SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Faculty: Science

Program: B.Sc.

Subject: BIOTECHNOLOGY

Academic Year: 2021 – 2022

F.Y.B.Sc. Biotechnology

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

PREAMBLE:

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

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

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

PROGRAM SPECIFIC OUTCOMES:

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

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

F.Y.B.Sc BIOTECHNOLOGY

SEMESTER I				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/week**
SIUSBT11	Core Subject	Basic Chemistry I	2	3
SIUSBT12	Core Subject	Bioorganic Chemistry	2	3
SIUSBT13	Core Subject	Basic Life Sciences I: Biodiversity and Cell Biology	2	3
SIUSBT14	Core Subject	Basic Life Sciences II: Microbial Techniques	2	3
SIUSBT15	Core Subject	Basic Biotechnology I: Introduction to Biotechnology	2	3
SIUSBT16	Core Subject	Basic Biotechnology II: Molecular Biology and Genetics	2	3
SIUSBT17	Ability Enhancement Course 1 (FC I)	Societal Awareness	2	3
SIUSBTP18 SIUSBTP19, SIUSBTP20	Core Subject Practicals	Practicals of SIUSBT11, SIUSBT12, SIUSBT13, SIUSBT14, SIUSBT15 and SIUSBT16	6	18
SEMESTER II				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/week**
SIUSBT21	Core Subject	Basic Chemistry II	2	3
SIUSBT22	Core Subject	Physical Chemistry	2	3
SIUSBT23	Core Subject	Basic Life Sciences I: Physiology and Ecology	2	3
SIUSBT24	Core Subject	Basic Life Sciences II: Genetics and rDNA Technology	2	3
SIUSBT25	Core Subject	Basic Biotechnology I: Microbial Techniques and Tissue Culture	2	3
SIUSBT26	Core Subject	Basic Biotechnology II: Enzymology and Immunology	2	3
SIUSBT27	Ability Enhancement Course 1 (FC I)	Globalization, Ecology and Sustainable Development	2	3
SIUSBTP28, SIUSBTP29, SIUSBTP30	Core Subject Practicals	Practicals of SIUSBT21, SIUSBT22, SIUSBT23, SIUSBT24, SIUSBT25 and SIUSBT26	6	18

