AC/07/08/2024/RS1

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

SIES College of Arts, Science and Commerce (Autonomous)
Affiliated to University of Mumbai

Syllabus under NEP effective from June 2024
Programme: B.Sc.
Subject: Biochemistry
Core Course

Class: S.Y.B.Sc. Semester: III and IV
Choice Based Credit System (CBCS)

Contents

Preamble

Biochemistry is a branch of biological science that delves into the chemical processes and information pathways governing the survival and propagation of life. It is an interdisciplinary science providing the learner an opportunity to elucidate molecular mechanisms and explore the intricate world of biomolecules and their applications. Under the aegis of New Education Policy-2020, the department offers a three-year BSc program and a four-year BSc Honours program with Biochemistry (major or minor). At the second-year level, along with the core Biochemistry course, the department also offers Vocational skill enhancement course and Skill enhancement course. In this program, we will embark on a comprehensive journey from the structure and function of biomolecules to their interactions and implications in health and disease. Through lectures, laboratory sessions, and interactive discussions, the student will not only gain insights of the biochemical processes and pathways, but also develop skills for employability and aptitude for research.

Objectives:

The goal of this interdisciplinary Biochemistry program is

1. Foundational knowledge: To build the foundation of Biochemistry and physiology in order to enable the student to pursue Biochemistry at a higher level.
2. Application of Biochemistry: To enable the student to recognize the application of biochemistry in areas of nutrition and food, pharmaceuticals, diagnostics, clinical research, bioinformatics, forensics, etc.
3. Laboratory skills: To develop essential laboratory skills for the experimental analysis of biochemical principles.

Program-Specific Outcome

At the end of the second year, the student should be able to:

- Comprehend the concepts in human physiology and understand the role of biomolecules regulating the myriad physiological processes
- Understand the physical and chemical properties of biomacromolecules
- Co-relate the structure of biomolecules with their properties and functions
- Explain the role of biomolecules in maintaining cellular integrity
- Know the significance of the various biochemical pathways that govern life.
- Apply the experimental skills in studying biomolecules and cellular processes
- Recognize the application of biochemistry in diverse fields of food, nutrition, clinical research, drug discovery, diagnostics, forensics, genomics, proteomics and bioinformatics
- Understand the concept of data collection and types of data presentation
- Employ statistical concepts to analyse experimental data.

Evaluation: Student's understanding of biochemistry will be evaluated through a combination of examinations, quizzes, laboratory reports, and class participation. These assessments are designed to gauge learner's comprehension of both theoretical concepts and practical applications.

Pos and PSOs for SYBSc Biochemistry syllabus (NEP-compliant)

The characteristic graduate attributes comprising of Programme Outcomes, Programme Specific Outcomes and Course Outcomes for a science graduate in the subject of Biochemistry are as follows:

Abbreviations used:

PO: Programme Outcome, PSO: Programme Specific Outcome, CO: Course Outcome

Cognitive Levels:- R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Serial Number	Details of Programme Outcomes (POs)
PO1 *(Skill level)*	**Academic competence and problem-solving ability** ● Understand fundamental concepts and gain in-depth disciplinary knowledge. ● Apply the knowledge of various courses learned under the program to solve societal issues and problems. ● Recognize and appreciate the scope and applications of the discipline of study. *Cognitive levels*: *R, U, Ap*
PO2 *(Skill level)*	**Critical Thinking and Analytical skills** ● Develop critical thinking and a sense of inquiry or asking relevant scientific questions. ● Demonstrate the ability to analyse, interpret and draw conclusions from qualitative/quantitative data. ● Critically evaluate ideas, theories, and concepts by following scientific and interdisciplinary approach *Cognitive levels: U, An, Ap*
PO3 *(Skill level)*	**Research Aptitude** ● Utilizing the contextual knowledge in an inter-disciplinary framework. ● Integrating research based knowledge and research methods involving problem definition, analysis and interpretation of data, synthesis of the information to provide valid conclusions. ● Exercising analytical skill, research ability, creativity, for employability and collaborating with industries. *Cognitive levels: A, An, E, C*
PO4 *(Skill level)*	**Effective Communication Skills** ● Demonstrate the ability to listen, analyse and reproduce the instructions. ● Express thoughts and ideas effectively through written and oral communication. ● Demonstrate skills to present complex information in a clear, lucid, and concise manner. *Cognitive levels: Ap, C*

