Sion (West), Mumbai – 400022.

(Autonomous)

Faculty: Science

Program: B.Sc.

Subject: BIOTECHNOLOGY

Academic Year: 2023 – 2024

T.Y.B.Sc. Biotechnology

Credit Based Semester and Grading Syllabi approved by Board of Studies in Biotechnology to be brought into effect from June 2021.

PREAMBLE:

Biotechnology, broadly defined, includes any technique that uses living organisms, or parts of such organisms, to make or modify products, to improve plants or animals, or to develop microorganisms for specific use. The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on. Biotechnology is the science of today and tomorrow. It has applications in all major service sectors i.e. health, agriculture, industry, environment etc. Biotechnology as an application science has taken firm footing in many countries, abroad where a number of transgenic crops, genetically modified food and recombinant therapeutic molecules for human and animal health are available in the market. Biotechnology as a science of service to human society is yet to make inroads in India

With the advent of World Wide Web in the early nineties and its subsequent growth, the latest research trends have become accessible from drawing rooms across the globe. This acted as a positive feedback mechanism in increasing the pace of research in all fields including Chemical Engineering and Bio-technology. This was the motivation for an in depth analysis of what is actually required for today's technology. It is also important to take advantage of the freely available software to enhance the quality and quantity of material that can be covered in the class room.

This restructured syllabus is therefore intended to combine the principles of physical, chemical and biological sciences along with developing advanced technology. The undergraduate curricula is prepared to impart primarily basic knowledge of the respective subject from all possible aspects. In addition, students will be trained to apply this knowledge particularly in day-to-day applications of biotechnology and hence get a flavor of research.

PROGRAM SPECIFIC OUTCOMES:

An undergraduate student upon completion of this program is expected to gain the following attributes:

- Understand and describe the nature of the basic concepts of Cell biology, Microbiology Chemistry and Biochemistry with an interdisciplinary perspective about of other branches of Life Sciences.
- Explain the application of Biotechnology in the field of Medicine, Agriculture, Environment and sustainable development.
- Describe and explain the concepts of Immunology, Neurochemistry recombinant DNA technology and correlate them towards diagnosis and therapy of diseases and understanding how they can contribute towards the alleviation of human suffering.
- Discover and examine the causes of environmental pollution and devise methods to control the release of biohazardous waste into the environment.
- Perform practical as per laboratory standards in Chemistry, Biochemistry, Microbiology and Molecular Biology – Understand and analyze the results.
- Effectively communicate using ICT enabled tools and Critically analyze and explain the data in a lucid manner.

T.Y.B.Sc BIOTECHNOLOGY

SEMESTER V				
Course Code	**Theory/Practical**	**Course Title**	**Credits**	**Lectures/week**
SIUSBT51	Theory	Cell Biology	2.5	4
SIUSBT52	Theory	Medical Microbiology & Instrumentation	2.5	4
SIUSBT53	Theory	Genomes and Molecular Biology	2.5	4
SIUSBT54	Theory	Research Methodology & Biostatistics	2.5	4
SIUSBTP56	Practicals	Cell biology + Medical Microbiology & Instrumentation	3.0	8
SIUSBTP57	Practicals	Genomes and Molecular Biology + Research Methodology & Biostatistics	3.0	8
SIUSBT55	Theory	Marine Biotechnology (Applied Component)	2.0	4
SIUSBTP58	Practicals	Marine Biotechnology (Applied Component)	2.0	4
	Total		**20**	**36**
SEMESTER VI				
Course Code	**Theory/Practical**	**Course Title**	**Credits**	**Lectures/week**
SIUSBT61	Theory	Biochemistry	2.5	4
SIUSBT62	Theory	Industrial Microbiology	2.5	4
SIUSBT63	Theory	Pharmacology and Neurochemistry	2.5	4
SIUSBT64	Theory	Environmental Biotechnology	2.5	4
SIUSBTP66	Practicals	Biochemistry & Industrial Microbiology	3.0	8
SIUSBTP67	Practicals	Pharmacology - Neurochemistry and Environmental Biotechnology (50M) + Project work (50M)	3.0	8
SIUSBT65	Theory	Agribiotechnology (Applied Component)	2.0	4
SIUSBTP68	Practicals	Agribiotechnology (Applied Component)	2.0	4
	Total		**20**	**36**