SEMESTER I

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT11	**BASIC CHEMISTRY I**		
Course Outcomes	On successful completion of the course, the student will understand the basic concepts of chemistry like nomenclature, chemical bonds and stereochemistry. Learner will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems		
Unit I Nomenclature and Classification	**Nomenclature and Classification of Inorganic Compounds:** Oxides, Salts, Acids, Bases, Ionic, Molecular and Coordination Compounds **Nomenclature and Classification of Organic Compounds:** Alkanes, Alkenes, Alkynes, Cyclic Hydrocarbons, Aromatic Compounds, Alcohols and Ethers, Aldehydes and Ketones, Carboxylic Acids and its derivatives, Amines, Amides, Alkyl Halides and Heterocyclic Compounds	**2**	**15**
Unit II Chemical Bonds	Bond length and bond order **Ionic Bond:** Nature of Ionic Bond, Structure of NaCl, KCl and CsCl, Factors influencing the formation of ionic bond **Covalent Bond:** Nature of covalent bond, Structure of CH_4, NH_3, H_2O, Shapes of $BeCl_2$, BF_3 **Coordinate Bond:** Nature of Coordinate Bond **Non-Covalent Bonds:** Van Der Waal 's forces: dipole - dipole, dipole – induced dipole **Hydrogen Bond:** Theory of hydrogen bonding, Types of hydrogen bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides)		**15**
Unit III Stereochemistry	**Isomerism –** Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality, Isomerism in Coordination Compounds **Geometric Isomerism and Optical Isomerism:** Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomerism (Cis-Trans Isomerism) in Alkenes and Cycloalkanes (3 and 4 membered ring) **Conformation:** Conformations of Ethane, Difference between Configuration and Conformation. **Configuration:** Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality, Representation of Configuration by "Flying Wedge Formula" **Projection formulae –** Fischer, Newman and Sawhorse, The Interconversion of the Formulae		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT12	**BIOORGANIC CHEMISTRY**		
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. They will describe and define the structure, function, classification and properties of carbohydrates, lipids, proteins and nucleic acids.		
Unit I **Biomolecules: Carbohydrates**	**Carbohydrates:** Structure, Function, Classification. Characteristic Reactions, Physical and Chemical Properties, D & L-Glyceraldehyde, Structure of Monosaccharide, Disaccharides, and Polysaccharides. Isomers of Monosaccharides, Mutarotation Concept of Epimers, anomers. Chemical/Physical Properties of Carbohydrate Chemical Reactions for Detection of Mono-, Di- and Polysaccharides Structural and functional polysaccharides-examples Glycoproteins and proteoglycans-examples	**2**	**15**
Unit II **Biomolecules: Amino acids and Proteins**	**Amino Acids:** Classification, Preparation and Properties, Isoelectric Point, Titration Curve of Amino Acids, Concept of Isoelectric pH, Zwitter ion, Structure of Peptides, Peptide Synthesis **Proteins:** Classification based on Structure and Functions, Primary Structure, N-terminal (Sanger and Edmans Method) and C-terminal Analysis (Enzyme) Reactions of Amino Acids, Sorenson's Titration, Ninhydrin Test, Denaturation of protein, Glycoproteins		**15**
Unit III **Biomolecules: Nucleic Acids and Lipids**	**Nucleic Acids:** Structure of Purine and Pyrimidine Bases, Structure of Nucleosides, Nucleotides and Polynucleotides **DNA and RNA**: Structure, types, and function of DNA and RNA, **Properties of DNA and RNA**, - Hydrogen Bonding between Nitrogenous Bases in DNA, Differences between DNA and RNA, cDNA, Denaturation, Annealing, Tm, Hypo & hyperchromic effect. **Lipids:** Classification of Lipids, Concept of Storage Lipids and Structural Lipids Properties of Saturated, Unsaturated Fatty Acids, Rancidity, and Hydrogenation of Oils **Triacylglycerol, Phospholipids, Sphingo lipids, Sterols:** Basic structure, function and examples **Lipoproteins**- Structure and Function		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT13	**BASIC LIFESCIENCE I: BIODIVERSITY AND CELL BIOLOGY**		
Course Outcomes	On successful completion of the course, student will be able to: • Discover and explain the diversity of life evolved over time via evolutionary mechanisms. • describe and distinguish the structure and other salient characteristics of bacteria and viruses ;cell organelles of eukaryotic cell and their functions		
Unit I **Origin of Life and Biodiversity (Plant, Animal & Microorganisms)**	Origin of Life, Chemical and Biological Evolution, Origin of Eukaryotic Cell Concept of Biodiversity, Taxonomical, Ecological and Genetic Diversity & its Significance **Introduction to Plant Diversity:** Algae, Fungi, Bryophyta, Pteridophytes, Gymnosperms and Angiosperms (with one example each) **Introduction to Animal Diversity:** Non-Chordates and Chordates (with at least one representative example) **Introduction to Microbial Diversity:** Archaebacteria, Eubacteria, Cyanobacteria, Actinomycetes, Eumycota-Habitats, Examples and Applications.	**2**	**15**
Unit II **Bacteria and Viruses**	**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 **Bacteria:** Classification, Types, Morphology (Size, Shape and Arrangement) Modes of cell division, Significance of Bacteria **Introduction to Viruses:** General Characters, Classification (Plant, Animal and Bacterial Viruses)		**15**
Unit III **Ultrastructure of Eukaryotic Cell**	**Ultrastructure of Eukaryotic Cell:** Plasma membrane, Cytoplasmic Matrix, Microfilaments, Intermediate Filaments, and Microtubules, Organelles of the Biosynthesis- Endoplasmic Reticulum & Golgi Apparatus, Lysosome, Endocytosis, Phagocytosis, Autophagy, Proteasome Eukaryotic Ribosomes, Mitochondria and Chloroplasts, Nucleus –Nuclear Structure, Nucleolus, External Cell Coverings- Cilia and Flagella, Comparison of Prokaryotic and Eukaryotic Cells		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT14	**BASIC LIFESCIENCE II: MICROBIAL TECHNIQUES**		
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. • Understand and explain the basic skills such as culturing microbes, maintaining microbes, good microbiological practices • perform basic experiments to determine the concentration of biomolecules using colorimetry		