PO5 *(Skill level)*	**Proficiency with Information and Communication Technology** ● Use e-resources for effective learning. ● Employ computational tools and internet to retrieve, analyse, present, communicate and disseminate scientific data and information ● Understand the scope and limitations of printed and electronic media in gathering, and disseminating scientific knowledge. *Cognitive levels: Ap, An, E*
PO6 *(Skill level)*	**Personal and behavioral competence** ● Demonstrate conversational competence through effective communication and interaction with peers and seniors ● Exhibit time management while completing tasks in classroom and laboratory ● Exhibit adaptability, team building and leadership qualities as a member of diverse groups ● Demonstrate the ability to work independently and responsibly ● Demonstrate awareness towards issues related to environment, sustainability, and gender equity *Cognitive levels: U, Ap, An, C*

Serial Number	**Details of Programme Specific Outcomes (PSOs)**
PSO1	**Academic Competence and problem-solving ability** ● Imbibe disciplinary knowledge and understand fundamental concepts of biology, chemistry and biochemistry ● Demonstrate coherent understanding of structure and functions of biomolecules ● Explain biochemical processes and underlying mechanisms ● Apply the concepts and mechanisms of metabolic and information pathways to solve problems related to human health and nutrition ● Recognize and appreciate the scope and applications of biochemistry in diverse fields such as pharmaceutical, biopharmaceutical, agriculture, food and nutrition, forensic, genetic engineering and tissue engineering. *Cognitive levels: R, U, Ap, An*
PSO2	**Critical thinking and analytical skills** ● Develop critical thinking and a sense of inquiry for asking relevant questions in the discipline of biochemistry ● Demonstrate the ability to analyse, interpret and draw conclusions from qualitative/quantitative data ● Critically evaluate ideas, theories and concepts by following scientific approach and an open minded and reasoned perspective. *Cognitive levels: U, An, E*

PSO3	**Experiential learning and Laboratory Skills** ● Follow and create standard operating procedures and Good Laboratory Practices ● Understand the principles and working of laboratory equipments ● Develop laboratory skills and qualities required for successful career in teaching, research, industry, etc. ● Apply the analytical and laboratory skills in deeper understanding of life processes and in finding solutions for issues and problems related to biochemistry ● Analyse and evaluate the existing processes, methods and techniques employed in biochemistry and related disciplines *Cognitive levels: R, U, Ap, An, C*
PSO4	**Research Aptitude and Interdisciplinary Approach** ● Demonstrate a sense of inquiry and capability for identifying problems related to health, food and nutrition, agriculture, etc. ● Articulate research problems or questions with an interdisciplinary approach ● Apply the principles of research design ● Employ research methods and tools for analysis and interpretation of data ● Employ computational tools in overcoming challenges related to applications of biochemistry *Cognitive levels: Ap, An, E, C*

Overall Credit Structure for S.Y. B.Sc.

Semester	Core I	Core II	Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC	Credits/ semester	Degree/ cumulative credits
I	4C	4C	4C	2C	VSC-2C	AEC-2C	FP-2C CC-2C	22C	UG Diploma 88C
II	4C	4C	4C	2C	SEC-2C	AEC-2C	FP-2C CC-2C	22C	
Total Credits	8C	8C	8C	4C	4C	4C	8C	44C	

SI: SIES
U: Undergraduate
BC: Biochemistry
CC: Core Course
VS: Vocational Skill Course
SE: Skill Enhancement Cours
OE: Open Elective/Generic open elective
VSC: Vocational Skill Course
SEC: Skill Enhancement Course
AEC: Ability Enhancement Course
VEC: Value Education Course
IKS: Indian Knowledge System
OJT: On-job training
FP: Field Project
CEP: Community engagement and service
CC: Co-curricular courses

Credit Structure of courses offered by Biochemistry department for S.Y. B.Sc. Biochemistry

