SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Faculty: Science

Program: B.Sc.

Subject: BIOTECHNOLOGY

Academic Year: 2018 – 2019

T.Y.B.Sc.

Credit Based Semester and Grading Syllabi approved by Board of Studies in Biotechnology to be brought into effect from June 2018.

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

SEMESTER V				
Course Code	**Course Title**	**Theory/Practical**	**Credits**	**Lectures/week**
SIUSBT51	Cell Biology	Theory	2.5	4
SIUSBT52	Medical Microbiology & Instrumentation	Theory	2.5	4
SIUSBT53	Genomes and Molecular Biology	Theory	2.5	4
SIUSBT54	Marine Biotechnology	Theory	2.5	4
SIUSBTP56	Cell biology+ Medical Microbiology & Instrumentation	Practical	3.0	8
SIUSBTP57	Genomes and Molecular Biology+ Marine Biotechnology	Practical	3.0	8
SIUSBT55	Biosafety	Theory	2.0	4
SIUSBTP58	Biosafety	Practical	2.0	4
	Total		**20**	**36**
SEMESTER VI				
Course Code	**Course Title**	**Theory/Practical**	**Credits**	**No. of Lectures and Practicals**
SIUSBT61	Biochemistry	Theory	2.5	4
SIUSBT62	Industrial Microbiology	Theory	2.5	4
SIUSBT63	Pharmacology and Neurochemistry	Theory	2.5	4
SIUSBT64	Environmental Biotechnology	Theory	2.5	4
SIUSBTP66	Biochemistry & Industrial Microbiology	Practical	3.0	8
SIUSBTP67	Pharmacology - Neurochemistry and Environmental Biotechnology (50M)+ Project work (50M)	Practical	3.0	8
SIUSBT65	Agribiotechnology	Theory	2.0	4
SIUSBTP68	Agribiotechnology	Practical	2.0	4
	Total		**20**	**36**

SEMESTER V

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT51	**Cell Biology**		
Course Objectives	To familiarize the students with basic concepts cell cycle, cell signaling, apoptosis and cancer. To introduce them to the stages involved in developmental biology		
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, Cell-Division Controls in Multicellular Animals.	**2.5**	**15**
II Cell Signalling	Cell signalling 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; 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**
IV Cancer Biology	Cancer: Introduction, Cancer as a Micro-evolutionary Process; The Molecular Genetics of Cancer; Cancer and Virus Cancer diagnosis and chemotherapy		**15**
Total			**60**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT52	**Medical Microbiology and Instrumentation**		
Course Objectives	To introduce the students to viruses, its classification and replication. They will also be familiarized to vaccines against various diseases To acquaint the students with various antimicrobial agents, its mode of action and development of resistance To have a firm foundation in 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 **Chemotherapeutic 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: Affinity chromatography; Ion-exchange chromatography; Molecular (size) exclusion chromatography; 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		**15**

PRACTICALS

SIUSBTP57 **3 credits** **72hrs**

(Practicals of SIUSBTP53 & SIUSBTP54)

1. Separation of components from a mixture using Affinity chromatography
(Kit may be used)
2. Separation of components from a mixture using ion exchange chromatography
(Kit may be used)
3. Separation of components from a mixture using Size exclusion chromatography
(Kit may be used)
4. HPLC method validation.
5. MIC and MLC of any one antibiotic
6. Antibiotic sensitivity test using agar cup method
7. Antibiotic sensitivity test using paper disc method
8. Antibiotic sensitivity test using ditch method.
9. Cancer Biology: (Field visit and 2 page report in the journal)
10. Chick embryo candling and inoculation methods Demonstration experiment
11. Book review (Emperor of all Maladies)