Unit I **Basic Techniques in Microbiology**	**Microscope:** Simple and Compound – Principle, Parts and types, Aberration, Functions and Applications; Dark Field, Phase Contrast **Colorimetry:** Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of E = kcl, Limitations of Beer-Lambert's Law, instrumentation	**2**	**15**
Unit II **Stains**	**Stains and Staining Solutions:** Definition of Dye and Chromogen, Structure of Dye and Chromophore, Functions of Mordant and Fixative, Natural and Synthetic Dyes, Classification, Simple Chemistry of stains, Staining, Differential Staining (Gram staining, Romanowsky's staining & Acid-Fast Staining with specific examples) Fluorescent stains, Fluorescence and phosphorescence, Principles of metachromatic granules		**15**
Unit III **Nutrition and Cultivation of Microorganisms**	**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 Sterilization of media and glasswares, Concept of Isolation and Methods of Isolation, Pure Culture Techniques		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT15	**BIOTECHNOLOGY I: INTRODUCTION TO BIOTECHNOLOGY**		
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 the role of microorganisms in the production of food, its spoilage, including food packaging. • understand and identify the different types of reactors or fermenters which are used for laboratory, pilot and industrial scale fermentations		
Unit I **Introduction and applications of Biotechnology**	History & Introduction to Biotechnology, What is Biotechnology? Definition of Biotechnology, Traditional and Modern Biotechnology Branches of Biotechnology and applications- Plant, Animal, Marine, Agriculture, Healthcare, Industrial, Pharmaceutical and Environmental Biotechnology. Application of Enzymes in Biotechnology, Ethics in Biotechnology	**2**	**15**
Unit II **Food Biotechnology**	Scope of Food technology, Primary sources of microorganisms in food, Microbial role in food products: Bacteria, Molds and yeasts. Food Deterioration and its Control. Unit Operation in Food Processing, General principles of food preservation- asepsis, heat treatment, pasteurization, Irradiation, appertization. Modern Biotechnological Regulatory Aspects in Food Industries Biotechnology and Food - Social Appraisal Introduction to food packaging, food product labels and categories		**15**
Unit III **Fermentation Biotechnology**	**Fermenters:** Definition, Characteristics, Types of fermenters: Surface and Submerged; Batch and Continuous, Aerobic and Anaerobic. Product Isolation and Purification. Solid state fermenter, Basic structure of stirred tank fermenters **Fermentation Technology:** Definition, Applications of Fermentation Technology, Microbial Fermentations		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT16	**BIOTECHNOLOGY II: MOLECULAR BIOLOGY & GENETICS**		
Course Outcomes	On successful completion of the course, students will be able to: • 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 mechanism. • Understand and identify the three well known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction and conjugation.		
Unit I **Replication**	DNA Replication in Prokaryotes and Eukaryotes- Semi-conservative DNA replication, DNA Polymerases and its role, *E. coli* Chromosome Replication, Bidirectional Replication of Circular DNA molecules, Rolling Circle Replication, DNA Replication in Eukaryotes, DNA Recombination –Holliday Model for Recombination, End replication problem, Action of telomerase	**2**	**15**
Unit II **Mutation and DNA Repair**	Definition and Types of Mutations, Mutagenesis and 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 and Recombination Repair, Ames test		**15**
Unit III **Microbial Genetics**	Genetic analysis in Bacteria- Prototrophs, Auxotroph. Mechanism of Genetic Exchange in Bacteria- Conjugation; Transformation; Transduction (Generalized Transduction, Specialized Transduction); Introduction to Bacterial Transposable Elements Bacteriophages – Lytic and Lysogenic cycle		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT17	**ABILITY ENHANCEMENT COURSE I (FC): SOCIETAL AWARENESS**		
Course Outcomes	On successful completion of the course, students will be able to • Understand and explain the concept of the Indian constitution • identify with the diversity, disparity, as well as the problems in society		
Unit I **Overview of Indian Society**	Understand the multi-cultural diversity of Indian society through its demographic composition: population distribution according to religion, caste, and gender; Appreciate the concept of linguistic diversity in relation to the Indian situation; Understand regional variations according to rural, urban and tribal characteristics; Understanding the concept of diversity as difference	**2**	**15**
Unit II **Concept of Disparity**	**Concept of Disparity- I :** Understand the concept of disparity as arising out of stratification and inequality; Explore the disparities arising out of gender with special reference to violence against women, female foeticide (declining sex ratio), and portrayal of women in media; Appreciate the inequalities faced by people with disabilities and understand the issues of people with physical and mental disabilities **Concept of Disparity-II:** Examine inequalities manifested due to the caste system and inter-group conflicts arising thereof; Understand inter-group conflicts arising out of communalism; Examine the causes and effects of conflicts arising out of regionalism and linguistic differences		**15**
Unit III **The Indian Constitution and Significance Aspects of Political Processes**	**The Indian Constitution:** Philosophy of the Constitution as set out in the Preamble; The structure of the Constitution-the Preamble, Main Body and Schedules; Fundamental Duties of the Indian Citizen; tolerance, peace and communal harmony as crucial values in strengthening the social fabric of Indian society; Basic features of the Constitution **Significant Aspects of Political Processes**: The party system in Indian politics; Local self- government in urban and rural areas; the 73rd and 74th Amendments and their implications for inclusive politics; Role and significance of women in politics		**15**

