SIES College of Arts, Science & Commerce

RISE WITH EDUCATION

**Sion (West), Mumbai – 400022**

**(Empowered Autonomous)**

# Faculty: Science

# Program: B.Sc.

# Subject: BIOTECHNOLOGY

**Academic Year: 2024 – 2025**

# S.Y.B.Sc. Biotechnology

**Credit Based Semester and Grading Syllabi approved by Board of Studies in Biotechnology to be brought into effect from June 2024.**

# 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 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 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.

| **Semester III** | | | | |
|---|---|---|---|---|
| **Course Type** | **Course Code** | **Course Title** | **Credits** | **Lectures/week** |
| DSC Major I | SIUBTMJ211 | Immunology | 3 | 3 |
| | SIUBTMJP211 | Practical | 1 | 2 |
| DSC Major II | SIUBTMJ212 | Cell biology and Cytogenetics | 3 | 3 |
| | SIUBTMJP212 | Practical | 1 | 2 |
| DSC Minor | SIUBTMN211 | Bio-organic chemistry | 3 | 3 |
| | SIUBTMNP211 | Practical | 1 | 2 |
| VSC | SIUBTVS211 | Biostatistics | 1 | 1 |
| | | Practical | 1 | 2 |
| OE | SIUBTOE211 | Food Science | 2 | 2 |
| AEC | SIUHNAE211 | Hindi / Marathi | 2 | 2 |
| CC | SIUEXCC211 | NCC/ NSS/ Sports /Cultural activities | 2 | |
| FP / CEP | SIUBTFP211 | Field projects/ Internships/ Apprenticeship/ community engagement and services | 2 | |
| | | **Total** | **22** | |
| **Semester IV** | | | | |
| **Course Type** | **Course Code** | **Course Title** | **Credits** | **Lectures/week** |
| DSC Major I | SIUBTMJ221 | Molecular Biology | 3 | 3 |
| | SIUBTMJP221 | Practical | 1 | 2 |
| DSC Major II | SIUBTMJ222 | Medical Microbiology | 3 | 3 |
| | SIUBTMJP222 | Practical | 1 | 2 |
| DSC Minor | SIUBTMN221 | Bioanalytical chemistry | 3 | 3 |
| | SIUBTMNP221 | Practical | 1 | 2 |
| SEC | SIUBTSE221 | Bioinformatics | 1 | 1 |
| | | Practical | 1 | 2 |
| OE | SIUBTOE221 | Food Processing and Safety | 2 | 2 |
| AEC | | Hindi / Marathi | 2 | 2 |
| CC | | NCC/ NSS/ Sports /Cultural activities | 2 | |
| FP / CEP | | Field projects/ Internships/ Apprenticeship/ community engagement and services | 2 | |
| | | **Total** | **22** | |

# SEMESTER III

| COURSE CODE | TITLE | CREDITS | LECTURES |
|---|---|---|---|
| **SIUBTMJ211** | **DSC MAJOR I : IMMUNOLOGY** | **4 (3+1)** | **1 lecture = 1 hour** |
| **Course Outcomes** | On successful completion of the course the learner will be able to:<br>• Conceptualize and explain the protective role of the immune system of the host<br>• Develop an understanding of the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms<br>• Describe the role and significance complement system<br>• Enlist the various immunotechniques & applications with respect to antigen-antibody interaction | | |
| **Unit I**<br>Basics of Immunology | Overview of Immune Systems, Types of immunity: Innate Immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity. Factors Influencing and Mechanisms of each. Cells and Organs of the immune system. Effector mechanisms of B cells, T cells and Phagocytes | **3** | **15** |
| **Unit II**<br>Antigens, Antibody & Complement System | Antigens and Antibodies: Types of Antigens, General Properties of Antigens, Haptens and Superantigens. Discovery and Structure of Antibodies. Classes of Immunoglobulins, Antigenic Determinants.<br>**Complement System**- Classical, Alternative and Lectin; Regulation and Biological Effects of Complement System; Regulation of Complement System | | **15** |
| **Unit III**<br>Immuno-techniques | Antigen-Antibody Interactions: Precipitation and Agglutination<br>**Precipitation Reactions:** Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis.<br>**Agglutination Reactions:** Passive, Reverse Passive, Agglutination Inhibition.<br>Coomb's Test; Complement Fixation Tests, RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry.<br>**Alternatives to Antigen-Antibody Reactions.** | | **15** |

