SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

Sion (West), Mumbai – 400022.
(Autonomous)

Faculty: Science

Program: Bachelor of Science

Program code: SIUBT

Subject: BIOTECHNOLOGY

Academic Year: 2023 – 2024

F.Y.B.Sc. Biotechnology

Credit Based Semester and Grading Syllabi as per NEP 2020 approved by Board of Studies in Biotechnology to be brought into effect from June 2023.

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 the 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 Biotechnology. 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 classroom.

This restructured syllabus is therefore intended to combine the principles of physical, chemical and biological sciences along with developing advanced technology. The undergraduate curriculum 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.

SEMESTER I

Course Code	Course Type	Course Title	Credits	Lectures (Hrs.)/ week
SIUBTMJ111	DSC-Major	Basic Biotechnology I	3	3
SIUBTMJP111	DSC-Major	Practical	1	2
SIUBTMN111	DSC-Minor	Bioorganic Chemistry I	3	3
SIUBTMNP111	DSC-Minor	Practical	1	2
SIUBTOE111	OE	Food and Nutrition	4	4
SIUENAE111	AEC	English	2	2
SIUSFVE111	VEC	Environment Studies	2	2
SIUSFIK111	IKS	Indian knowledge system	2	2
SIUBTVS111	VSC	Microbial Techniques	1(Theory) + 1(Practical)	2
SIUBTSE111	SEC	Analytical Skills	1(Theory) + 1(Practical)	2
		Total	22	

SEMESTER II

Course Code	Course Type	Course Title	Credits	Lectures (Hrs.)/ week
SIUBTMJ121	DSC-Major	Basic Biotechnology II	3	3
SIUBTMJP121	DSC-Major	Practical	1	2
SIUBTMN121	DSC-Minor	Bioorganic Chemistry-II	3	3
SIUBTMNP121	DSC-Minor	Practical	1	2
SIUBTOE121	OE	Introduction to Forensic Science	4	4
SIUENAE121	AEC	Language-English	2	2
SIUSFVE121	VEC	Understanding India	2	2
SIUBTVS121	VSC	Biofertilizer production	1(Theory) + 1(Practical)	2
SIUBTSE121	SEC	Tissue Culture	1(Theory) + 1(Practical)	2
	Field projects/ Internships/ Apprenticeship / Community engagement and services	NCC/NSS/ Sports / Cultural	2	2
		Total	22	

SEMESTER 1

COURSE CODE	TITLE	CREDITS	LECTURES
	DSC-Major- BASIC BIOTECHNOLOGY I	**4 (3+1)**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, students will be able to: ● define biotechnology, provide examples of biotechnology products, give examples of job responsibilities associated with different branches in biotechnology ● describe and distinguish the structure and other salient characteristics of bacteria and viruses ;cell organelles of eukaryotic cell and their functions; understand and explain the basic skills such as culturing microbes, maintaining microbes, good microbiological practices, identify nutritional requirements for growth of bacteria; ● laws of inheritance, genetic basis of loci and alleles and deviation from Mendelian principles as well as non-mendelian inheritance; Hardy-Weinberg law and explain the assumptions		
Unit I	**Introduction and scope of Biotechnology** History & Introduction to Biotechnology **(1L)** What is Biotechnology? Definition of Biotechnology, Traditional and Modern Biotechnology **(2L)** Branches of Biotechnology and applications- Plant, Animal, Marine, Agriculture, Healthcare, Industrial, Pharmaceutical and Environmental Biotechnology. **(4L)** Molecular farming. Recombinant DNA technology applications in GM Fruits, Golden rice, Edible vaccines, and transgenic sheep. BT research in India, biotech institutions in India , biotech success stories Ethics in Biotechnology **(4L)** Scope of Food technology, Introduction to food packaging, food product labels and categories **(4L)**	**1**	**15**
Unit II	**Fundamentals of Microbiology I** **Introduction to Microbial Diversity:** Archaebacteria, Eubacteria, Cyanobacteria, Actinomycetes, Fungi, Eumycota **(2L)** **Bacteria:** Classification, Types, Morphology (Size, Shape and Arrangement) Modes of cell division **(2L)** **Ultrastructure of Prokaryotic Cell:** Concept of Cell Shape and Size, Detail Structure of Slime Layer, Capsule, Flagella, Pilli, Cell Wall (Gram Positive and Negative), Cell Membrane, Protoplast and Spheroplast, Cytoplasm and Genetic Material Storage Bodies and Spores **(5L)**	**1**	**15**