Sem I Topics for Project Guidance: Growing Social Problems in India:

- *Substance abuse- impact on youth & challenges for the future*
- *HIV/AIDS- awareness, prevention, treatment and services*
- *Problems of the elderly- causes, implications and response*
- *Issue of child labor- magnitude, causes, effects and response*
- *Child abuse- effects and ways to prevent*
- *Gender awareness and sensitization in the society regarding rights of women*
- *Trafficking of women- causes, effects and response*

SEMESTER I (Practicals)

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP18	**Basic Chemistry**	**2**	**30 hrs**
Course outcome	On successful completion of the course, the student will able to report the presence of various functional groups present in the organic compounds, use colorimeter to determine the absorption maxima of various compounds and estimate the concentration of various compounds.		

1. Spot test for compounds belonging to Carboxylic Acid, Phenol, Aldehyde/Ketone, Ester, Alcohol, Amine, Nitro Compounds, Haloalkane, Haloarene
2. Verification of Beer Lamberts Law and determination of absorption maxima
3. Spot test for Carbohydrates, Fats and Proteins and Amino Acids, and Nucleic Acids
4. Estimation of reducing sugar by DNSA method
5. Estimation of Protein by Biuret method and Lowry method
6. Estimation of Acid number and Iodine value of Oil

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP19	**Basic Life Sciences**	**2**	**30 hrs**
Course outcome	On successful completion of the course, the student will able to infer the importance of the routine laboratory equipment. They would be skilled to perform routine microbiological experiments like staining, media preparation & sterilization. They will also be able to cultivate, isolate & characterize microorganisms.		