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| **SIUBTMJP211 (Practical)** | 1. Complement Fixation Test (CFT)- Demonstration<br>2. Passive Agglutination- RA Factor Test<br>3. Immunoelectrophoresis<br>4. Double immunodiffusion (Ouchterlony method)<br>5. SRID<br>6. HEPALISA (Kit-Based)<br>7. DOT-ELISA<br>8. Western Blotting - Demonstration<br>9. Flow Cytometry – Lab Visit/Demonstration. | **1** | |

| COURSE CODE | TITLE | CREDITS | LECTURES |
|---|---|---|---|
| **SIUBTMJ212** | **DSC MAJOR II : CELL BIOLOGY AND CYTOGENETICS** | **4 (3+1)** | **1 lecture = 1 hour** |
| **Course Outcomes** | On successful completion of the course the learner will be able to:<br>• discuss the types of cytoskeleton, their assembly and functions in a cell,<br>• describe cell membrane, various membrane transport mechanisms and cell junctions,<br>• analyze the structure of chromosome, understand the dosage compensation and determine the map distance via linkage analysis | | |
| **Unit I**<br>Cytoskeleton | **Cytoskeleton**: Overview of the Major Cytoskeleton.<br>**Microtubules:** Structure and Composition.<br>**MAPs:** Functions- Role in Mitosis, Structural Support and Cytoskeleton Intracellular Motility.<br>**Motor Proteins:** Kinesins, Dynein; MTOCs.<br>Dynamic Properties of Microtubules. Microtubules in Cilia and Flagella.<br>**Microfilaments:** Structure, Composition Assembly and Disassembly.<br>**Motor Protein:** Myosin.<br>**Muscle Contractility:** Sliding Filament Model.<br>**Actin Binding Proteins:** Examples of Non-Muscle Motility.<br>**Intermediate Filaments:** Structure, Composition; Assembly and Disassembly, Types and Functions. | **3** | **15** |
| **Unit II**<br>Cell Membrane | **Cell Membrane:** Principles of Membrane Transport-Transporters and Channels; Active Transport, Passive transport; Types of Transporters, Types of ATP Driven Pumps - Na+ K+ Pump, $Ca^{+2}$ ATPase pump, Gated Ion channels: Voltage gated ion channels: K+, Na+; Ligand gated ion channels: Acetylcholine receptor<br>Cell Junctions;Cell Adhesion and Extracellular Material; Microvilli; Tight Junctions, Gap Junctions; Cell Coat and Cell Recognition. Cellular Interaction | | **15** |
| **Unit III**<br>Cytogenetics | **Cytogenetics**: Structure of Chromosome - Heterochromatin, Euchromatin, Polytene Chromosomes, Cytogenetic staining | | **15** |

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|---|---|---|---|
| | **Variation in Chromosomal Structure and Number:** Deletion, Duplication, Inversion, Translocation, Euploidy, Aneuploidy, Polyploidy and Syndromes.<br><br>**Sex Determination and Sex Linkage:** Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO), Dosage Compensation and Barr Body.<br><br>Environmental effect on expressions of the genes<br><br>**Concept of Genetic linkage and mapping**<br>**Pedigree analysis** | | |
| **SIUBTMJP212 (Practical)** | 1. Pedigree analysis : Autosomal and sex-linked<br>2. Mapping based on Three-point cross & Tetrad analysis<br>3. Study of polytene chromosomes<br>4. Study of Chromosomal Aberrations via Karyotype -Normal male and female and Syndromes- Trisomy 21, Trisomy13, Trisomy 18, Klinefelter and Turner, Cri-du-Chat and Philadelphia chromosome<br>5. Induction of Polyploidy by PDB Treatment using Suitable Plant Material | **1** | |