Name of Program: B.Sc. Biochemistry			**Name of Department:** Biochemistry			
Class	**Semester**	**Course Code**	**Course Title**	**Credits**	**No. of lectures/ per week**	**Marks**
SYBSc	I	SIUBCMJ211 and SIUBCMN211	Biomacromolecules	03	03	75
		SIUBCMJP211 and SIUBCMNP211	Biomacromolecules Practical	01	01	25
		SIUBCMJ212	Human Physiology	03	03	75
		SIUBCMJP212	Human Physiology practical	01	01	25
		SIUBCVS211	Introduction to biostatistics	02 (01Th + 01P)	03 (01Th + 02P)	50
SYBSc	II	SIUBCMJ221	Bioanalytical techniques	03	03	75
		SIUBCMJP221	Bioanalytical techniques Practical	01	01	25
		SIUBCMJ222 and SIUBCMN221	Membrane Biology	03	03	75
		SIUBCMJP222 and SIUBCMNP222	Membrane biology and Microbiology Practical	01	01	25
		SIUBCSE221	Introduction to bioinformatics	02 (01Th + 01P)	03 (01Th + 02P)	50

Summary of syllabus
SEMESTER III

Course Title & Course Codes	Units	Topic Headings	Credits	Hours/Week
Biomacromolecules SIUBCMJ211 and SIUBCMN211	I	Protein Biochemistry	3	3
	II	Enzymes		
	III	Nucleic acids		
Core Practical SIUBCMJP211 and SIUBCMNP211		Biomacromolecules Practical	1	2
Human Physiology SIUBCMJ212	I	Digestion and Absorption	3	3
	II	Excretion and Respiration		
	III	Cardiovascular system and Nervous system		
Core Practical SIUBCMJP212		Human Physiology practical	1	2
VSC SIUBCVS211		Introduction to biostatistics	2	2 (tutorial)

Summary of syllabus
SEMESTER IV

Course Title & Course Codes	Units	Topic Headings	Credits	Hours/Week
Bioanalytical Techniques SIUBCMJ221	I	Spectroscopy & Centrifugation	3	3
	II	Electrophoresis		
	III	Chromatography		
Core Practical SIUBCMJP221		Bioanalytical techniques Practical	1	2
Membrane biology SIUBCMJ222 and SIUBCMN222	I	Composition and function of plasma membrane	3	3
	II	Membrane transport		
	III	Bioenergetics		
Core Practical SIUBCCMJP222 and		Membrane biology and Microbiology practical	1	2
VSC SIUBCSE221		Introduction to bioinformatics	2	1 +2(Practical)

Semester III
Syllabus- Core Course-1 Theory (Major+Minor)

Course Title: Biomacromolecules **Course code: SIUBCMJ211 and SIUBCMN211** **Credits: 03** **Hours/week: 03**

Expected Course Outcome

On completion of this course, learner should be able to

1. *Classify proteins based on their function and structure*
2. *Discuss the four levels of structural organisation of proteins*
3. *Explain how structure determines function of proteins with example*
4. *Analyse the given data to solve the primary structure or sequence of polypeptide*
5. *Classify enzymes and identify the class based on EC number*
6. *Discuss enzyme kinetics*
7. *Compute enzyme activity and express it in standard units*
8. *Appraise the applications of enzymes in different fields*
9. *Discuss enzyme inhibition and compare the different types of inhibitions*
10. *Describe the structure of nucleic acids and co-relate with their properties*
11. *Discuss different types of mutations and infer their consequences*

Total hours: 45	**SIUBCMJ211 and SIUBCMN211: Biomacromolecules**	**Credit: 3**
Unit 1	**Protein Biochemistry**	**15L**
	1. Proteins *Prerequisite: Structure and properties of amino acids with one letter code words (Guided self-study)* 1.1 Classification based on shape and function. Structural hierarchy of proteins Primary structure: Formation and characteristics of peptide bond, phi and psi angles 1.2 Secondary structure: alpha helix- characteristics, forces stabilizing, factors influencing helix stability. Example: keratin beta sheet: characteristics, parallel/ antiparallel, forces stabilizing, example: silk fibroin Super secondary structures: Domains and Motifs (DNA binding) 1.3 Tertiary structure - forces stabilizing, example myoglobin, Function of myoglobin Quaternary structure - forces stabilizing, example hemoglobin, Function of hemoglobin 1.4 Primary structure/sequence determination of protein: Separation of polypeptide chains, breaking disulphide bonds by mercaptoethanol, End group analysis: Sanger reaction, Edman reaction, Dansyl chloride. Cleavage of polypeptide- Trypsin, Chymotrypsin, Pepsin, Aminopeptidase, Carboxypeptidase. 1.5 Protein denaturation: Diseases resulting from altered protein conformation: Prion and Alzheimer's.	
Unit 2	**Enzyme and Enzyme kinetics**	**15L**
	2.1 General properties of enzymes, Classification of enzymes- IUBB/EC classification (up to I digit)	

