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

S.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 I				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/week**
SIUSBT31	Core Subject	Biophysics	2	3
SIUSBT32	Core Subject	Applied Chemistry-I	2	3
SIUSBT33	Core Subject	Immunology	2	3
SIUSBT34	Core Subject	Cell biology and Cytogenetics	2	3
SIUSBT35	Core Subject	Molecular Biology	2	3
SIUSBT36	Core Subject	Bioprocess Technology	2	3
SIUSBT37	General Elective	Research Methodology	2	3
SIUSBTP38, SIUSBTP39, SIUSBTP40	Core subject Practical	Practical of SIUSBT31, SIUSBT32, SIUSBT33, SIUSBT34, SIUSBT35 and SIUSBT36	6	18
Semester II				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/week**
SIUSBT41	Core Subject	Biochemistry	2	3
SIUSBT42	Core Subject	Applied Chemistry-II	2	3
SIUSBT43	Core Subject	Medical Microbiology	2	3
SIUSBT44	Core Subject	Environmental Biotechnology	2	3
SIUSBT45	Core Subject	Biostatistics and Bioinformatics	2	3
SIUSBT46	Core Subject	Molecular Diagnostics	2	3
SIUSBT47	General Elective	Entrepreneurship Development	2	3
SIUSBTP48, SIUSBTP49, SIUSBTP50	Core subject Practical	Practical of SIUSBT41, SIUSBT42, SIUSBT43, SIUSBT44, SIUSBT45 and SIUSBT46	6	18