	Nutrition and Cultivation of Microorganisms: Nutritional Requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth Factors. Classification of Different Nutritional types of Organisms, Design and Types of Culture Media: Simple Medium, Differential, Selective and Enriched Media. **(4L)** Concept of Isolation and Methods of Isolation, Pure Culture Techniques **(2L)**		
Unit III	**Fundamentals of genetics** **Mendelian and Non-Mendelian genetics-** Genotype and Phenotype, Mendel's Laws of Heredity Monohybrid Cross: Principle of dominance and segregation. Dihybrid Cross: Principle of independent assortment **(3L)** Application of Mendel's Principles, Punnett Square Mendel's Principle in Human Genetics **(1L)** Incomplete Dominance & Co-dominance Multiple Alleles **(2L)** Gene Interaction- Epistasis **(2L)** Extra-chromosomal inheritance- Chloroplast and Mitochondria **(2L)** **Population genetics:** Genetic Structure of Populations – Genotypic Frequencies and Allelic Frequencies, Hardy- Weinberg Law and its assumptions, Genetic Variations in Populations- Measuring Genetic Variation at Protein Level and measuring Genetic Variations at DNA level **(3L)** Genetic Drift, Speciation **(2L)**	**1**	**15**
Practical	1. Aseptic transfer 2. Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabouraud Agar 3. Isolation of Organisms (T-streak, Polygon method) and its Colony Characteristics 4. Study of motility of microorganisms by hanging drop method. 5. Isolation of organisms from Food / Environmental samples 6. Problems in Mendelian Genetics	**1**	**15**

COURSE CODE	TITLE	CREDITS	LECTURES
Subject II	**DSC-Minor- BIOORGANIC CHEMISTRY I**	**4 (3+1)**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, the student will be introduced to the basic concepts of bioorganic molecules, their structure, classification and physicochemical characteristics. The learner will be skilled in describing and defining the structure, function, classification and properties of carbohydrates, lipids and nucleic acids.		
Unit I	**Carbohydrates** Structure, Function, Classification. Characteristic Reactions, Physical and Chemical Properties, D & L-Glyceraldehyde, Structure of Monosaccharide, Disaccharides, and Polysaccharides**(3L)** Isomers of Monosaccharides, Mutarotation Concept of Epimers, anomers.**(4L)** Chemical/Physical Properties of Carbohydrate Chemical Reactions for Detection of Mono-, Di- and Polysaccharides **(4L)** Structural and functional polysaccharides-examples **(2L)** Glycoproteins and proteoglycans-examples**(2L)**	**1**	**15**
Unit II	**Nucleic Acids:** Structure of Purine and Pyrimidine Bases, Structure of Nucleosides, Nucleotides and Polynucleotides **(3L)** **DNA and RNA**: Structure, types, and function of DNA and RNA **(4L)** **Properties of DNA and RNA** - Hydrogen Bonding between Nitrogenous Bases in DNA, Differences between DNA and RNA, cDNA, Denaturation, Annealing, Tm, Hypo & hyperchromic effect.**(5L)** Chemical synthesis of DNA and DNA hybridization **(3L)**	**1**	**15**
Unit III	**Lipids:** Classification of Lipids, Concept of Storage Lipids and Structural Lipids Properties of Saturated, Unsaturated Fatty Acids, Rancidity, and Hydrogenation of Oils **(4L)** **Triacylglycerol, Phospholipids, Sphingolipids, Sterols:** Basic structure, function, and examples **(3L)** **Lipoproteins**- Structure and Function **(2L)** Use of Lipids as cofactors, signals and pigments **(3L)**	**1**	**15**

	Methods involved in the Extraction, separation and identification of cellular lipids **(3L)**		
Practical	1. Spot test for Carbohydrates (Benedict, Anthrone and Molisch), 2. Spot test for Fats 3. Spot test for Nucleic Acids 4. Estimation of reducing sugar by DNSA method 5. Estimation of Acid number of Oil 6. Estimation of Iodine value of Oil	**1**	**15**

