmental conditions influence the efficiency of these methods.
- Demonstrate the use of centrifugation for separating cell components, electrophoresis for analyzing proteins or nucleic acids, spectroscopy for determining compound concentration, and chromatography for separating analytes.
- Critically evaluate how the choice of method impacts experimental outcomes and scientific interpretations.

Unit	Unit Name	Topics	No. of Lectures
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I	Centrifugation and Electrophoresis	Centrifugation Basic Principle of Centrifugation- Relative Centrifugal Force (RCF); Types of rotors – fixed angle rotor, vertical tube rotor, swinging bucket rotors; Principle, working and applications of – Differential centrifugation and Density gradient centrifugation. Electrophoresis Basic Principle of Electrophoresis- Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Principle, Working, Detection and Application of – Native PAGE, SDS-PAGE, Isoelectric Focusing, 2D PAGE, Agarose Gel Electrophoresis, Pulse-field gel electrophoresis.	15
II	Spectroscopy and Chromatography	Spectroscopy Principle, instrumentation, working and applications of: UV-Vis Spectroscopy; Fluorescence Spectroscopy; Infrared Spectroscopy; Atomic Absorption Spectroscopy; Mass Spectroscopy. Chromatography Principle, instrumentation, working and applications of: Affinity chromatography, Ion-exchange chromatography; Size exclusion Chromatography; Gas Chromatography, HPLC.	15
Textbooks: - Principles and Techniques in Biochemistry and Molecular Biology (7th Edition)- John Walker and Keith Wilson - Biophysical Chemistry: Principles and Techniques – Upadhyay Additional References: - Physical Biochemistry: Principles and Applications (2nd edition) – David Sheehan - Introduction to Instrumentation in Life Sciences- Prakash S. Bisen Anjana Sharma - Biophysical Chemistry by James P Allen.			

Course Code	PRACTICAL-6	Credits	Lectures/Week
25BTMJ61	Environmental Biotechnology + Pharmacology & Neurochemistry + Plant & Animal Biotechnology + Instrumentation Techniques	2	4
Course Outcomes: After successful completion of this course, students would be able to: - Identify LD50 and ED50 evaluation models (e.g., daphnia), and recall the methods to study heavy metal effects on bacterial growth - Discuss the principles of chromatography techniques and their applications in mixture separation. - Analyze industrial effluent samples to determine total solids, chromium content, and other physico-chemical parameters. - Perform experiments for surface sterilization, trypsinization, and estimation of cell viability in animal tissues.			

Topics:

1. Surface sterilization of explant.
2. Trypsinization of the animal tissue.
3. Determination of the percentage viability of cells by Trypan Blue.
4. LD 50, ED 50 evaluation using suitable models e.x daphnia.
5. Study the effect of heavy metals on the growth of bacteria.
6. Determination of Total Solids from an effluent sample.
7. Study of physico-chemical (pH, color, turbidity, BOD, COD) parameters of any one industrial effluent sample.
8. Estimation of chromium from Effluents (Demonstration)
9. Separation of components from a mixture using Affinity chromatography (Kit may be used)
10. Separation of components from a mixture using ion exchange chromatography (Kit may be used)
11. Separation of components from a mixture using Size exclusion chromatography (Kit may be used)
12. HPLC method validation.

Course Code	MINOR-I SEM – VI	Credits	Lectures/ Week
25BTMRC621	Chemistry - V	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Recall the pathways involved in nucleic acid synthesis and metabolism along with definitions, classifications, and chemical properties of enzymes.
- Explain the regulatory mechanisms governing nucleic acid biosynthesis, emphasizing the role of enzymes in pathway modulation.
- Evaluate enzyme kinetics by measuring reaction rates and determining kinetic parameters (e.g., K_m , V_{max}) in nucleic acid-related reactions.
- Analyze how enzyme regulation (e.g., feedback inhibition) influences nucleic acid metabolism and cellular homeostasis.