SEMESTER III

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT31	**Biophysics**		
Course Objective	To have a firm foundation in the fundamentals and applications of current biophysical theories and to develop an understanding of the different aspects of classical physics and its applications in the field of biology.		
Unit I Optics and Electromagnetic Radiations	**Introduction to Optics and Lasers:** **Optics:** Properties of light: Reflection, Refraction**,** Dispersion and Interference; **Lasers:** Properties of lasers, Stimulated Emissions, Laser Action, Applications of Laser; **Electromagnetic Radiation:** Introduction to Electromagnetic Radiation; **Spectroscopy:** Types and Properties of Spectra; Basic Laws of Light Absorption. **Spectrophotometer:** Principle; Instrumentation and Applications; UV-Vis Spectrophotometer, Single and Dual-beam Spectrophotometer **Microscopy:** Types of Microscopy: Electron Optics; Electron Microscopy: Preparation of Specimens, SEM TEM, Immuno-electron Microscopy, Fluorescence Microscopy and Confocal Microscopy	**2**	**15**
Unit II Heat, Sound, Magnetism and Fluid Dynamics	**Heat:** Concept of Temperature; Modes of Heat Transfer; Measuring Temperature; Platinum Resistance Thermometer, Thermocouple and Thermistors **Sound:** Types of Sound Waves - Audible, Ultrasonic and Infrasonic Waves; Doppler Effect; Applications of Ultrasonic Waves **Magnetism:** Magnetic Field; Magnetism of Earth; Para-magnetism, Diamagnetism, Ferromagnetism. Nuclear Magnetism and Biomagnetism **Fluid Dynamics:** ***Viscosity:*** Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's Viscometer. ***Surface Tension:*** Definition - Surface Tension and Surface Energy; Capillary Action; Angle of Contact; Wettability; Temperature Dependence of Surface Tension. Applications in Biology.		**15**
Unit III Electrophoresis	Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Moving Boundary Electrophoresis; Principle of Electrophoresis; Supporting Matrix; Paper electrophoresis; AGE; Native and SDS PAGE (reducing and non-reducing, continuous and discontinuous); IEF and 2D PAGE. Staining and Detection methods; Gel-Documentation. Applications in Biology.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT32	**Applied Chemistry-I**		
Course Objectives	To acquaint the students with fundamentals and applications of organic compounds and understand the role of green chemistry and its application in industry.		
Unit I **Organic Chemistry**	**Introduction to Types of Organic Reactions**: Addition, Elimination and Substitution Reactions. Essential and Non-essential Elements in Biological Systems. Role of Metal Ions in Biological Systems. **Metal Coordination in Biological Systems:** Enzymes, Apoenzymes and Coenzymes. Biological Role of Metalloenzymes wrt Myoglobins, Haemoglobin. Biological Role of Carboxypeptidases, Catalases and Peroxidases. **Structure and Function:** Dioxygen Binding, Transfer and Utilization; Metal Complexes in Medicines.	**2**	**15**
Unit II **Synthesis of Organic Compounds**	**Synthesis of Organic Compounds:** Criteria for Ideal Synthesis; Selectivity and Yield. Linear and Convergent Synthesis and Multicomponent Reactions. Microwave Assisted Organic Ultrasound in Synthesis and Polymer supported Synthesis. Retrosynthesis.		**15**
Unit III **Green Chemistry and Synthesis**	**Green Chemistry and Synthesis:** Introduction to Green Chemistry; Need and Relevance of Green Chemistry; Principles of Green Chemistry. Green Synthesis in Industry: Green Materials, Green Reagents, Green Solvents and Green Catalysts.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT33	**Immunology**		
Course Objectives	To understand the role of complements in immune response and different immune cell receptors involved in immune reaction To introduce them to the principles underlying various immune-techniques		
Unit I **Effectors of Immune Response**	**Complement System**- Classical, Alternate and Lectin; Regulation and Biological Effects of Complement System; Deficiencies of Complement System **MHC Classes** – General Organization and Inheritance; Structures and Peptide Interactions; Class I and II Diversity and Polymorphism; Antigen Presentation - Endocytic and Exocytic Pathways; MHC Restriction.	**2**	**15**
Unit II **Cell Receptors**	**T-cell Receptor Complex:** Structure, mechanism, T cell co-receptor complex **B-cell Receptor:** Structure, mechanism, B cell co-receptor complex **Toll-like receptors (TLRs)** **B-T cell interaction (B-T cell cooperation).** Introduce cell cytotoxic responses as the effector mechanism		**15**
Unit III **Immuno-Techniques**	**Precipitation Reactions:** Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis. **Agglutination Reactions:** Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests, RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. **Alternatives to Antigen-Antibody Reactions.**		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT34	**Cell Biology and Cytogenetics**		