SEMESTER V

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT51	**CELL BIOLOGY**		
Course Outcomes	On successful completion of the course the learner will be able to: ● describe cell cycle mechanism and its control, ● outline signal transduction pathway, mechanism of cellular responses underlying various conditions & defects in signaling and related disorders, ● discuss pre & post fertilization events & investigate pattern formation & positional identification in embryogenesis in Drosophila, ● identify the roles of oncogenes and tumor suppressors in Cancer, examine the causes, symptoms, stages, diagnosis and treatment of cancer		
I Cell cycle	Cell cycle Introduction: Prokaryotic and Eukaryotic; The Early Embryonic Cell Cycle and the Role of MPF; Yeasts and the Molecular Genetics of Cell Cycle Control; Apoptosis and necrosis, Cell-Division Controls in Multicellular Animals	**2.5**	**15**
II Cell Signaling	Cell signaling and signal transduction: Introduction General Principles of Cell Signaling; Signaling via G-Protein-linked Cell-Surface Receptors; Signaling via Enzyme-linked Cell-Surface Receptors; Target-Cell Adaptation, The Logic of Intracellular; Signaling: Lessons from Computer-based "Neural Networks".		**15**
III Developmental Biology	Overview of how the modern era of developmental biology emerged through multidisciplinary approaches; Gametogenesis- Spermatogenesis and Oogenesis, Structure of sperm and ovum, Morphological changes during maturation of gametes, Ovarian cycle, Events during fertilization- Capacitation and acrosome reaction, Post fertilization events- Cleavage, Blastulation, Implantation, Gastrulation, Formation of notochord. Artificial Reproductive techniques - IVF & Embryo transfer, Intrauterine, intrafallopian and intracytoplasmic transfer		**15**
IV Cancer Biology	Cancer: Introduction, Types of cancer, Characteristics, Causes, The Molecular Genetics of Cancer: Oncogenes and Tumor suppressor genes Tumor antigens and markers Cancer as a Micro-evolutionary Process; Immune response against cancer, Cancer diagnosis and Therapy (Chemotherapy and Immunotherapy)		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT52	**MEDICAL MICROBIOLOGY AND INSTRUMENTATION**		
Course Outcomes	On successful completion of the course the learner will be able to: ● classify viruses, understand its replication, propagation and assays, ● compare the mode of action of various antimicrobial agents as well as illustrate the mechanism of resistance development ● analyze the requirements & engineering different types of vaccines and examine the importance of new emerging vaccine technologies. ● enlist the principle and applications of various bioanalytical techniques including chromatography and radioactivity		
I Virology	Introduction to viruses-Position in biological spectrum; Virus properties; General structure of viruses Baltimore Classification and Taxonomy (ICTV); Cultivation of viruses; Reproduction of ds DNA phages Hepatitis /ss RNA (influenza), animal viruses and plant (TMV)virus; Virus purification and assays; Cytocidal infections and cell damage; Viroids and Prions	**2.5**	**15**
II Chemo therapeutic drugs	Discovery and Design of antimicrobial agents; Classification of Antibacterial agents, Selective toxicity, MIC, MLC; Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin; Injury to Plasma membrane: Polymyxin; Inhibition of protein synthesis Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides-Erythromycin; Inhibition of Nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole; Antimetabolites: Sulphonamides, Trimethoprim; Drug Resistance: Mechanism, Origin and transmission of drug resistance; Use and misuse of antimicrobial agents; Antifungal drugs, Antiviral drugs		**15**
III Vaccines	Immunization, immunization schedule, Vaccines- Live and Attenuated Vaccines, Inactivated and killed vaccines, subunit vaccines-HSV, cholera, HPV, Peptide vaccines-Foot and mouth disease, Malaria; Attenuated vaccines – cholera, HSV, Edible vaccines; Gene therapy, Human gene therapy- in vitro & in vivo		**15**
IV Bioanalytical techniques	Principle, working and applications of: Gas chromatography, HPTLC, HPLC - Method development and validation; Isotopes in Biology: Nature of radioactivity; Detection Techniques using GM counter, Scintillation counter, autoradiography; Applications of Tracer techniques in Biology, H-NMR and C-NMR (with Numerical)		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT53	**GENOMICS AND MOLECULAR BIOLOGY**		