Unit	Unit Name	Topics	No. of Lectures
I	Biochemistry of Nucleic Acid	Biosynthesis of Nucleic Acid De novo synthesis pathway of Purines and Pyrimidines; Salvage pathway of Purines and Pyrimidines; Regulation of Nucleic acid biosynthesis Metabolism of Nucleic acid Purine and Pyrimidine metabolism; Inborn errors of nucleic acid metabolism.	15
II	Enzyme Kinetics	Definition, Classification, Nomenclature, Chemical Nature, Properties of Enzymes, Mechanism of Enzyme action, Active sites, Enzyme specificity, Effect of pH, Temperature, substrate concentration on enzyme activity, enzyme kinetics, Michaelis-Menten equation, types of enzyme inhibitions-Competitive, Uncompetitive, Non-competitive, allosteric modulators Co-Factors, Zymogens, Immobilized Enzymes.	15

Textbooks:

- Lehninger's Biochemistry, Nelson Cox
- Biochemistry (4th edition) - Voet and Voet.
- Biochemistry (4th edition) - Satyanarayana and Chakrapani

Additional References:

- Harper's Illustrated Biochemistry, Murray

Course Code	PRACTICAL OF MINOR-I	Credits	Lectures/ Week
25BTMRCP621	Practical - Chemistry-V	2	2
Course Outcomes: After successful completion of this course, students would be able to: - Recall the principles of DNA purity analysis using spectrophotometry and the determination of melting temperatures (T_m) for DNA and RNA samples. - Describe the role of uric acid measurement in diagnosing metabolic disorders like gout. - Evaluate enzyme activity by analyzing the effects of pH, substrate concentration, and temperature, along with inhibitors. - Discuss how inhibitors affect enzyme activity and the importance of studying enzyme kinetics under varying conditions.			
Topics: - To check the Purity of DNA by Spectrophotometer (Demonstration). - To study the melting temperature (T_m) of DNA and RNA samples. - Determination of specific activity of amylase from different sources. - Immobilization of yeast (invertase enzyme) and detection of conversion of substrate (sucrose) to product (glucose). - To study Purine Metabolism Disorders - To study Pyrimidine Metabolism Disorders - To solve Michaelis-Menten Numerical Problems - Study the effect of temperature on the activity of an enzyme. - Study the effect of pH on the activity of an enzyme. - Study the effect of Enzyme Concentration on the activity of an enzyme. - Study the effect of Substrate on the activity of an enzyme. - Study of effect of inhibitors on enzyme activity.			

Course Code	MINOR-II SEM – VI	Credits	Lectures/ Week
25BTMRM622	Microbiology - V	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Identify various types of fermented foods (sauerkraut, cucumber, bread, soya bean) and beverages along with the downstream process involved.
- Explain the relationship between product application and cost considerations in DSP and microbial fermentation processes used in producing foods and beverages.
- Apply techniques for cell breakage to harvest fermented products and analyze the efficiency of solvent recovery processes.
- Evaluate the impact of microbial fermentation on food quality, shelf life, and nutritional value and the type of waste generated.

Unit	Unit Name	Topics	No. of Lectures
I	Downstream Processing (DSP)	Downstream processing; definition, criteria, and typical steps involved in DSP (with examples); Target application of product vs cost; Separation of cells and whole broth; Methods of cell breakage for harvesting intracellular products; Typical unit operation- Filtration; Centrifugation; Solvent recovery; Membrane processes; Drying; Crystallization; Types and nature of waste generated in bioprocess.	15
II	Applications of Industrial Microbiology	Fermented foods Products: Meat and Fish, bread, Soya Sauce, Vegetables: Sauerkraut, Cucumber. Production of Cheese and its types: Cheddar and Swiss cheese. Beverages - Alcoholic beverages -Production of Beer Food additives and supplements a) Lipids, Nucleosides, nucleotides and related compounds- Vitamins b) Natural food preservatives- bacteriocins from lactic acid bacteria.	15

Textbooks:

- Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts.
- Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
- Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield, NH, USA (2007)
- Michael Waites and Morgan , Rockney and Highton -Industrial microbiology : An Introduction

Additional References:

- Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
- Food Microbiology (3rd edition) - Adams & Moss.