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT53	**Genomics and Molecular Biology**		
Course Objectives	To have a strong foundation in tools used in molecular biology and its application in genetic engineering of plants and animals. They will also be acquainted with genome sequencing techniques and human genome mapping		
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 Gene sequencing and editing	Maxam Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing, Pyrosequencing; Human genome mapping and it's implications in health and disease; RNAi, ZNF Zinc finger nucleases), TALENS (Transcription Activator Like Effector Nucleases), CRISPER/Cas system (Clustered Regularly Interspersed Repeats)		**15**
Total			**60**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT54	**Marine Biotechnology**		
Course Objectives	To introduce the students to marine ecosystem and its potential as the treasure for novel bioactive compounds, cosmeceuticals, drugs, antimicrobial agents, functional foods and nutraceuticals		
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	**2.5**	**15**
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		**15**
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		**15**
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		**15**
Total			**60**

PRACTICALS

SIUSBTP57 3 credits 72hrs
(Practicals of SIUSBTP53 & SIUSBTP 54)

1. Transformation in *E.coli*
2. Genomic DNA Extraction: Animal cells.
3. Restriction enzyme digestion and ligation (Kit may be used).
4. Phage titration: *Demonstration*
5. Polymerase chain reaction. *Demonstration*
6. Replica plate technique
7. Bacterial gene expression (Kit may be used).
8. Study of any 5 marine bacteria and algae (Macro and micro)
9. DPPH assay for antioxidant extracted from marine algae
10. Extraction of carotenoids from marine algae/Bacteria/Fungi
11. Extraction and estimation of Gelatin / Collagen.
12. Extraction of alkaloids from marine organisms and their separation by TLC.

APPLIED COMPONENT

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT55	**Biosafety**		
Course Objectives	This course has been introduced to stress upon the importance of biosafety and good laboratory practices in Biotechnology		
I Introduction to biosafety	Introduction; Biological Risk Assessment, Hazardous Characteristics of an Agent; Genetically modified agent hazards; Cell cultures; Hazardous Characteristics of Laboratory Procedures; Potential Hazards Associated with Work Practices; Safety Equipment and Facility Safeguards; Pathogenic risk and management	**2**	**12**
II GLP	Concept of GLP; Practicing GLP; Guidelines to GLP; Documentation of Laboratory work; Preparation of SOPs; Calibration records; Validation of methods; Documentation of results; Audits & Audit reports		**12**
III Detection and testing of contaminants	Microbial Contamination in food and pharma product; Some common microbial contaminants; Microbiological Assays for pharmaceutical products; Regulatory Microbiological testing in pharmaceuticals		**12**
IV Biosafety in Biotechnology	Concepts on biosafety in Biotechnology; Regulating rDNA technology; Regulating food and food ingredients; Genetically engineered crops, livestock Bioethics; Contemporary issues in Bioethics		**12**
Total			**48**

PRACTICALS

SIUSBTP58 **2 Credits** **48 hours**

(Practicals of Applied Component)

1. Validation of micropipette, measuring cylinders, colorimeters
2. Calibration of pH meter and weighing balance
3. Vitamin B_{12} bioassay
4. Testing for adulterants in food; ex. Starch in milk
5. Making SOP for any 2 major laboratory instruments
6. Sterility testing of injectables
7. Effect of UV as a method of microbial control
8. Determination of Phenol coefficient of disinfectant
9. Detection of adulterants in food products like tea, coffee, milk, oil etc
10. Decontamination and biomedical waste segregation

SEMESTER VI

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT61	**Biochemistry**		
Course Objectives	This topic has been introduced to acquaint the students with the concepts of biochemistry such as metabolism, bioenergetics, nutrition and endocrinology		
I Bioenergetics	Laws of thermodynamics, Concept of enthalpy, Entropy, Free energy with relation to living system, Standard free energy change and equilibrium constant, Energy rich compound-ATP as energy currency, Structure of ATP hydrolysis, other energy rich compounds, Phophoryl group transfers, ATP and muscle contraction, ATP and active transport, Transphosphorylation reaction, Biological oxidation-reduction reaction, Flavin nucleotides, NAD, NADP	**2.5**	**15**
II Metabolism	Carbohydrate biosynthesis and its regulation: Peptidoglycan in Bacteria; Starch and sucrose in Plants; Glycogen in Animals; Biosynthesis and regulation of 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 – oxcytocin and vasopressin; Thyroid gland – Thyroxine, calcitonin; Parathyroid gland – PTH; Adrenal medulla – epinephrine and norepinehprine; 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**
Total			**60**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT62	**Industrial Microbiology**		
Course Objectives	To familiarize students with the various processes in fermentation technology such as upstream, downstream. To introduce students to various applications involved in dairy technology. They will be also taught the importance of quality control and quality assurance		
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.		**15**
III Fermentation process	Introduction to Inoculum development; Bacterial and fungal inoculum development with one example each, scale up, scale down; Production of: Streptomycin; Protease; Mushroom; Glutamic acid; Lysine, ethanol production Semi-synthetic Penicillin, Biotransformation.		**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.		**15**
Total			**60**