Course Outcomes	On successful completion of the course the learner will be able to demonstrate the understanding of: ● gene cloning and its methods ● methods of producing transgenic plants and animals; advantages and ethical concerns of using transgenic animals ● recent advances in techniques in genetics and molecular biology- NGS, microarray, and ● different sequencing techniques and modification of genes in vivo using mi/siRNA, Crispr cas		
I Genetic engineering of plants	Genetic engineering of plants; Methodology. Plant transformation with the Ti plasmid of *A.tumefaciens*, 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	**2.5**	**15**
II Transgenic Animals	Transgenic mice-methodology-retroviral method, DNA microinjection, ES method; genetic manipulation with cre-loxP; Vectors for animal cells; Transgenic animals recombination system; Cloning live stock by nuclear transfer; Green Fluorescent Protein; Transgenic fish		**15**
III Tools in Molecular Biology	Cloning vectors-Plasmids (pUC series), Cosmids, phagemids M13, shuttle vectors, YAC vectors, expression vectors pET; Gene cloning-Isolation and purification of DNA; Isolation of gene of interest: Restriction digestion, electrophoresis, blotting, cutting, and joining DNA, methods of gene transfer in prokaryotes and eukaryotes; Recombinant selection and screening methods: genetic, immunochemical, Southern and Western analysis, nucleic acid hybridization, HART, HRT; Expression of cloned DNA molecules and maximization of expression; Cloning strategies-genomic DNA libraries, cDNA libraries, chromosome walking and jumping		**15**
IV Techniques in Molecular Biology	PCR: Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection. Maxam Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing, Pyrosequencing; Human genome mapping and its implications in health and disease; RNAi, ZNF Zinc finger nucleases), TALENS (Transcription Activator Like Effector Nucleases), CRISPER/Cas system (Clustered Regularly Interspersed Repeats)		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT54	**RESEARCH METHODOLOGY & BIOSTATISTICS**		
Course outcomes	On successful completion of the course the learner will be able to demonstrate the understanding of: • research methodology, its criteria and significance of a research problem, • merits and demerits of experimental design and means of data collection, • significance of scientific communication and overall contents of report writing • Implement various statistical tools for analysis of biological data		
I Introduction to Research Methodology and Research Problem	Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; Research Methods versus Methodology; Scientific and statistical hypothesis, Research Process; Criteria of Good Research; Problems Encountered by Researchers in India; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem.	**2.5**	**15**
II Research Design and Data Collection	Meaning of Research Design; Need for Research Design; Features of a Good Design; Important Concepts Relating to Research Design; Different Research Designs; Basic Principles of Experimental Designs; Developing a Research Plan – Collection of Primary Data; Observation Method; Interview Method; Collection of Data through Questionnaires; Collection of Data through Schedules; Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method		**15**
III Scientific Communication and Report Writing	Scientific Communication: Communication elements - verbal and non-verbal communications, principles of effective communications, oral presentations, Scientific writing, Introduction to scientific reports and writing, egg: writing reviews, papers and bibliography. Report Writing: Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Introduction to Plagiarism		**15**
IV Biostatistics	Normal distribution - properties, Sampling distribution of means, Standard error of means, Hypothesis testing: Null and alternative hypothesis, importance; Type I and II errors, Level of significance, Steps in Testing Statistical Hypothesis; Concept of inferential statistics; Parametric Tests: - Z Test- Single Mean and Two Means, t-Test-Single Mean, Paired and Unpaired; Theory and Problems based on- Coefficient of Correlation and Simple Linear Regression Analysis		**15**