<table>
<tr><th>COURSE CODE</th><th>TITLE</th><th>CREDITS</th><th>LECTURES</th></tr>
<tr><td>SIUBTMN211</td><td>DSC MINOR : BIO-ORGANIC CHEMISTRY</td><td>4<br>(3+1)</td><td>1 lecture =<br>1 hour</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">On successful completion of the course the learner will be able to describe and discuss:<ul><li>amino acid and nucleic acid metabolism & associated metabolic disorders</li><li>fatty acids oxidation reactions and lipid storage disease</li><li>reactions, regulation and disorders associated with carbohydrate catabolism, pathways and electron transport chain</li></ul></td></tr>
<tr><td>Unit I<br>Amino Acid and Nucleotide Metabolism</td><td>Amino Acid Breakdown:<br>Deamination, Transamination, Urea Cycle<br>(Reactions and Metabolic Disorders - PKU, Maple syrup urine disease, Alkaptouria, Albinism, tyrosinemia)<br><br>Amino Acids as Biosynthetic Precursors:<br>Biosynthesis of Serotonin, GABA, Histamine, Glutathione.<br>(Sequence of Reactions, Regulation and Metabolic Disorders - Epilepsy, Allergic responses, Hemolytic anemia)<br><br>Nucleotide Metabolism:<br>Degradation of Purines and Pyrimidines (Sequence of Reactions and Metabolic Disorders - Gout and Lesch-Nyhan syndrome)</td><td rowspan="3">3</td><td>15</td></tr>
<tr><td>Unit II<br>Lipid Metabolism</td><td>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.<br>(Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above pathways)<br><br>Lipid storage diseases- Tay Sachs disease, Fabry’s disease, Niemann-Pik’s disease and Gaucher disease</td><td>15</td></tr>
<tr><td>Unit III<br>Carbohydrate Metabolism</td><td>Glycolytic Pathway and its Regulation, Homolactic Fermentation; Alcoholic Fermentation; Energetics of Fermentation;<br><br>Citric Acid Cycle and its Regulation;.<br>(Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above pathways)</td><td>15</td></tr>
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| | Electron Transport System:<br>Electron Transport and Oxidative Phosphorylation. Inhibitors of ETS<br><br>Energy Rich Compounds: ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, NAD, NADP, FAD, etc. | | |
| **SIUBTMNP211 (Practical)** | 1. Determination of Cholesterol in Serum.<br>2. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum)<br>3. Estimation of Uric acid and Creatinine in Urine<br>4. Qualitative Detection of Ketone Body in Urine<br>5. Isolation of Mitochondria by differential centrifugation and Demonstration of ETC using a Marker Enzyme | **1** | |

# SEMESTER IV

| COURSE CODE | TITLE | CREDITS | LECTURES |
|---|---|---|---|
| **SIUBTMJ221** | **DSC MAJOR I : MOLECULAR BIOLOGY** | **4 (3+1)** | **1 lecture = 1 hour** |
| **Course Outcomes** | On successful completion of the course the learner will be able to describe:<br>• transcription process in prokaryotes and eukaryotes,<br>• translation and post-translational modifications,<br>• regulatory mechanism of gene expression in prokaryotes and eukaryotes | | |
| **Unit I** Gene Expression- Transcription | Gene Expression- an Overview.<br>**Transcription Process in Prokaryotes:** RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain<br>**Transcription in Eukaryotes:** Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNAs; Transcription of other Spliceosomes; RNA editing | **3** | **15** |
| **Unit II** Gene Expression- Translation | Nature of Genetic Code, Wobble Hypothesis<br>**Translation:** Process of Protein Synthesis. Initiation, Elongation, Translocation, Termination of translation in Prokaryotes and Eukaryotes;<br>Post Translational Modifications Protein sorting | | **15** |
| **Unit III** Regulation of Gene Expression | **Bacteria:** *lac* Operon of *E. coli*; *trp* Operon of *E. coli*<br>**Viruses:** Lytic / Lysogenic Regulation<br>**Eukaryotes:** Operons in Eukaryotes; Control of Transcriptional Initiation; Gene Silencing and Genomic Imprinting; Post-Transcriptional Control; RNA Interference | | **15** |
| **SIUBTMJP221 (Practical)** | 1. Study of *lac* gene expression using blue-white screening<br>2. Induction and screening of β-galactosidase activity<br>3. Extraction of genomic DNA and separation using agarose gel electrophoresis<br>4. Determination of DNA concentration and purity using absorbance<br>5. Quantitative estimation of DNA by DPA<br>6. Quantitative estimation of RNA by Orcinol<br>7. Quantitative estimation of Protein using Folin-Lowry method | **1** | |