	2.2 Active site of enzyme, mechanism of action: lock and key, induced fit, transition state theory. Cofactors, Coenzymes (role of vitamins), Prosthetic groups, Apoenzyme and Holoenzyme 2.3 Enzyme kinetics Factors affecting enzyme-catalysed reaction Derivation of Michaelis- Menten equation, Km, Lineweaver Burk plot, Catalytic efficiency- turnover number, Enzyme activity: Katal, IU Specific activity of enzyme. 2.4 Enzyme inhibition: Competitive (allopurinol and Sulphonamides, Methotrexate), Noncompetitive (Iodoacetate and Diisopropyl fluorophosphate) and Uncompetitive inhibition 2.5 Applications of enzymes in therapy (Streptokinase, Hyaluronidase), diagnosis (Creatine kinase, LDH), industry (Amylase, Protease, lipase)	
Unit 3	**Nucleic acids**	**15 L**
	Prerequisite: Structure of nitrogen bases (purine and pyrimidine), sugars (ribose and deoxyribose), phosphate group. Structure and nomenclature of nucleoside and nucleotide (Guided self study), 3.1 Unusual bases in DNA and RNA, phosphodiester bond formation, shorthand representation of nucleotides, properties of bases. 3.2 Fredrick Griffith experiment, Avery, Macleod, and Mc Carty experiment and Hershey Chase Experiment 3.3 DNA: Structure elucidation: Rosalind Franklin- X-ray diffraction pattern (Physical evidence), Chargaff's rules (Chemical evidence), A, B and Z forms of DNA, Organization of DNA as Chromatin, Effect of heat on DNA: Hypochromism, Hyperchromism, Denaturation of DNA, Tm. 3.4 Extrachromosomal DNA: Mitochondrial and chloroplast DNA 3.5 RNA: rRNA, t-RNA, m-RNA, hnRNA, snRNA, miRNA. Catalytic role of RNA 3.6 Genetic Code 3.7 Mutations, types of mutation (Point mutation, base pair substitutions, Frameshift mutations), Mutagenic agents (Examples of physical and chemical agents)	

Semester III
Syllabus- Core Course-1 Practical (Major+Minor)

Course Title: Biomacromolecules Practical
Course code: SIUBCMJP211 and SIUBCMNP211
Credits: 01 **Hours/week: 02**

Expected Course Outcome

On completion of this course, learner should be able to

1. *Isolate biomolecules (casein and DNA) from their natural source.*
2. *Employ the basic reactions of biomolecules for their identification.*
3. *Estimate biomolecules by spectroscopy.*
4. *Estimate activity of enzymes and determine the kinetic parameters, Km and Vmax*

Sr No	Title	
	Biomacromolecules Practical	
1	Qualitative analysis of proteins (Albumin, gelatin, casein and peptones)	
2	Identification of CHOs and proteins (Spotting - unknown compound)	
3	Estimation of proteins by Biuret method	
4	Estimation of RNA by Orcinol	
5	Isolation of DNA from onion and 260: 280 ratio	
6	Isolation of casein from milk	
7	Extraction of amylase from sweet potato	
8	Determination of Km of amylase- Michaelis Menton plot	

References for Biomacromolecules Course Theory and Practical

1. Textbook of Biochemistry 4th Edition Rafi MD
2. Biochemistry, U Satyanarayana
3. Lehninger Principles of Biochemistry 7th Edition Michael M. Cox, David L. Nelson
4. Harper's Illustrated Biochemistry, 30th Edition, Victor Rodwell, David Bender, Kathleen Botham, P. Anthony Weil
5. Biochemistry, Jeremy Berg, John Tymoczko, Gregory Gatto Jr, Lubert Stryer, 9th Edition, W.H Freeman
6. Biochemistry, Donald Voet and Judith Voet, 4th Edition, Wiley Publications
7. Introductory Practical Biochemistry, SK Sawhney and Randhir Singh
8. Biochemical Methods Edition 3 by Sadasivam and Mani
9. Practical Biochemistry by Plummer

Semester III
Syllabus- Core Course-2 Theory (Major)