APPLIED COMPONENT

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT55	**MARINE BIOTECHNOLOGY**		
Course Outcomes	On successful completion of the course the learner will be able to: ● identify the different marine ecosystem & illustrate the methods for marine bioprospecting ● assess the importance of pharmaceuticals, nutraceuticals as well as cosmeceuticals derived from marine source		
I **Marine Biotechnology- Introduction & Bioprospecting**	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; Biotechnological Potential of Marine Microbes; Bioactive compounds from other Marine Organisms: fungi, Microalgae, Macroalgae, Actinomycetes, sponges		**12**
II **Marine Drugs and Enzymes**	Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna - marine toxins, antiviral and antimicrobial agents; Approved Marine Drugs as Pharmaceuticals**;** Marine Natural products and its Challenges; Marine Microbial Enzymes - Marine Extremozymes and Their Significance, Current Use of Marine Microbial Enzymes	**2**	**12**
III **Marine Functional foods and Nutraceuticals**	Marine Functional Foods: Marine Sources as Healthy Foods or Reservoirs of Functional Ingredients; Marine-Derived Ingredients with Biological Properties; Functional Foods Incorporating Marine-Derived Ingredients; Marine Nutraceuticals: Marine Bioactives as Potential Nutraceuticals, Functional Carbohydrates, Polyunsaturated Fatty Acids; Carotenoids, Soluble Calcium, Fish Collagen and Gelatin, Marine Probiotics		**12**
IV **Marine Bioresources and Cosmetics**	Marine Bioresources, Marine Secondary Metabolites, Marine Proteins, Marine Lipids; Cosmetics from Marine Sources: Scenario of Marine Sources in the Cosmetic Industry, 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		**12**

COURSE CODE	PRACTICALS	CREDITS
Course outcomes	On successful completion of the course, the learner will be able to analyze and interpret result output from various common analytical instruments as well as perform diffusion-based experiments to analyze the sensitivity pattern of test strains against commonly prescribed antibiotics.	
SIUSBTP56 (Practicals of SIUSBTP51 & SIUSBTP52)	1. HPLC method validation. 2. GC validation 3. HPTLC validation 4. MIC and MLC of any one antibiotic 5. Antibiotic sensitivity test using agar cup method 6. Antibiotic sensitivity test using paper disc method 7. Antibiotic sensitivity test using ditch method. 8. Cancer Biology: (Field visit and 2-page report in the journal) 9. Chick embryo candling and inoculation methods (Demonstration experiment)	**3**
Course outcomes	On successful completion of the course, the learner will be able to perform basic molecular biology experiments and bioprospect marine sources for various resources.	
SIUSBTP57 (Practicals of SIUSBTP53 & SIUSBTP54)	1. Transformation in *E.coli* (Problem based questions) 2. Genomic DNA Extraction: Animal cells. 3. Restriction enzyme digestion and ligation (Kit may be used). (Problem based questions) 4. Phage titration: Demonstration 5. Polymerase chain reaction. Demonstration 6. Replica plate technique 7. Bacterial gene expression (Kit may be used). 8. Sanger's DNA sequencing method - Analysis 9. Research paper - poster making and presentation 10. Biostatistics problems	**3**
Course outcomes	On successful completion of the course, the learner will be able to calibrate routine laboratory equipment, check the sterility of pharmaceutical compounds, detect the presence of various food adulterants as well as segregate & categorize biomedical waste.	
SIUSBTP58 (Practicals of SIUSBTP55 – Applied Component)	1. Study of any 5 marine bacteria and algae (Macro and micro) 2. DPPH assay for antioxidant extracted from marine algae 3. Extraction of carotenoids from marine algae/Bacteria/Fungi 4. Extraction and estimation of Gelatin. 5. Extraction and estimation of Collagen 6. Extraction of alkaloids from marine organisms and their separation by TLC.	**2**