COURSE CODE	TITLE	CREDITS	LECTURES
OE	**Food and Nutrition**	**4**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, the student will be able to ● Understand the concepts of human nutrition, basic and advanced concepts of complementary nutrition, nutrition for fitness and exercise and food psychology.		
Unit I	**Human nutrition** Carbohydrates: Overview of Classification, Functions Carbohydrate recommendations(**2L)** Glycemic Index and Glycemic Load, Sugar substitutes-Nutritive and non - nutritive sweeteners Synthetic and Natural sweeteners (**3L)** Fats and Fatty acids: Overview of Classification, Functions RDAs of total dietary fat and fatty acid consumption(**2L)** Fatty acid ratios, SFA, MUFA & PUFAs in health & disease (**2L)** Proteins and Amino acids- Overview of Classification, Functions, Essential Amino acid requirements and AA imbalances(**3L)** Vitamins and minerals: Overview of Classification, Functions(**3L)**	**1**	**15**
Unit II	**Complementary Nutrition- Basic and advanced aspects** Classification, Health benefits, Mechanism of action, sources & recommendations of Prebiotics, Probiotics and Synbiotics -Types, Sources of prebiotics and probiotics, Health benefits, Regulations (**5L)** Bioactive Dietary Components, Functional foods, Phytochemicals, Flavonoids, Phytoestrogens (**4L)** Meal Replacers, - Classification, Health benefits, Mechanism of action, Recommendations & concerns (**3L)** Functional foods Organic foods Convenience foods (**3L)**	**1**	**15**

Unit III	**Nutrition For Exercise & Fitness** Definition and domains of fitness-Physical, Mental, Social & Spiritual domains of fitness Components of physical fitness (**4L)** Health oriented components -cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition. (**2L)** Skill oriented components-agility, balance, coordination, power, reaction time, and speed -Factors influencing Physical fitness - Role of exercise and nutrition in Physical fitness, Psychological Fitness- stress- Causes, consequences & strategies of management (**3L)** Nutrition and Physical Fitness in sports persons Classification of sports activities (**3L)**, Body Composition of Sports Persons Energy metabolism during Exercise (aerobic and anaerobic) (**3L)**	**1**	**15**
Unit IV	**Food Psychology** The psychology of food choices and eating behavior- Models of food choice, Influences on food choice(**1L)** Social and psychological models of food choice- Role of family and peers, Food and Culture, Mood, emotions and food choice,(**2L)** Food cravings and addiction, Food Rewards (**1L)** Influences of Media on food choice (**1L)** Role of stress in choosing foods (**1L)** Alcohol and tobacco use and abuse (**2L)** Behavior modification strategies to influence food and nutrition choices in disease conditions- Obesity - Behavioral phenotype in obesity, mindful eating, Diabetes, Allergies (**2L)** Psychology of the food and nutrition consumer- The psychology of the food shopper (**1L)** Factors affecting food purchase (**1L)**, Food quality and consumer expectations,(**1L)**Packaging and labeling based on the psychology of the consumer, Ethnic, religious and economic influences on food choice of the consumer (**1L)**, Consumer perception of processed foods,	**1**	**15**

	supplements, organic and genetically modified foods (**1L**T**)**		

COURSE CODE	**TITLE**	**CREDITS**	**LECTURES**
VSC	**Microbial techniques**	**2 (1+1)**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, students will be able to ● describe the principles which underlie sterilization of culture media, glassware and plasticware to be used for microbiological work		
Unit I	**Enumeration of Microorganisms:** Direct and Indirect Methods: Direct microscopic count – Breed's count, Petroff -Hausser counting chamber, Hemocytometer. Viable count – Spread plate and Pour plate technique. Turbidity measurements – Nephelometer and spectrophotometer techniques (**7L**) **Growth curve:** Phases of growth, generation time, growth rate **(3L)** **Sterilization and Disinfection:** Definition, Sterilization of media and glass wares; Types and Applications- Dry Heat, Steam under pressure, Gases, Radiation and Filtration; Chemical Agents and their Mode of Action- Aldehydes, Halogens, Phenol, Alcohol, and Detergents; Ideal Disinfectant-Properties, and Evaluation of Disinfectant **(5L)**	**1**	**15**
Practical	1. Introduction of laboratory instruments-Autoclave, Hot air Oven, Incubator, pH meter, Rotary Shaker and Centrifuge 2. Sterilization of media and glassware 3. Enumeration of microorganism by pour plate and spread plate method 4. Enumeration by Breed's count 5. Growth curve of *E. coli* 6. Effect of pH and temperature on growth of	**1**	**15**

	microorganisms 7. Principles and practices of lab safety, Decontamination and disposal		