1. Introduction of laboratory instruments-Autoclave, Hot air Oven, Incubator, pH meter, Rotary Shaker and Centrifuge
2. Components and working of Simple, Compound, Dark Field and Phase Contrast Microscope
3. Staining and study of Plant and Animal Tissues
4. Special Staining Technique for Cell Wall, Capsule, Lipid granules and Endospores, and Fungal Staining
5. Monochrome Staining, Negative staining, Differential Staining Gram Staining,
6. Study of Permanent slides of Cyanobacteria
7. Sterilization of media and glassware
8. Aseptic transfer
9. Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabourauds Agar
10. Isolation of Organisms : T-streak, Polygon method
11. Colony Characteristics of Microorganisms

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP20	**Basic Biotechnology**	**2**	**30 hrs**
Course outcome	On successful completion of the course, the student will able to analyze the bacteriological quality of milk, determine and extract milk protein. They would be able to extract & assess the quality of DNA isolated from plant source.		

1. Isolation of organisms causing Food Spoilage
2. Microscopic determination of Microbial flora from Yoghurt
3. Analysis of Milk- Methylene Blue, Resazurin Test
4. Extraction of Casein from Milk and Pynes method
5. Meat Tenderization using Papain
6. Isolation and purification of DNA from plant source (Onion)

SEMESTER II

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT21	**BASIC CHEMISTRY II**		
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		
Unit I **Water 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 **Solutions:** Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numericals expected). **Primary and Secondary Standards:** Preparation of Standard Solutions, Principle of Volumetric Analysis. **Acids and Bases:** Lowry-Bronsted and Lewis Concepts. Strong and Weak Acids and Bases - Ionic Product of Water - *pH, pKa, pKb*. Hydrolysis of Salts. **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.	**2**	**15**
Unit II **Titrimetry and Gravimetry**	**Titrimetric Analysis:** Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples Types of Titration: Acid –Base, Redox. Precipitation, Complexometric Titration. Acid – Base Titration. - Strong Acid Vs Strong Base -Theoretical aspects of Titration Curve and End Point Evaluation. Theory of Acid –Base Indicators, Choice and Suitability of Indicators. **Gravimetric Analysis:** Introduction, principle, Solubility and Precipitation, Factors affecting		**15**

	Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate. Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate. (Numerical Expected).		
Unit III **Analytical Techniques**	**Analytical Techniques Chromatography:** Definition, Principles, Types, Introduction to Paper Chromatography -Ascending, Descending and Radial, Thin Layer Chromatography, Introduction to Column Chromatography-Principle, and its Applications.		**15**

COURSE CODE	**TITLE**	**CREDITS**	**LECTURES**
SIUSBT22	**PHYSICAL CHEMISTRY**		
Course Outcomes	On successful completion of the course, students will be able to explain: • the thermodynamic and kinetic forces involved in chemical reactions which determine how much and how soon products are formed • the fundamentals of acid/base reactions, redox reactions and precipitation reactions		
Unit I **Thermo-dynamics**	**Thermodynamics:** System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.) Laws of Thermodynamics and its Limitations, Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency. Laws of Thermodynamics as applied to Biochemical Systems. Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.	**2**	**15**
Unit II **Chemical Kinetics**	**Reaction Kinetics:** Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order & Molecularity of Reaction, Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numericals expected) Determination of Order of Reaction by a) Integration Method b) Graphical Method c) Ostwald ‘s Isolation Method d) Half Time Method. (Numericals expected).		**15**

Unit III **Oxidation and Reduction Reactions**	**Principles of Oxidation & Reduction Reactions:** Oxidizing and Reducing Agents, Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate. Balancing Redox Reactions by Ion Electron Method Oxidation, Reduction, Addition and Substitution & Elimination Reactions		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT23	**LIFESCIENCE I : PHYSIOLOGY AND ECOLOGY**		
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 • Presence and role of different types of environments and habitats where microorganisms grow such as the microbiomes of the human gut and animal gut.		
Unit I **Plant Physiology**	Photosynthesis, Intracellular Organization of Photosynthetic System. Fundamental Reactions of Photosynthesis, Photosynthetic Pigments, Role of Light. Hill Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photo Induced Electron Flow, Energetics of Photosynthesis, Photorespiration, Dark Phase of Photosynthesis, Calvin Cycle, C-3, C-4 pathways, CAM pathway	**2**	**15**
Unit II **Animal Physiology**	Physiology of Digestion, Movement of Food and Absorption, Secretary functions of Alimentary Canal, Digestion and Absorption, assimilation in Gut of Mammals Anatomy of Mammalian Kidney, Structure of Nephron, Physiology of Urine Formation and Role of Kidney in Excretion and Osmoregulation Physiology of Respiration, Mechanism of Respiration, Principles of Gaseous Exchange in the Blood and Body Fluids 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.		**15**