SEMESTER VI

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT61	**BIOCHEMISTRY**		
Course Outcomes	On successful completion of the course the learner will be able to describe: ● protein structure, interactions between Proteins and Ligands as well as interactions modulated by chemical energy ● synthesis and regulation of various biomolecules & crosstalk of various metabolic pathways ● structure, storage, release, transport, function as well as disorders associated with various hormones ● dietary sources, bioactive form, functions and disorders associated with vitamins and minerals		
I Proteins	Protein structure: Protein Tertiary and Quaternary Structures –Protein Denaturation and Folding; Ramachandran Plot; 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.	**2.5**	**15**
II Metabolism	Gluconeogenesis, pentose phosphate pathway, Glyoxylate pathway, reductive TCA, Carbohydrate biosynthesis and its regulation, Starch and sucrose in Plants; Glycogen in Animals; Biosynthesis and regulation of Fatty acid, Cholesterol, Atherosclerosis.		**15**
III Endocrinology	Mechanism of action 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 – Glucocortocoids; Pancreas – insulin and glucagon; Female Gonads – estrogen and progesterone; Male gonads – testosterone; Placenta – hCG		**15**
IV Nutrition	Minerals and Vitamins; Dietary sources, bioactive form, functions and disorders associated with fat soluble (A D E K) and water-soluble vitamins; Minerals - physiological and biochemical functions of principle and trace elements.; Malnutrition – Over nutrition (obesity) and PEM (Kwashiorkor and Marasmus)		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT62	**INDUSTRIAL MICROBIOLOGY**		
Course Outcomes	On successful completion of the course the learner will: ● prioritize the importance of starter culture as well as outline the steps involved in manufacturing of various fermented products ● discuss the different methods of downstream processing for purification ● Outline the steps in production of various fermented compounds as well as inspect the importance of scale up and scale down ● Implement good manufacturing practices, QA/QC as well as restate the importance of ISO		
I **Dairy technology**	Milk: Normal flora, changes in raw milk; Enumeration; Factors affecting bacteriological quality; Dairy technology Preservation methods; Pasteurization; Starter Cultures; Fermented products - Production process and spoilage of - Cheese: Swiss and Cheddar; Butter; Yogurt and Buttermilk	**2.5**	**15**
II **Down-stream Processing (DSP)**	Introduction of DSP; Foam separation; Types of Precipitation; Filtration, Centrifugation; Chromatography in DSP; Cell disruption- physical and chemical methods; Solvent recovery, Membrane processes; Drying; Crystallization and Whole broth processing; Protein purification		**15**
III **Fermentation process**	Scale up, scale down; Production of: Streptomycin; Protease; Mushroom; Glutamic acid; Lysine, Vitamin B12, Humulin, Biotransformation, Probiotics and Prebiotics.		**15**
IV **QA-QC**	Concept of GMP; Requirements of GMP implementation, Documentation of GMP practices; Regulatory certification of GMP; Quality Control (QC): Concept of QC, Requirements for implementing QC; QA concepts: Concept of QA, Requirements for implementing QA. ISO concepts and benefits.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT63	**BASIC PHARMACOLOGY AND NEUROCHEMISTRY**		
Course Outcomes	On successful completion of the course the learner will be able to: ● describe the mechanism of drug action and inspect the dose response relationship ● discuss the absorption, distribution, metabolism and excretion of drugs ● explain the generation and propagation of nerve impulse and examine the action of neuromodulators as well as neurotoxins		
I **General principles of Pharmacology**	Mechanism of drug action; drug receptors and biological responses**;** second-messenger systems, the chemistry of drug–receptor binding**;** dose–response relationship: therapeutic index; ED, LD; Potency and Intrinsic Activity; Drug antagonism	**2.5**	**15**
II **Drug Absorption and Distribution**	Absorption of drugs from the alimentary tract ; factors affecting rate of gastrointestinal absorption; absorption of drugs from lungs; skin; absorption of drugs after parenteral administration factors influencing drug distribution, binding of drugs to plasma proteins, Physiological barriers to drug distribution.		**15**
III **Metabolism and Excretion**	Drug metabolism: enzyme systems: oxidative and reductive enzymes: phase I reactions; conjugative enzymes: phase II reactions; Pharmacogenomics of drug metabolizing enzymes; Excretion of drugs: Renal excretion; Biliary Excretion; Pulmonary excretion; Excretion in other body fluids: sweat, saliva; Drug concentration–time profiles and basic pharmacokinetic parameters; Additional pharmacokinetic parameters: Bioavailability, clearance, distribution.		**15**
IV **Neurochemistry**	Anatomy and functioning of the brain -Neuronal pathways; Propagation of nerve impulses; Neuronal excitation and inhibition, Generation and propagation of Action potential, Graded potential, Synapses and gap junctions; Action of Neurotoxins and neurotransmitters, Incapacitating agents.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT64	**ENVIRONMENTAL BIOTECHNOLOGY**		
Course Outcomes	On successful completion of the course the learner will be able to: ● classify and compare different renewable sources of energy ● describe different methods of effluent treatment as well as strategize treatment of industrial wastes ● discuss waste water and solid treatment methods as well as explain the biodegradation of persistent chemicals		
I **Renewable sources of energy**	Energy sources renewable – solar energy, wind power, geothermal energy and hydropower, biomass energy; Biogas technology- biogas plant & types, biodigester. Biogas- composition, production and factors affecting production, uses; Biofuels – ethanol production. Microbial hydrogen production Biodiesel, Petrocrops.	**2.5**	**15**
II **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; Characteristics and treatment strategies of waste from tanning industry; petroleum industry; paper & pulp industry; Dairy, Distillery, Dye, Antibiotic industry		**15**
III **Wastewater treatment**	Wastewater treatment- introduction, biological treatment, impact of pollutants on biotreatment, use of packaged organisms and genetically engineered organisms in waste treatment, Heavy metal pollution – sources, microbial systems for heavy metal accumulation, techniques used for heavy metal removal, biosorption by bacteria, fungi and algae, factors affecting biosorption limitations of biosorption		**15**
IV **Hazardous waste management**	Solid waste treatment; Composting and Vermicomposting, pollution indicators & biosensors, Removal of oil spillage & grease deposits, Biodegradation of xenobiotics-persistent compounds, chemical properties influencing biodegradability.		**15**