Course Objectives	To develop an understanding of the cytoskeleton and cell membrane To familiarize the students with structure of chromosomes, types of chromosomal aberrations as well as sex determination and sex linkage		
Unit I **Cytoskeleton**	**Cytoskeleton**: Overview of the Major Cytoskeleton. **Microtubules:** Structure and Composition. **MAPs:** Functions- Role in Mitosis, Structural Support and Cytoskeleton Intracellular Motility. **Motor Proteins:** Kinesins, Dynein; MTOCs. Dynamic Properties of Microtubules. Microtubules in Cilia and Flagella. **Microfilaments:** Structure, Composition Assembly and Disassembly. **Motor Protein:** Myosin. **Muscle Contractility:** Sliding Filament Model. **Actin Binding Proteins:** Examples of Non-Muscle Motility. **Intermediate Filaments:** Structure, Composition; Assembly and Disassembly, Types and Functions.	**2**	**15**
Unit II **Cell Membrane**	**Cell Membrane:** Uptake of Nutrients by Prokaryotic Cells; Cell Permeability. Principles of Membrane Transport-Transporters and Channels; Active Transport, Passive transport; Types of Transporters, Types of ATP Driven Pumps - Na+ K+ Pump. Cell Junctions;Cell Adhesion and Extracellular Material; Microvilli; Tight Junctions, Gap Junctions; Cell Coat and Cell Recognition. Cellular Interactions.		**15**
Unit III **Cytogenetics**	**Cytogenetics**: Structure of Chromosome - Heterochromatin, Euchromatin, Polytene Chromosomes, Cytogenetic staining **Variation in Chromosomal Structure and Number:** Deletion, Duplication, Inversion, Translocation, Euploidy, Aneuploidy, Polyploidy and Syndromes-Klinefelter, Turner, Cri-du-Chat, Trisomy -21, Trisomy-18 and Trisomy-13. **Sex Determination and Sex Linkage:** Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO), Dosage Compensation and Barr Body. **Genetic Linkage, Crossing Over and Chromosomal Mapping:** Tetrad Analysis; Two-point Cross; Three- point Cross; Pedigree Analysis.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT35	**Molecular Biology**		
Course Objectives	To have an insight into mechanism of gene expression and regulation at the level of transcription and translation in prokaryotes and eukaryotes		
Unit I **Gene Expression-Transcription**	Gene Expression- an Overview. **Transcription Process in Prokaryotes:** RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain. **Transcription in Eukaryotes:** Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNAs; Transcription of other Spliceosomes; RNA editing.	**2**	**15**
Unit II **Gene Expression-Translation**	**Nature of Genetic Code.** **Wobble Hypothesis**. **Translation:** Process of Protein Synthesis (Initiation, Elongation, Translocation, Termination); **Post Translation Modifications.** **Protein sorting.**		**15**
Unit III **Regulation of Gene Expression**	**In Bacteria:** *lac* Operon of E. coli; *trp* Operon of E. coli. **In Viruses:** Lytic / Lysogenic Regulation **In Eukaryotes:** Operons in Eukaryotes; Control of Transcriptional Initiation; Gene Silencing and Genomic Imprinting; Post-Transcriptional Control; RNA Interference.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT36	**Bioprocess Technology**		
Course Objectives	To understand the basics skills applied in fermentation technology and build a foundation for more advanced studies in bioprocess technology. To develop skills associated with screening of industrially important strains. To understand principles underlying design of fermenter and fermentation process.		
Unit I **Microorganisms in Industrial Processes**	**Types of Microorganisms used in Industrial Processes:** Bacteria, Actinomycetes, Fungi and Algae. **Screening and maintenance of strains:** Primary Screening and Secondary Screening; Cultivation; Preservation of Industrially Important Microbial Strains.	**2**	**15**
Unit II **Fermenters**	**Design of a fermenter:** Stirred Tank Fermenter- Basic Design; Parts of a Typical Industrial Fermentor. **Fermentation Media:** Components; Design and Optimization. **Sterilization:** Sterilization of Fermenter and Fermentation Media. **Process Parameters:** pH, Temperature, Aeration, Agitation, Foam, etc. **Types of Fermentation:** Surface and Submerged; Batch and Continuous, Aerobic and Anaerobic. Product Isolation and Purification.		**15**
Unit III **Fermentation Processes**	**Study of representative fermentation processes**: Penicillin, Ethanol, Beer, Wine, Vinegar **Assay of Industrial Products:** Chemical and Biological; Types and Subtypes Advantages and Disadvantages.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT37	**Research Methodology**		
Course Objectives	To develop research aptitude, logical thinking and reasoning by understanding basic principles of research methodology and identify a research problem. To identify the overall process of designing a research study from its inception to its report		
Unit 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; 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**	**15**
Unit 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**
Unit 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**
Internal Evaluation	Submission of Research Report/ Project/ Case Study/ Assignment		