COURSE CODE	TITLE	CREDITS	LECTURES
SEC	**Analytical skills**	**2 (1+1)**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, Students will: ● examine, identify the parts and use different microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist. ● perform basic experiments to determine the concentration of biomolecules using colorimetry		
Unit I	**Microscope:** Simple and Compound – General Principle of optics, Various parts and their functions - objectives numerical aperture, resolving power, depth of focus working distance, aberration, oculars; condensers. Dark Field microscope, Phase Contrast microscope **(6L)** **Stains and Staining Solutions:** Definition of Dye and Chromogen, Functions of Mordant, Intensifiers and Fixative, Natural and Synthetic Dyes, Classification, Differential Staining (Gram staining, Romanowsky's staining & Acid-Fast Staining), Fluorescent stains, Principles of metachromatic granules **(5L)** **Colorimetry:** Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of E = kcl, Limitations of Beer-Lambert's Law, Instrumentation **(4L)**	**1**	**15**
Practical	1. Components and working of Simple, Compound, Dark Field and Phase Contrast Microscope 2. Verification of Beer Lambert's Law and determination of absorption maxima 3. Special Staining Technique for Cell Wall, Capsule, Lipid granules and Endospores. 4. Fungal Staining	**1**	**15**

	5. Monochrome Staining 6. Negative staining 7. Differential Staining: Gram Staining		

SEMESTER II

COURSE CODE	TITLE	CREDITS	LECTURES
	DSC-Major- BASIC BIOTECHNOLOGY II		**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, student will be able to demonstrate the understanding of: ● photosynthesis and the fundamental reactions, Digestion, respiration and circulation in animals ● describe the process of semi-conservative DNA replication in eukaryotic cells and compare this method with DNA synthesis in prokaryotes, ● describe different types and mutations and repair mechanisms.		
Unit I	**Plant Physiology:** Photosynthesis, Intracellular Organization of Photosynthetic System, Photosynthetic Pigments, Fundamental Reactions of Photosynthesis **(2L)** Role of Light. Hill Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photo Induced Electron Flow, Energetics of Photosynthesis **(3L)** Photorespiration, Dark Phase of Photosynthesis, Calvin Cycle, C-4 and CAM pathway **(2L)** **Animal Physiology:** Physiology of Digestion, Movement of Food and Absorption, Secretary functions of Alimentary Canal, Digestion and Absorption, assimilation in Gut of Mammals **(3L)** Anatomy of Mammalian Kidney, Structure of Nephron, Physiology of Urine Formation and Role of Kidney in Excretion and Osmoregulation **(2L)** Physiology of Respiration, Mechanism of Respiration, Principles of Gaseous Exchange in the Blood and Body Fluids **(1L)** Blood and Circulation: Blood Composition, Structure and Function of its Constituents, Blood Coagulation and Anti- Coagulants, Hemoglobin and its Polymorphism Regulation of the Circulation Mechanism and working of Heart in Human. **(2L)**	**1**	**15**
Unit II	**DNA Replication: 9L** DNA Replication in Prokaryotes and Eukaryotes- Semi-conservative DNA replication, DNA	**1**	**15**

	Polymerases and its role, *E. coli* Chromosome Replication, Bidirectional Replication of Circular DNA molecules, Rolling Circle Replication, DNA Replication in Eukaryotes, End replication problem, Action of Telomerase **Recombinant DNA technology : 6L** Genetic Engineering in *E.coli*, Cloning Vector - Plasmid, Enzymes - DNA Polymerases, Restriction Endonucleases, Ligases, Reverse Transcriptases, Nucleases, Terminal Transferases, Phosphatases		
Unit III	**Mutations (8L)** Definition and Types of Mutations, Mutagens (Examples of Physical, Chemical and Biological Mutagens) Types of Point Mutations, DNA repair – Photo reversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair **Genetic analysis in Bacteria (7L)** Prototrophs, Auxotroph Mechanism of Genetic Exchange in Bacteria- Conjugation; Transformation; Transduction (Bacteriophages – Lytic and Lysogenic cycle), Introduction to Bacterial Transposable Elements	**1**	**15**
Practical	1. Staining and study of Plant and Animal Tissues 2. Isolation and purification of DNA from plant source (Onion) 3. Study of Hill ‘s reaction 4. Colorimetric study of Absorption Spectrum of Photosynthetic Pigments 5. Erythrocyte count using Hemocytometer 6. Leukocyte count using Hemocytometer 7. Estimation of Hemoglobin in Mammalian Blood by Sahli’s Hemometer 8. Study of Human Blood Groups 9. Differential staining of Blood cells 10. Study of Mitosis	**1**	