PRACTICALS

SIUSBTP66 **3 credits** **72hrs**

(Practicals based on SIUSBTP61& SIUSBTP 62)

1. Estimation of Milk protein-Pynes method
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)
8. Estimation vitamin C by DCPIP method from food samples.
9. Estimation of Vitamin B12 using chemical method and biological method.
10. Estimation of Fe and Ca titrimetrically
11. Estimation of phosphorus using Fiske and Subbarow method

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT63	**Basic pharmacology and Neurochemistry**		
Course Objectives	The students will be exposed to the various concept in pharmacology such as absorption, distribution, metabolism and excretion They would also be introduced to the field of neurochemistry		
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, Synapses and gap junctions; Action of Neuro toxins and neurotransmitters, Incapacitating agents.		**15**
Total			**60**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT64	**Environmental Biotechnology**		
Course Objectives	To emphasize upon the importance of industrial effluent treatment and waste water management To acquaint the students with alternatives of traditional non-renewable energy resources		
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; 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**
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**	Biodegradation of waste from tanning industry; petroleum industry; paper & pulp industry; Dairy, Distillery, Dye, Antibiotic industry; Removal of oil spillage & grease deposits		**15**
Total			**60**

PRACTICALS

SIUSBTP67 **3 credits** **72hrs**

(Practicals based on SIUSBT63, SIUSBT64 and Skill based project)

1. LD 50, ED 50 evaluation using suitable models e.x daphnia
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

APPLIED COMPONENT

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT65	**Agricultural Biotechnology**		
Course Objectives	To teach the application of biotechnology in agriculture using various techniques such as plant tissue culture, molecular markers. Students would be exposed to the significance of biopesticide, biofertilizers and the effect of stress on plant growth		
I Plant Tissue Culture	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, signalling		**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 Formulations Biocontrol, Polymicrobial Inoculant Formulations; Biopesticides – types, Bacillus thuringiensis, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application)		**12**
Total			**48**

PRACTICALS

SIUSBTP68 **2 credits** **48 hrs**

Practicals based on Applied component

1. RAPD analysis demonstration experiment
2. Isolation of *Rhizobium*
3. Isolation of *Azotobacter*
4. Isolation of Phosphate solubilising bacteria
5. Study of effect of abiotic stress on plants.
6. Rapid screening tests for abiotic stress tolerance (drought, - PEG, Mannitol & salinity)
7. Estimation of antioxidants and antioxidant enzymes - Ascorbate, Catalase, and Peroxidase
8. Visit to green house facility and submission of field visit report.

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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 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	20 Marks
2.	Internal Assessment 2	15 Marks
3.	Active participation	05 Marks

Semester End Examination – 60 Marks

S. No.	Particulars	Marks
	All questions are compulsory Number of questions – 4 (Four) Each question carries 15 Marks	
1.	Q1 – Unit I a. Answer in one sentence (any three out of five) b. Short notes (any three out of five)	 3 Marks 12 Marks
2.	Q2 – Unit II a. Answer in one sentence (any three out of five) b. Short notes (any two out of three)	 3 Marks 12 Marks
3.	Q3 – Unit III a. Answer in one sentence (any three out of five) b. Short notes (any three out of five)	 3 Marks 12 Marks
4.	Q4 – Unit IV a. Answer in one sentence (any three out of five) b. Short notes (any three out of five)	 3 Marks 12 Marks
	TOTAL	**60 Marks**