SEMESTER III (PRACTICAL)

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP38	**PRACTICALS based on SIUSBT31 and SIUSBT32**	**2**	**30 Hrs**

1. Extraction of Plasmid DNA and Separation by Agarose Gel Electrophoresis.
2. Determination of Purity of Plasmid DNA using UV Spectrophotometry.
3. Study of the Structure and Function of an Electron Microscope
4. Demonstration of Structure and Working of a Fluorescence Microscope (Stained Preparation).
5. Electrophoresis of Proteins by PAGE and SDS-PAGE (Demonstration)
6. Purification of any TWO Organic Compounds by Recrystallization Selecting Suitable Solvent.
7. Organic Estimations: Acetone, Amide, Benzoic Acid.
8. Organic Preparations:
   a) Acetylation of Primary Amine (Preparation of Acetanilide).
   b) Base Catalysed Aldol Condensation (Synthesis of Dibenzalpropanone).

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP39	**PRACTICALS based on SIUSBT33 and SIUSBT34**	**2**	**30 hrs.**

1. Complement Fixation Test (CFT)- Demonstration
2. Passive Agglutination- RA Factor Test.
3. Immunoelectrophoresis.
4. Double immunodiffusion (Ouchterlony method)
5. SRID
6. ELISA (Kit-based) - HEPALISA.
7. DOT-BLOT
8. Western Blotting - Demonstration.
9. Flow Cytometry – Lab Visit/Demonstration.
10. Study of Chromosomal Aberrations-Normal male and female and Syndromes- Trisomy 21 Trisomy 13 Trisomy 18, Klinefelter and Turner, Cri-du-Chat and Philadelphia chromosome
11. Induction of Polyploidy by PDB Treatment using Suitable Plant Material.
12. Study of Polytene Chromosomes.
13. Mapping based on Tetrad Analysis and Three Point Cross.
14. Pedigree Analysis- Autosomal and Sex-Linked.

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP40	**PRACTICALS based on SIUSBT35 and SIUSBT36**	**2**	**30 hrs.**

1. Study of *E.coli* Diauxic Growth Curve- (Lactose and Glucose).
2. Comparison of Growth curve and selection of industrially important strains
3. Study of *lac* Gene Expression using Blue-White Selection.
4. Induction and screening of β-galactosidase activity
5. Screening for an Antibiotic Producing Strain of Microorganism.
6. Estimation of Penicillin by Chemical (Iodometric) Method.
7. Estimation of Penicillin by Biological (Bioassay) Method.
8. Lab Scale Production of Ethanol.
9. Purification of Ethanol from Broth Culture of *Saccharomyces spp.* By distillation
10. Estimation of Alcohol from Recovered Broth by Dichromate Method.