COURSE CODE	TITLE	CREDITS	LECTURES
	DSC-Minor- BIOORGANIC CHEMISTRY-II	**4 (3+1)**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, Student will be able to ● prepare buffers and learn the handling of basic analytical techniques like chromatography and colorimetry, describe the fundamentals of acid/base equilibria, buffer behavior, acid/base titrations, estimate the strength of acids and bases and determine the pH ● describe and define the structure, function, classification and properties of amino acids and proteins. ● classify the enzymes and explain mechanism of action and structure, study enzyme kinetics and calculate Vmax, Km values.		
Unit I	**Water, Solutions and Buffers** **Chemistry of Water:** Properties of Water, Interaction of Water with Solutes (Polar, Non-Polar, Charged), Non-Polar Compounds in Water – Change in its Structure and the Hydrophobic Effect, Role of Water in Biomolecular Structure and Function, Water as a Medium for Life (**3L)** **Solutions:** Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numericals expected). (**3L)** **Primary and Secondary Standards:** Preparation of Standard Solutions, Principle of Volumetric Analysis.(**2L)** **Acids and Bases:** Lowry-Bronsted and Lewis Concepts. Strong and Weak Acids and Bases - Ionic Product of Water - *pH, pKa, pKb*. Hydrolysis of Salts. (**4L)** **Buffer solutions:** Concept of Buffers, Types of Buffers, Derivation of Henderson equation for Acidic and Basic buffers, Buffer action, Buffer capacity (Numericals expected) pH of Buffer Solution.(**3L)**	**1**	**15**
Unit II	**Proteins and amino acids** **Amino Acids:** Classification, Preparation and Properties, **(3L)**	**1**	**15**

	Isoelectric Point, Titration Curve of Amino Acids, Concept of Isoelectric pH, Zwitter-ion, Structure of Peptides, Peptide Synthesis **(3L)** **Proteins:** Classification based on Structure and Functions,**(3L)** Primary Structure, N-terminal (Sanger and Edmans Method) and C-terminal Analysis (Enzyme) **(3L)** Reactions of Amino Acids, Sorenson's Titration, Ninhydrin Test, Denaturation of protein, Glycoproteins **(3L)**		
Unit III	**Enzymes** Definition, Classification, Nomenclature, Chemical (**2L)** Nature and Properties of Enzymes, Co- Factors, Zymogens, Active Sites, Enzyme Specificity (**3L)** Mechanism of Enzyme Action (**2L)** Effect of pH, Temperature and Substrate Concentration on Enzyme Activity (**3L)** Enzyme Kinetics, Michaelis - Menten Equation (**2L)** Types of Enzyme Inhibitions - Competitive, Uncompetitive, Non-Competitive Allosteric, Modulators (**3L)**	**1**	**15**
Practical	1. Preparation of Standard (Molar, Molal and Normal solutions) and Buffer Solutions 2. Determination of strength of HCl in commercial sample 3. Determination of amount of $NaHCO_3$ + Na_2CO_3 in the given solid mixture titrimetrically 4. Separation of amino acids by paper chromatography 5. Estimation of Protein by Biuret method 6. Meat Tenderization using Papain 7. Qualitative Assay of Enzyme Amylase, Invertase, Urease, Lipase, Catalase and Dehydrogenase 8. Enzyme Kinetics : Study of the effect of pH, Temperature on activity of Enzyme	**1**	**15**