APPLIED COMPONENT

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT65	**AGRICULTURAL BIOTECHNOLOGY**		
Course Outcomes	On successful completion of the course the learner will be able to: ● design PTC media and discuss the importance of PTC for production of fine chemicals; describe the biotic & abiotic stress and development of systemic and induced resistance ● classify and explain different plant breeding markers and examine the significance of barcoding ● outline the importance of biofertilizer, biopesticide as well as prepare microbial inoculants		
I Plant Tissue Culture	Introduction to PTC media and role of phytohormones-, Auxin, Gibberellins, Cytokinins, Ethylene, Abscissic acid; Initiation and maintenance of callus, organogenesis, virus elimination, plant cell culture as a system for production of fine chemicals, plant suspension cultures, elicitation and permeabilization, biotransformation, Hairy root culture, Micropropagation, Somatic embryogenesis and synthetic seeds.	**2**	**12**
II 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.		**12**
III 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, tmHpsbA), steps, recent advances, Benefits, Limitations.		**12**
IV Biofertilizers And Biopesticides	**Biofertilizer**: Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers, Anammox; Nonsymbiotic Nitrogen Fixers Plant Growth Promoting Microorganisms-Phosphate- Solubilizing Microbes (PSM), 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		**12**

	Formulations Biocontrol, Polymicrobial Inoculant Formulations; **Biopesticides** – types, Bacillus thuringiensis, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application)		