Course Code	PRACTICAL OF MINOR-II	Credits	Lectures/ Week
25BTMRMP622	Practical - Microbiology-V	2	2
Course Outcomes: After successful completion of this course, students would be able to: ● Apply core techniques in downstream processing to recover and purify biotechnological products. ● Demonstrate the ability to perform microbial fermentation for the production of food, beverages, and industrial biomolecules. ● Analyze and interpret the efficiency of various cell disruption and recovery methods for intracellular product extraction. ● Evaluate the nature and management of bioprocess waste and understand its environmental impact.			
Topics: 1. Estimation of sucrose fermentation by yeast using the DNSA method. 2. Enumeration of Microorganisms in the given samples of food. 3. Fermentation of Vegetables for the production of Sauerkraut or Cucumber. 4. Detection and determination of coliforms in foods and beverages. . 5. Analysis of waste in Bioprocessing. 6. Production of Alcoholic Beverages : Beer 7. Study of the Filtration technique for Broth clarification. 8. Identification of different types of cheeses based on Texture, Aroma, Microbial Flora and Aging. 9. Production of Cheese by coagulation of Milk Protein. 10. Study of the different methods of Solvent extraction for Product recovery. 11. Study of various Drying techniques : Oven and Lyophilization. 12. Demonstration of Crystallization as a purification technique.			

Course Code	MINOR-III SEM – VI	Credits	Lectures/ Week
25BTMRL623	Life Science - V	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Identify the principles of plant stress biology and genetic markers used in Plant breeding.
- Describe the use of genetic markers in improving plant resistance to stress conditions through breeding programs.
- Utilize molecular markers to identify stress tolerance traits in crop plants.
- Analyze the role of genetic markers in identifying traits linked to stress tolerance in plant breeding.

Unit	Unit Name	Topics	No. of Lectures
I	Plant Stress Biology	Abiotic stress – Physiological and molecular responses of plants to water stress, salinity stress, temperature stress –heat and cold, Photooxidative stress, stress perception and stress signaling pathways; Ionic and osmotic homeostasis, reactive oxygen species scavenging; Biotic stress - plant interaction with bacterial, viral and fungal pathogens; plant responses to pathogen–biochemical and molecular basis of host-plant resistance; toxins of fungi and bacteria; systemic and induced resistance–pathogen derived resistance, signaling.	15
II	Molecular Markers in Plant Breeding	Genetic markers in plant breeding- Classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP); Application of Molecular Markers to Plant Breeding [quantitative trait locus (QTL) mapping]; Plant DNA Barcoding- Barcoding Markers (matK, rbcl, ITS, tmH-psbA), steps, recent advances, Benefits, Limitations.	15

Textbooks:

- Introduction to Plant Physiology -Hopkins
- Biotic interactions in plant-pathogen association-M. J. Jeger
- Biotechnology (3rd Edition)- S.S. Purohit.
- Principles of Gene Manipulation (7th Edition) - Primrose S.B., Twyman R.M.

Additional References:

- Introduction to Plant Biotechnology (3rd Edition) –H.S. Chawla

Course Code	PRACTICAL OF MINOR-III	Credits	Lectures/ Week
25BTMRLP623	Practical – Life Science-V	2	2
Course Outcomes: After successful completion of this course, students would be able to: ● Identify the enzymes and antioxidants, such as catalase, peroxidase, and ascorbate, involved in plant stress responses. ● Explain the physiological effects of abiotic stresses like drought and salinity on plant growth and development. ● Measure the activity of catalase, peroxidase, and ascorbate in plants subjected to abiotic stress. ● Analyze the patterns obtained from RAPD experiments to assess genetic variability in stress responses.			
Topics:. 1. Rapid screening tests for abiotic stress tolerance (drought, - PEG, Mannitol & salinity NaCl) 2. Study of the effect of abiotic stress on plants. 3. Estimation of antioxidant enzyme- Catalase activity in presence of abiotic stress. 4. Estimation of antioxidant enzyme- Peroxidase activity in presence of abiotic stress. 5. Estimation of antioxidant- Ascorbate in presence of abiotic stress. 6. RAPD analysis demonstration experiment. 7. Assignment on DNA Marker.			

Course Code	APPLIED COMPONENT	Credits	Lectures/ Week
25BTAC631	Agribiotechnology	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

- Identify the fundamental principles of precision agriculture, greenhouse technology, biofertilizers, and biopesticides.
- Explain the characteristics and mechanisms of biofertilizers and biopesticides in traditional as well as greenhouse cultivation.
- Demonstrate the application of nutrient management, fertigation, microbial inoculants and biopesticides for crop protection and growth promotion in traditional as well as greenhouse environments.
- Evaluate the advantages, challenges and impact of different types of biofertilizers and biopesticides on controlled agricultural systems such as greenhouse, phytotrons.