SEMESTER IV

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT41	**Biochemistry**		
Course Objectives	To gain an insight into the metabolic processes associated with catabolism of carbohydrates, amino acids, lipids and nucleotides and explain the role of energy rich molecules in metabolism.		
Unit I **Carbohydrate Metabolism, ETS and Energy Rich Compounds**	**Carbohydrate Metabolism**: Glycolytic Pathway and its Regulation, Homolactic Fermentation; Alcoholic Fermentation; Energetics of Fermentation; Citric Acid Cycle and its Regulation; Gluconeogenesis; Pentose Phosphate Pathway; Glyoxalate Pathway; Reductive TCA. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above pathways) **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.	**2**	**15**
Unit II **Amino Acid Metabolism**	**Amino Acid Breakdown:** Deamination, Transamination, Urea Cycle, Breakdown of Glucogenic and Ketogenic Amino Acids. **Amino Acids as Biosynthetic Precursors:** Biosynthesis of Epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione. (Sequence of Reactions, Regulation and Metabolic Disorders of the above pathways)		**15**
Unit III **Lipid and Nucleotide Metabolism**	**Lipid Metabolism:** Mobilization, Transport of Fatty Acids. Beta, Alpha and Omega Oxidation of Saturated Fatty Acids; Oxidation of Unsaturated Fatty Acids; Oxidation of Odd Chain Fatty Acids. Energy Yield, Ketone Body Breakdown to Yield Energy. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above pathways) **Nucleotide Metabolism:** Degradation of Purines and Pyrimidines		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT42	**Applied Chemistry-II**		
Course Objectives	To develop an understanding of the different aspects of analytical chemistry. To gain knowledge of natural product chemistry and related acquired skills. To gain an understanding of basic concepts in polymer chemistry and Nanomaterials.		
Unit I **Sampling and Separation Techniques**	**Sampling**: Importance of Sampling and Sampling techniques, Types of Sampling - Random and Non-Random Sampling of Solids, Liquids and Gases. **Separation Techniques:** Solvent Extraction - Partition Coefficient and Distribution Ratio, Extraction Efficiency, Separation Factor, Role of Complexing Agents, Chelation, Ion pair Formation, Solvation, and Soxhlation. **Centrifugation** – Basic principles of sedimentation. Preparative: differential and density gradient, isopycnic and rate zonal gradient materials, preparation, sample application, recovery, choice of rotors. Analytical centrifuge	**2**	**15**
Unit II **Chromatographic Techniques**	**Column chromatography and its types:** Column chromatography: Principle, packing of column, matrix used, parts of column chromatography. Principle, working and application of Adsorption chromatography, partition chromatography, Affinity, Gel Permeation and Ion-Exchange chromatography, Applications		**15**
Unit III **Polymers and Nanomaterials**	**Polymers:** Introduction to Polymers, Types of Polymers: Monomers, Polymer, Homopolymer, Copolymer, Thermoplastics and thermosets, Addition and Condensation Polymers (Examples and Uses) Stereochemistry of Polymers Biodegradable Polymers **Nanomaterials:** Introduction to nanomaterials, Types of nanomaterials, Forms of Nanomaterials: Nanoparticles, Nanofilms, Nanotubes and Quantum Dots, Synthesis and characterization of Nanomaterials, Applications of Nanomaterials.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT43	**Medical Microbiology**		
Course Objectives	To gain insight into host parasite relationship and virulence factors To study the pathogenesis and epidemiology of various diseases caused by microorganisms and its prophylaxis.		
Unit I **Infectious Diseases**	**Host Parasite Relationship:** Normal Flora; Factors Affecting the Course of Infection and Disease; Mechanisms of Infection and Virulence Factors. **Infection:** Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers. **Diseases:** Origin of Pathogens; Vectors; Acquisition of Infection; Koch's Postulates.	**2**	**15**
Unit II **Medical Microbiology-Causative Organisms-I**	**Skin:** *S. aureus, S. pyogenes* **Respiratory Tract Infections:** *M. tuberculosis, S. pneumoniae* (Characteristics, Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR). **Urinary Tract Infections:** *E.coli*: Characteristics, Virulence, Clinical disease, and *E.coli* Infections. *Proteus*		**15**
Unit III **Medical Microbiology-Causative Organisms-Ii**	**GI Tract Infections:** *Salmonella* and *Shigella* spps. (Characteristics, Virulence - Pathogenesis and Immunity, Clinical Disease, Carriers Lab Diagnosis, Typing Prophylaxis and Treatment). **Sexually Transmitted Diseases:** *Syphilis* and *Gonorrhea***.** **Nosocomial Infections:** *Ps. aeruginosa*		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT44	**Environmental Biotechnology**		
Course Objectives	To gain insight on the causes, types and control methods for environmental pollutions and bioremediation		
Unit I **Water and Soil Pollution**	**Types of Pollution** **Water Pollution:** Causes, Types and Classification; Eutrophication; Assessment of Water Quality- Pollutant Monitoring and Control; **Soil and Solid Waste Pollution**: Characteristics of Wastes, Impacts of Solid waste on Health, Occupational Hazards and Control. **Soil Erosion:** Concept, Causes and Effects.	**2**	**15**
Unit II **Air Pollution and Monitoring**	**Air Pollution:** Types; Sources; Classification of Air Pollutants; Air Pollution Monitoring and Control **Green House Effect:** Factors Responsible for Green House Effect; Green House Gases. Global Warming; Ozone Depletion; Kyoto Protocol; UV Radiation; Acid Rain.		**15**