Unit III **Ecosystems and Interactions**	Ecology and Biogeography. Ecosystems, Definition and Components, Structure and Function of Ecosystems. Aquatic and Terrestrial Ecosystems, Biotic and Abiotic Factors, Trophic Levels, Food Chain and Food Web, Ecological Pyramids (Energy, Biomass and Number) Nutrient Cycle and Biogeochemical Cycles: Water, Carbon, Oxygen, Nitrogen and Sulphur. Interactions, Commensalism, Mutualism, Predation and Antibiosis, Parasitism.		**15**

COURSE CODE	**TITLE**	**CREDITS**	**LECTURES**
SIUSBT24	**LIFE SCIENCES II: GENETICS AND RDNA TECHNOLOGY**		
Course Outcomes	On successful completion of the course, students will be will be able to define and describe • laws of inheritance, genetic basis of loci and alleles and deviation from Mendelian principles • Hardy-Weinberg law and explain the assumptions • enzymes used in genetic engineering and explain their functions.		
Unit I **Fundamentals of Genetics**	Genotype and Phenotype, Mendel's Laws of Heredity Monohybrid Cross: Principle of dominance and segregation. Dihybrid Cross: Principle of independent assortment. Application of Mendel's Principles, Punnett Square Mendel's Principle in Human Genetics, Incomplete Dominance & Co-dominance Multiple Alleles. Gene Interaction- Epistasis Extra-chromosomal inheritance- Chloroplast and Mitochondria	**2**	**15**
Unit II **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 Natural Selection, Genetic Drift, Speciation, Role of population genetics in conservation biology		**15**
Unit III **Genetic Engineering**	Experimental evidences for DNA and RNA as Genetic Material, Genetic Engineering in *E.coli* and other Prokaryotes, Yeast, Fungi and Mammalian Cells, Cloning Vectors-Plasmids (pBR 322, pUC). Enzymes- DNA Polymerases, Restriction Endonucleases, Ligases, Reverse Transcriptases, Nucleases, Terminal Transferases, Phosphatases		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT25	**BIOTECHNOLOGY I: MICROBIAL TECHNIQUES AND TISSUE CULTURE**		
Course Outcomes	On successful completion of the course, students will be to • Describe the principles which underlie sterilization of culture media, glassware and plastic ware to be used for microbiological work • Identify nutritional requirements of bacteria for growth; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria • Explain the basics of animal and plant tissue culture		
Unit I **Sterilization Techniques**	**Definition:** Sterilization and Disinfection **Types and Applications: Dry** Heat, Steam under pressure, Gases, Radiation and Filtration **Chemical Agents and their Mode of Action:** Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents **Ideal Disinfectant:** Properties, Examples of Disinfectants and Evaluation of Disinfectant	**2**	**15**
Unit II **Growth and Enumeration of Microorganisms**	**Growth:** Growth Phases, Growth Curve, Arithmetic Growth and Growth Yield, Measurement of Growth, Chemostat and Turbidostat **Enumeration of Microorganisms:** Direct and Indirect Methods **Preservation of Cultures:** Principle and Methods, Cryogenic Preservation Advantages and Limitations		**15**
Unit III **Plant and Animal Tissue Culture**	**Basics of Plant Tissue Culture:** Cell Theory, Concept of Cell Culture, Cellular Totipotency, Design of PTC lab with equipment **Basics of Animal Tissue Culture:** Introduction to Animal Cell Cultures, equipment such as medium filtration devices, cell counters, liquid-nitrogen-storage tanks etc. Design of ATC lab. Applications of PTC and ATC such as Clonal and micro-propagation, Secondary metabolite production commercial production of plants Cell lines for vaccine production, therapeutic proteins, pharmaceutical agents, and anti-cancerous agents		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT26	**BIOTECHNOLOGY II : ENZYMOLOGY AND IMMUNOLOGY**		
Course Outcomes	On successful completion of the course, students will be to: • Classify the enzymes and explain mechanism of action and structure, study enzyme kinetics and calculate Vmax, Km values. • Conceptualize and explain the protective role of the immune system of the host and developed an understanding of the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms. • Correlate & deduce the applications of enzymes and antibodies.		