Unit	Unit Name	Topics	No. of Lectures
I	Precision Agriculture & Agriculture Systems	Introduction to Precision Agriculture and Agriculture systems; Precision Cultivation- tools, sensors for information acquisition; Green house Technology- Types of green house, importance, functions and features of greenhouse; Design criteria and calculation; Construction material, covering material and its characteristics; Growing media; Greenhouse irrigation system; Nutrient management; Greenhouse heating, cooling and shedding and ventilation system; Computer controlled environment; Phytotrons, fertigation and roof system.	15
II	Biofertilizers & Biopesticides	Biofertilizer: Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers, Non-symbiotic Nitrogen Fixers; Plant Growth Promoting Microorganisms- Phosphate-Solubilizing Microbes; Phytohormones and Cytokinins, Induced Systemic Resistance; Plant Growth Promotion by Fungi-Mycorrhizae Arbuscular Mycorrhizae, Ectomycorrhizae; Microbial Inoculants - Inocula, Carriers, and Applications; Monoculture and Co-culture Inoculant Formulations, Biocontrol, Polymicrobial Inoculant Formulations. Biopesticides: Types of Biopesticides; <i>Bacillus thuringiensis</i> , insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application).	15

Textbooks:

- Biotechnology for Sustainable Agriculture- Ram Lakhan Singh, Sukanta Mondal
- Microbial Biopesticides- Opendar Koul, G. S. Dhaliwal
- Sustainable Crop Protection under Protected Cultivation- P. Parvatha Reddy
- Microbial-Based Biopesticides: Methods and Protocols – Travis R. Glare, Maria E. Moran-Diez
- Intelligent Environmental Sensing- Henry Leung, Subhas Chandra Mukhopadhyay
- Biofertilizers in agriculture and Forestry, N. S. Subbarao

Additional References:

- A textbook of Biotechnology- RC Dubey
- Frontiers in Sustainable Agriculture. (2021). Biopesticides in Sustainable Agriculture. Retrieved from <https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2021.619058/full>
- Gurubasajar, N., & Basaiah, T. (2025). Integrating microbial consortia into biofertilizers for sustainable agriculture: Enhancing plant productivity and soil health. *Archives of Agriculture and Environmental Science*, 10(1), 157-163. <https://doi.org/10.26832/24566632.2025.1001023>

Course Code	PRACTICAL- APPLIED COMPONENT	Credits	Lectures/ Week
25BTACP631	Practical – Agribiotechnology	2	2
Course Outcomes: After successful completion of this course, students would be able to: ● Isolate and culture Rhizobium, Azotobacter, and phosphate-solubilizing bacteria using microbiological techniques. ● Perform compost and soil analysis to determine key parameters like pH, water content, and nutrient levels. ● Describe how soil and compost properties (e.g., carbon content, nitrate levels) influence plant growth and productivity. ● Assess the efficiency of microbial inoculants (e.g., Rhizobium and Azotobacter) in promoting plant growth based on experimental observations.			
Topics: 1) Isolation of Rhizobium 2) Isolation of Azotobacter 3) Isolation of Phosphate solubilizing bacteria 4) Compost Analysis- C, NO₃, NO₂, Ca 5) Soil analysis- pH, Moisture, Water content 6) Assignment on greenhouses. 7) Visit to greenhouse facility and submit a field visit report.			

Evaluation Scheme for Third Year (UG) under NEP (2 credits)

I. Internal Evaluation for Theory Courses – 20 Marks

1. **Continuous Internal Assessment (CIA-1)** - Tutorial/ Project / Presentations/ Group Discussion / Ind. Visit. =**10 marks**
2. **Continuous Internal Assessment (CIA-2)**- Online Unit Test = **10**

marks II. External Examination for Theory Courses – 30 Marks

Duration: 1 Hour

Theory question paper pattern: All questions are compulsory.

Question	Based on	Marks
Q.1	Unit I	15
Q.2	Unit II	15

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be sub-divided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.

III. Practical Examination

- Each core subject carries 50 Marks
- Duration: 4 Hours for each practical course.
- Certified Journal is compulsory for appearing at the time of Practical Exam