COURSE CODE	TITLE	CREDITS	LECTURES
OE	**Introduction to Forensic Science**	**4**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, the student will understand the basic concepts of forensic science, forensic medicine, medical law and ethics, forensic psychology and acts, and emerging trends in forensic science.		
Unit I	**Fundamentals of Forensic Science** History, Development and Fundamentals of Forensic Science, Definition and Origin of term *"forensis"* Nature, need and scope**(1L)** Principles and laws of forensic science **(2L)** Domains in Forensic Science divisions- ballistics, voice, audio-video, automobiles engineering **(3L)** Questioned documents division- (stylistics, linguistics, counterfeit) **(3L),** Cyber division (**1L),** Fingerprint division (Prints and other impressions) **(2L),** Psychology (Criminal profiling, polygraphy, narco analysis, brain mapping) (**3L)**	**1**	**15**
Unit II	**Essentials of Forensic Science** Crime scene investigation and reconstruction, forensic photography (**2L)** Forensic medicine: Introduction and forensic medicine and legal procedure (**2L)** Medical law and ethics(**1L)** Personal identification (**1L)** Medico legal autopsy (**2L)** Thanatology, death, and its causes Stages of death (**2L)** Instrumentation(**2L)** Basics of Microscopy, Chromatography - Paper, TLC, HPTLC, GC, HPLC Basic Spectroscopy, UV-Visible spectrophotometer (**3L)**	**1**	**15**
Unit III	**Forensic Psychology and Acts** Narco-analysis- Theory, procedure, admissibility in court, prospects, merits, and demerits of the technique (**3L)**, Brain Mapping- Theory, procedure, admissibility in court, prospects, merits, and demerits of the technique (**4L)**, Polygraph- Theory, procedure,	**1**	**15**

	admissibility in court, prospects, merits, and demerits of the technique(**4L)**. **Special Acts:** Narcotic Drugs and Psychotropic Substance Act , 1985 IT Act, 2005 Wildlife Protection Act 1972 (**4L)**		
Unit IV	**Emerging Trends in Forensic Science** Brain mapping, polygraph, PCR, DNA fingerprinting (**3L)** Digital Forensics (**2L)**: Computer Crimes- Definition Types of computer crimes Cyber Crimes - Definition, Types of cyber-crimes**(3L)** Computer security(**3L)** Online security (**2L)** Data retrieval (**2L)**	**1**	**15**

COURSE CODE	TITLE	CREDITS	LECTURES
VSC	**Biofertilizer production**	**2**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, the student will understand the basics of biofertilizer production, examples of bacterial biofertilizers, and composting.		
Unit I	Introduction, History and concept of Bio fertilizers, status scope and importance of Bio fertilizers, Classification of Bio fertilizers.(**3L)** Nitrogen fixation(**2L)** Features of bacterial Biofertilizers- Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia; Cyanobacterial biofertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza.(**3L)** Biofertilizers -Storage, shelf life, quality control and marketing. Factors influencing the efficacy of bio fertilizers.(**3L)** **Composting** - Procedure and factors involved in the development of compost.(**2L)** Determination of good quality compost using various physical and chemical parameters(**2L)**	**1**	**15**
Practical	1. Study of Permanent slides of Cyanobacteria 2. Isolation and enrichment of *Azotobacter* species 3. Isolation and enrichment of *Rhizobium* species 4. Production of compost at the lab scale 5. Determination of good quality of compost using physical parameters viz. pH, Moisture content, Specific gravity, Water holding capacity etc. 6. Determination of good quality of compost using chemical parameters viz. Carbon content and Calcium content. 7. Production technology: Strain selection, sterilization, growth	**1**	**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SEC	**TISSUE CULTURE**	**2**	**1 lecture = 1 hour**
Course Outcomes	On successful completion of the course, the student will understand the basic concepts of animal and plant tissue culture, design of tissue culture laboratory and applications.		
Unit I	**Basics of Plant Tissue Culture:** Cell Theory, Cellular Totipotency, Concept of Cell Culture, Design of PTC lab with equipment, Plant tissue culture media and phytohormones. Applications of PTC - Clonal and micro-propagation, callus culture, development of synthetic seeds and GMO **(7L)** **Basics of Animal Tissue Culture:** Introduction to Animal Cell Culture; Terminologies - Primary cell culture, Passaging, Confluency, Cell line, Organ culture; Equipment - CO_2 Incubator, Laminar-Air flow, Inverted microscope, medium filtration devices, Cell counters, liquid-nitrogen-storage tanks; Design of ATC laboratory; Applications of ATC - Cell lines for vaccine production, therapeutic proteins, pharmaceutical agents, and anticancer agents **(8L)**	**1**	**15**
Practical	1. Preparation of Stock Solutions for the Preparation of MS Media for PTC. 2. Surface Sterilization and establishment of the explant under aseptic condition on basal MS media. 3. Isolation of the plant protoplast from the callus and study of its morphology under the microscope. 4. Trypsinization of Tissue and Viability Count	**1**	**15**

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