Unit I Enzymes	Definition, Classification, Nomenclature, Chemical Nature, Properties of Enzymes, Co- Factors, Zymogens, Active Sites, Enzyme Specificity, Mechanism of Enzyme Action, Effect of pH, Temperature and Substrate Concentration on Enzyme Activity, Enzyme Kinetics, Michelis - Menten Equation, Types of Enzyme Inhibitions - Competitive, Uncompetitive, Non-Competitive Allosteric, Modulators.	**2**	**15**
Unit II Immunology	Overview of Immune Systems, Cell and Organs involved, Types of immunity: Innate Immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity - Factors Influencing and Mechanisms of each. Antigens and Antibodies: Types of Antigens, General Properties of Antigens, Haptens and Superantigens Discovery and Structure of Antibodies (Framework region) Classes of Immunoglobulins, Antigenic Determinants.		**15**
Unit III Applications of Enzymology and Immunology	Application of enzymes in food, Pharmaceutical, pulp, textile and other industries; diagnostic & therapeutic applications. Immobilized enzymes-Techniques of enzyme immobilization; applications of immobilized enzymes. Vaccines- Introduction and types, Hybridoma- Monoclonal Antibody production; MAbs in diagnosis and therapy, Polyclonal antibody production and its application.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIUSBT27	**ABILITY ENHANCEMENT COURSE 2 (FC): GLOBALIZATION, ECOLOGY AND SUSTAINABLE DEVELOPMENT**		
Course Outcomes	On successful completion of the course, students will be to identify with the concepts of globalization, ecology and environment as well the problems in society.		
Unit I **Globalization and Indian Society and Human Rights**	**Globalization and Indian Society:** Understanding the concepts of liberalization, privatization and globalization; Growth of information technology and communication and its impact manifested in everyday life; Impact of globalization on industry: changes in employment and increasing migration; Changes in agrarian sector due to globalization; rise in corporate farming and increase in farmers' suicides. **Human Rights:** Concept of Human Rights; origin and evolution of the concept; The Universal Declaration of Human Rights; Human Rights constituents with special reference to Fundamental Rights stated in the Constitution	**2**	**15**
Unit II **Ecology and Sustainable Development**	**Ecology and Sustainable Development:** Importance of Environment Studies in the current developmental context; Understanding concepts of Environment, Ecology and their interconnectedness; Environment as natural capital and connection to quality of human life; Environmental Degradation causes and impact on human life; Sustainable development, concept and components; poverty and environment		**15**
Unit III **Understanding and Managing Stress and Conflict in Contemporary Society**	**Understanding Stress and Conflict:** Causes of stress and conflict in individuals and society; Agents of socialization and the role played by them in developing the individual; Significance of values, ethics and prejudices in developing the individual; Stereotyping and prejudice as significant factors in causing conflicts in society. Aggression and violence as the public expression of conflict **Managing Stress and Conflict in Society:** Types of conflicts and use of coping mechanisms for managing individual stress; Maslow's theory of self-actualization; Different methods of responding to conflicts in society; Conflict-resolution and efforts towards building peace and harmony in society		**15**

Sem II Topics for Project Guidance: Growing Social Problems in India:

- *Increasing urbanization, problems of housing, health and sanitation*
- *Changing lifestyles and impact on culture*
- *Farmers' suicides and agrarian distress*
- *Debate regarding genetically modified crops*
- *Development projects and human rights violations*
- *Increasing crime/suicides among youth*
- *Environment and Sustainable Development-integration of economic, social and environmental aspects towards a balanced holistic concept of sustainable development*

SEMESTER II (Practicals)

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP28	**Chemistry**	**2**	**30 hrs**
Course Outcomes	On successful completion of the course, students will be able to prepare standard solutions, evaluate the strength & quantify various compounds. They would also be able to examine & separate amino acid mixtures using a basic chromatographic separation method.		