UNIT III B**ioremediation**	**Concept of Bioremediation:** Microorganisms in Bioremediation, Myco-remediation and Phytoremediation. Bioremediation Technologies. Measuring Bioremediation in the Field. Bioaugmentation and Biostimulation. Monitoring the Efficacy of Bioremediation		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT45	**Bioinformatics and Biostatistics**		
Course Objectives	To develop an understanding in basic concepts of bioinformatics and its use in sequence alignment To apply the various statistical tools for analysis of biological data.		
Unit I **Introduction to Computers and Biological Databases**	**Computer Basics:** Organization of a Computer; I/O Units; Computer Memory; Processor; Binary Arithmetic; Logic Circuit; Architecture; Operating System. Internet Basics: Connecting to the Internet, E-mail, FTP, www, Difference between www and Internet. **Biological Databases:** Classification of Databases- Raw and Processed databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) databases; Structure and Sequence databases. Specialized Databases - Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP). **Genome Information Resources:** DNA Sequence Databases specialized Genomic Resources. Protein Databases based on Composition, Motifs and Patterns. Protein Str. Visualization Software.	**2**	**15**
Unit II **BLAST and Sequence Alignment**	**Pairwise Alignment:** Identity and Similarity; Global and Local Alignment; Pairwise Database Searching. FASTA **BLAST and Sequence Alignment**: BLAST and its Types; Retrieving Sequence using BLAST **Multiple Sequence Alignment:** Goal of Multiple Sequence Alignment; Computational Complexity; Manual Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching; Analysis Packages; MSA and phylogenetic trees.		**15**
Unit III **Biostatistics**	Theory and Problems based on- Coefficient of Correlation and Regression Analysis; Steps in Testing Statistical Hypothesis; Parametric Tests: - Z Test-Single Mean and Two Means, t-Test-Single Mean, Paired and Unpaired; Chi- square Test.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT46	**Molecular Diagnostics**		
Course Objectives	To develop a learning and understanding of the basic principles used in molecular diagnosis and gain critical thinking and analytical skills to understand new diagnostic methods.		
Unit I **Basics of Molecular Diagnostics**	**Introduction to Molecular Diagnostics:** Overview of Molecular Diagnostics; History of Molecular Diagnostics; Molecular Diagnostics in post genomic era; Areas used in Molecular Diagnostics; Future prospects- Commercializing Molecular Diagnostics, Personalized medicine, Theranostic. **Characterization and analysis of Nucleic-acids and Proteins:** Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and restriction enzyme mapping **Hybridization techniques:** Southern, Northern, Western Blotting technique and FISH; Markers, probes and its Clinical applications.	**2**	**15**
Unit II **Nucleic Acid Amplification Methods**	**Target amplification:** PCR - General Principle; Components of a Typical PCR reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection. **PCR Types:** Reverse Transcriptase and Real Time PCR **Probe amplification:** Ligase Chain Reaction		**15**
Unit III **Molecular Biology based Diagnostics**	**DNA Polymorphism and Identification:** RFLP and Parentage Testing; RFLP and Sickle-Cell Anemia. **Molecular Diagnostics for infectious diseases:** Molecular testing for Neisseria, Molecular diagnosis for HIV-1; **Genetic Counselling and Molecular Diagnosis:** Genetic testing- Need and uses; genetic counselling. Case studies- Diagnostic testing for Cystic fibrosis; Fragile X diagnostic and Carrier testing, CML and Down Syndrome **Ethical, Social and legal issues to molecular genetic testing**		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT47	**Entrepreneurship Development**		
Course Objectives	To develop and systematically apply an entrepreneurial way of thinking that will allow identification and creation of business opportunities. To help design strategies for successful implementation of ideas and write a business plan.		
Unit I **Introduction to Entrepreneurship Development and IPR**	**Entrepreneurship:** Concept of Entrepreneur; Entrepreneurship; Need and Importance; Factors Influencing Entrepreneurship; Essentials of a Successful Entrepreneur **Intellectual Property Rights (IPR):** Introduction, Types and Management of IPR.	**2**	**15**
Unit II **Setting-up of an Enterprise and Planning**	Location of Enterprise; Real Estate and Human Resource Planning, Financial Planning; Role of Government and Financial Planning Institutions in Entrepreneurship Development; Raising Money from Venture Capitalists, Government Grants, Product Selection and Ideas; Project Planning and Formulation; Project Feasibility Assessment; Regulatory Affairs, Corporate Laws, Innovation, IPR generation and Protection, Preparation of a Business Plan, Characteristics and Importance of Planning.		**15**
Unit III **Marketing, Sales, Advertising and International Market Research**.	Marketing Plan for an Entrepreneur; Strategic Alliances, Advertising and Sales Promotion; Market Assessment, Need for International, Domestic vs. International Market research Market Research, Cost and Methodology of Market Research, Desk and Field Research.		**15**
Internal evaluation	Submission and Presentation of Business Proposal for any Biotechnological Product/Enterprise.		