COURSE CODE	PRACTICALS	CREDITS
Course Outcomes	On successful completion of the course, the learner will be able to isolate lactic acid bacteria, analyze the bacteriological quality of milk and enumerate the normal flora of milk. They will be skilled to detect cholesterolemia and diabetes as well as quantify the amount of vitamin and various ions.	
SIUSBTP66 (Practicals of SIUSBTP61 & SIUSBTP62)	1. Isolation and identification of Lactic acid bacteria 2. Microbial analysis of Milk by MBRT and RRT 3. Phosphatase test in Milk 4. DMC of milk sample 5. Isolation of Normal flora from Milk and curd 6. Determination of blood glucose levels for detection of diabetes mellitus. 7. Determination of serum cholesterol (total, HDL and LDL ratio) (Problem based questions) 8. Estimation of vitamin C by DCPIP method from food samples. 9. Estimation of Vitamin B12 using chemical and biological method. (Problem based questions) 10. Estimation of Fe and Ca titrimetrically 11. Estimation of phosphorus using Fiske and Subbarow method	**3**
Course Outcome	On successful completion of the course, the learner will be able to evaluate the toxicity associated with phenolic compounds released in the environment, assess physico-chemical parameters of effluent sample as well as study the effect of heavy metal of bacterial growth as a potential candidate for bioremediation.	
SIUSBTP57 (Practicals of SIUSBTP63& SIUSBTP64 and Skill-based project)	1. LD 50, ED 50 evaluation using suitable models ex. daphnia (Problem based questions) 2. Determination of synergistic action of drugs 3. Study the effect of heavy metals on the growth of bacteria. 4. Determination of Total Solids from an effluent sample. 5. Study of physico-chemical (pH, color, turbidity, BOD, COD) parameters of any one industrial effluent sample 6. Estimation of chromium from Effluents (Demonstration) 7. Visit to ETP/ CETP	**3**
Course Outcomes	On successful completion of the course, the learner will be able to prepare plant tissue culture media and use it for callus induction. They would also enrich & cultivate potential biofertilizers as well as study the effect of various stresses on the growth of the plant.	
SIUSBTP68 (Practicals of SIUSBTP65 – Applied Component)	1. RAPD analysis demonstration experiment 2. Preparation of MS medium (media preparation, molarity, molality problems) 3. Surface sterilization of explant and inoculation in MS medium 4. Callus induction 5. Isolation of *Rhizobium*	**2**

	6. Isolation of *Azotobacter* 7. Isolation of Phosphate solubilising bacteria 8. Study of effect of abiotic stress on plants. 9. Rapid screening tests for abiotic stress tolerance (drought, -PEG, Mannitol & salinity) (statistical analysis) 10. Estimation of antioxidants and antioxidant enzymes - Ascorbate, Catalase, and Peroxidase (problem based) 11. Visit to green house facility and submission of field visit report.	

EVALUATION SCHEME

The performance of the learner shall be evaluated into TWO Parts.
The learner's performance shall be assessed by Internal Assessment of **40 Marks** and Semester End Examination (theory) of **60 Marks for each term**.
Practical examination will be conducted at the end of each semester for **300 Marks**.
The allocation of marks for the Internal Assessment and Semester End Examinations are as follows:-

Internal Assessment – 40 Marks
There will be **two** internal assessment tests:

S. No.	Particulars	Marks
1.	Internal Assessment 1 - Centralized	20 Marks
2.	Internal Assessment 2 - Departmental	20 Marks

Semester End Examination – 60 Marks (offline)

S. No.	Particulars	Marks
	All questions are compulsory Number of questions – 5 (Five) Each question carries 12 Marks	
1.	Q1 – Unit I a. Answer the following (any two out of three)	12 Marks
2.	Q2 – Unit II a. Answer the following (any two out of three)	12 Marks
3.	Q3 – Unit III a. Answer the following (any two out of three)	12 Marks
4.	Q4 – Unit IV a. Answer the following (any two out of three)	12 Marks
5	Q5. Short notes (medley of all units) (Any three out of five)	12 marks
	TOTAL	**60 Marks**

References:

1. Ali, M. A., Gyulai, G., & Al-Hemaid, F. (2015). Plant DNA Barcoding and Phylogenetics. LAP LAMBERT Academic Publishing.
2. Altieri, M. A. (2018). Agroecology: the science of sustainable agriculture. CRC Press.
3. Altman, A., & Hasegawa, P. M. (Eds.). (2011). Plant biotechnology and agriculture: prospects for the 21st century. Academic press.
4. Barnes, R. S. K., & Hughes, R. N. (1999). An introduction to marine ecology. John Wiley & Sons.
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