| COURSE CODE | TITLE | CREDITS | LECTURES |
|---|---|---|---|
| **SIUBTMJ222** | **DSC MAJOR II : MEDICAL MICROBIOLOGY** | **4 (3+1)** | **1 lecture = 1 hour** |
| **Course Outcomes** | On successful completion of the course the learner will be able to:<br>• describe the host-parasite interactions and epidemiology of infectious diseases,<br>• discuss the transmission, pathogenesis and diagnosis of skin, respiratory and urinary tract infections,<br>• outline the pathogenesis, diagnosis and treatment of sexually transmitted diseases GI infections | | |
| **Unit I**<br>Basics of Infectious Diseases | **Host Parasite Relationship:** Normal Flora; Factors Affecting the Course of Infection and Disease; Mechanisms of Infection and Virulence Factors.<br>**Infection:** Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers.<br>**Diseases:** Origin of Pathogens; Vectors; Acquisition of Infection; Koch's Postulates. | **3** | **15** |
| **Unit II**<br>Medical Microbiology-Causative Organisms-I | **Skin:** *S. aureus*<br>**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).<br>**Urinary Tract Infections:** *E.coli* (Characteristics, Virulence, Clinical disease, and *E.coli* Infections) | | **15** |
| **Unit III**<br>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).<br>**Sexually Transmitted Diseases:** *Syphilis* and *Gonorrhea*.<br>**Nosocomial Infections:** *P. aeruginosa* | | **15** |
| **SIUBTMJP222 (Practical)** | 1. Gradient plate technique<br>2. Media (NA, MacConkey, MSA, CLED, Cetrimide), Gram staining and Biochemical Tests (Sugar fermentation, IMViC, TSI, Catalase, Coagulase) for bacteria<br>3. RPR Test (Kit Based).<br>4. Acid fast staining of *Mycobacterium* | **1** | |

| COURSE CODE | TITLE | CREDITS | LECTURES |
|---|---|---|---|
| **SIUBTMN221** | **DSC MINOR : BIOANALYTICAL CHEMISTRY** | **4 (3+1)** | **1 lecture = 1 hour** |
| **Course Outcomes** | On successful completion of the course, students will be able to:<br>• understand the handling of basic analytical techniques like chromatography and centrifugation<br>• discuss electromagnetic radiations and applications of spectrophotometer and microscopy<br>• describe the types of electrophoresis and specific requirements, investigate the parameters affecting electrophoresis and its applications | | |
| **Unit I**<br>Chromato-graphy | **Chromatography:** Definition, Principles, Types, Introduction to Paper Chromatography -Ascending, Descending and Radial, Thin Layer Chromatography<br><br>**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 | **3** | **15** |
| **Unit II**<br>Spectroscopy & Microscopy | Introduction to Electromagnetic Radiation; Types and Properties of Spectra; Basic Laws of Light Absorption.<br><br>**Spectrophotometer:** Principle; Instrumentation and Applications; UV-Vis Spectrophotometer, Single and Dual-beam Spectrophotometer<br><br>**Microscopy:** Types of Microscopy: Electron Optics; Electron Microscopy: Preparation of Specimens, SEM, TEM, Immuno-electron Microscopy, Fluorescence Microscopy and Confocal Microscopy | | **15** |
| **Unit III**<br>Electrophoresis & Centrifugation | **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); Staining and Detection methods; Gel-Documentation.<br>Applications in Biology.<br><br>**Centrifugation –** Basic principles of sedimentation.<br>Preparative: differential and density gradient, isopycnic and rate zonal gradient materials, preparation, sample application, recovery, choice of rotors. Analytical centrifuge | | **15** |

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| **SIUBTMNP221 (Practical)** | 1. Separation of components from a mixture using Affinity chromatography (Kit may be used)<br>2. Separation of components from a mixture using ion exchange chromatography (Kit may be used)<br>3. Separation of components from a mixture using Size exclusion chromatography (Kit may be used)<br>4. Study of the Structure and Function of an Electron Microscope<br>5. Demonstration of Structure and Working of a Fluorescence Microscope (Stained Preparation)<br>6. Extraction of plasmid DNA and separation using agarose gel electrophoresis<br>7. Electrophoresis of Proteins by PAGE and SDS-PAGE (Demonstration)<br>8. Separation of chloroplast using sucrose density gradient centrifugation | **1** | |

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## Evaluation Scheme for Semester III and IV

| Course Type | Internal | Sem-End | Practical | Participation / Report | Total |
|---|---|---|---|---|---|
| DSC Major I | 25 | 50 | 25 | - | 100 |
| DSC Major II | 25 | 50 | 25 | - | 100 |
| DSC Minor | 25 | 50 | 25 | - | 100 |
| OE | 20 | 30 | - | - | 50 |
| AEC | 20 | 30 | - | - | 50 |
| VSC | 50 | - | - | - | 50 |
| CC | - | - | - | 50 | 50 |
| FP / CEP | - | - | - | 50 | 50 |
| | | | | **Total** | **550** |