1. Preparation of Standard (Molar, Molal and Normal solutions) and Buffer Solutions
2. To determine enthalpy of dissolution of salt like KNO_3
3. Study the kinetics of reaction between thiosulphate ion and HCl
4. Determination of the volume strength of hydrogen peroxide solution by titration with standardized potassium permanganate solution
5. Determination of amount of K oxalate and oxalic acid in the given solution titrimetrcially
6. Determination of strength of HCl in commercial sample
7. To Standardize commercial sample of NaOH using KHP (Potassium hydrogen phthalate)
8. Determination of amount of $NaHCO_3 + Na_2CO_3$ in the given solid mixture titrimetrcially
9. Determination of the amount of Mg (II) present in the given solution complexometrically
10. Determination of percent composition of $BaSO_4$ and NH_4Cl in the given mixture gravimetrically
11. Separation of amino acids by paper chromatography

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP29	**Life Sciences**	**2**	**30 hrs**
Course Outcomes	On successful completion of the course, students will be able to demonstrate Hill's reaction and colorimetrically analyze various photosynthetic pigments. Students will also be skilled to perform blood cell count, estimate hemoglobin levels and mitosis.		

1. Study of Hill 's reaction
2. Colorimetric study of Absorption Spectrum of Photosynthetic Pigments
3. Activity of Salivary Amylase on Starch
4. Study of Mammalian Blood, Blood count using Hemocytometer and estimation of Hemoglobin in Mammalian Blood (PowerPoint)
5. Study of Human Blood Groups
6. Study of Mammalian Kidney and Heart
7. Differential staining of Blood cells
8. Problems in Mendelian Genetics
9. Study of Mitosis
10. Study of Interactions Commensalism, Mutualism, Predation and Antibiosis, Parasitism

COURSE CODE	TITLE	CREDITS	NOTIONAL HOURS
SIUSBTP30	**Biotechnology**	**2**	**30 hrs**
Course Outcomes	On successful completion of the course, students will be able to prepare various stock solutions for plant tissue culture experiments and use to cultivate callus. They will calculate the growth rate of bacteria, perform various enumeration techniques to count animal & bacterial cell as well as deduce the effect of various factors on enzyme.		

1. Preparation of Stock Solutions and Preparation of Media for PTC
2. Aseptic Transfer Technique, Surface Sterilization and Inoculation for Callus Culture
3. Trypsinization of Tissue and Viability Count
4. Qualitative Assay of Enzyme Amylase, Urease, Lipase, Catalase and Dehydrogenase
5. Enzyme Kinetics : Study of the effect of pH, Temperature on activity of Enzyme
6. Enumeration of microorganism by pour plate and spread plate method
7. Enumeration by Breed's count
8. Growth curve of *E. coli*
9. Encapsulation of yeast and estimation of invertase activity

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 - Centralized	20 Marks
2.	Internal Assessment 2 - Departmental	20 Marks

Semester End Examination – 60 Marks

S. No.	Particulars	Marks
	All questions are compulsory Number of questions – 4 (Four) Each question carries 12 Marks	
1.	Q1 – Unit I a. Answer in one sentence (any three out of five) b. Short answers (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 answers (any three out of five)	 3 Marks 12 Marks
3.	Q3 – Unit III a. Answer in one sentence (any three out of five) b. Short answers (any three out of five)	 3 Marks 12 Marks
4.	Q4. Short notes (medley of all units) (Any three out of five)	 12 Marks
	TOTAL	**60 Marks**

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