SEMESTER IV (Practical)

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP48	**Practical based on SIUSBT41 and SIUSBT42**	**2**	**30 hrs.**

1. Gradient Plate technique
2. Determination of Cholesterol in Serum.
3. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum).
4. Estimation of Uric acid and Creatinine in Urine.
5. Qualitative Detection of Ketone Body in Urine.
6. Isolation of Mitochondria by differential centrifugation and Demonstration of ETC using a Marker Enzyme.
7. Separation of Chloroplast using Sucrose Density Gradient
8. Separation of Binary (Solid-Solid) Mixture (Min 4 Compounds).
9. Identification of Organic Compound of Known Chemical Type (Min 4 Compounds).
10. Separation of components from a mixture using Affinity chromatography (Kit may be used)
11. Separation of components from a mixture using ion exchange chromatography (Kit may be used)
12. Separation of components from a mixture using Size exclusion chromatography (Kit may be used)
13. Chemical and Biological Synthesis of Silver Nanoparticles and its characterization by UV-Vis Spectrophotometer.

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP49	**Practical based on SIUSBT43 and SIUSBT44**	**2**	**30 hrs.**

1. Identification of *S.aureus*-Isolation, Catalase, Coagulase Test.
2. Identification of *E.coli*-Isolation, Sugar Fermentations, IMViC.
3. Identification of *Salmonella*- Isolation, Sugar Fermentations, TSI Slant.
4. Identification of *Shigella*- Isolation, Sugar Fermentations, TSI Slant.
5. Identification of *Proteus*- Isolation, Sugar Fermentations, IMViC.
6. Identification of *Pseudomonas* - Isolation, Urease test, Oxidase Test, TSI Slant.
7. RPR Test (Kit Based).
8. Permanent Slide- *Mycobacterium.*
9. Biological Oxygen Demand (BOD).
10. Chemical Oxygen Demand (COD)
11. Study of rhizospheric organism by Contact slide method
12. Study pond ecosystem using Winogradsky's Column
13. Isolation of Bacteria from Air by Gravity Sedimentation Method.
14. Most Probable Number (MPN) – Presumptive, Confirmed and Completed tests.

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP50	**Practical based on SIUSBT45 and SIUSBT46**	**2**	**30 hrs.**

1. Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases.
2. Basic formatting using MS word
3. Use of MS Excel
4. Preparation of graph using MS excel
5. Use of powerpoint
6. Use of Coral draw for posters
7. Use of NCBI BLAST Tool.
8. Pairwise and Multiple Sequence Alignment and Phylogeny.
9. Classification of Proteins using CATH/SCOP.
10. Visualization PDB Molecules using Rasmol/Raswin.
11. Handling and Calibration of Micropipette.
12. Isolation and visualization of Genomic DNA by AGE (Bacteria and Yeast).
13. Quantitative estimation of DNA by DPA method
14. Quantitative estimation of RNA by Orcinol method
15. Problems on Restriction Enzyme Digestion
16. Problems on PCR
17. RFLP- Kit Based.
18. Primer Designing through Open Online Source NCBI- BLAST.

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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:

Sr. 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

Sr. 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 – Short notes based on Unit I, II and III (any three out of five)	15 Marks
	TOTAL	**60 Marks**