Course Title: Human Physiology	**Course code: SIUBCMJ212**
Credits: 03	**Hours/week: 03**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Discuss the organs involved in digestion and absorption of macronutrients and micronutrients.*
2. *Explain the mechanism of digestion and absorption of macronutrients and micronutrients.*
3. *Discuss and appraise the role of organs involved in the process of excretion and respiration.*
4. *Explain the mechanisms involved in the process of excretion and respiration in human body.*
5. *Discuss the organs of the cardiovascular and nervous system.*
6. *Explain and appraise the biochemical process of cardiac cycle and nerve impulse.*

Total hours: 45	**Human Physiology**	**Credit: 3**
Unit 1	**Physiology of Gastrointestinal tract (GIT)** 1.1 Function of GIT (tongue, salivary glands, pharynx, oesophagus, stomach, small intestine, and large intestine); Overview of layers of GI wall and Propulsion and mixing of food in the alimentary tract. 1.2 Secretions of GIT- composition and function of saliva; gastric, pancreatic; liver (Bile), secretion of small intestine and large intestine. 1.3 Digestion of carbohydrates, proteins and fats 1.4 Absorption: Anatomical basis of absorption; Absorption in small intestine- absorption of water, ions and nutrients (carbohydrates, proteins and fats) Absorption in the large intestine- formation of feces. 1.5 Physiology of GI disorders: General disorder- Vomiting; Disorder of swallowing- Achalasia; Disorders of stomach- Gastritis; Peptic ulcer; Disorder of small intestine: Sprue.	**15L**
Unit 2	**2.1 Renal Physiology** 2.1.1 Functions of kidneys 2.1.2 Mechanism of urine formation and its composition 2.1.3 Role of aldosterone and ADH in regulating renal excretion, Diabetes insipidus 2.1.4 Acute and chronic renal failure, - causes and effects, Renal calculi	**15L**

	2.2 Respiration 2.2.1 Overview and organization of respiratory system 2.2.1 Function of the respiration process 2.2.2 Functions of the respiratory passageways- trachea, bronchi, bronchioles 2.2.3 Mechanism of breathing: Inspiration and expiration 2.2.4 Composition of air and partial pressure of gases 2.2.5 Transport and exchange of gases-O2 and carbon dioxide in blood	
Unit 3	**Cardiovascular and Nervous System** **3.1 Cardiovascular system** 3.1.1 Structure of heart, layers, chambers, and valves of heart 3.1.2 Physiology of cardiac muscle, Sliding filament theory 3.1.3 Cardiac cycle and cardiac output 3.1.4 Hypertension, Angina Pectoris, Atherosclerosis, Coronary Artery Disease **3.2 Nervous System** 3.2.1 Overview and classification of nervous system 3.2.2 Structure of neuron and its types, classification of nerves 3.2.3 Saltatory and continuous conduction: Resting membrane potential of a neuron and generation of nerve impulse 3.2.4 Synapse and properties of synapse, introduction to neurotransmitters (Dopamine, Serotonin, Acetylcholine, and GABA) 3.2.5 Parkinsons and Multiple Sclerosis	**15L**

Semester III
Syllabus- Core Course-2 Practical (Major)

Course Title: Human Physiology	**Course code: SIUBCMJ212**
Credits: 01	**Hours/week: 02**

Expected Course Outcomes

On completion of this course, learner should be able to

1. Explain the structure and function of various cell types in human body
2. Identify the components of skeletal system and vertebral column
3. Co-relate the structure of skeletal system with its function
3. Appraise and compare the various reflexes through simple experiments and observations
4. Develop skills to measure blood pressure, pulse rate and oxygen saturation and assess the physiological condition
5. Analyse the components of electrocardiogram and assess the clinical condition

Sr No	Human Physiology Practical	
1	Different cell types in human body- identification and function: Stem, Blood, Nerve, Muscle, cartilage, Bone, Skin, endothelial, epithelial, fat and sex cells. (permanent slides/images)	
2	Observation and identification (Models/images) :Identification of organs Skeletal system: Bones, cartilage, ligaments and tendons Vertebral column (cervical, thoracic, lumbar, sacrum and coccyx); pectoral girdle (Clavicle and scapula); Upper extremity (Humerus, radius, ulna, carpals, metacarpals, phalanges), Pelvic girdle, Lower extremity (Femur, tibia, fibula, patella, tarsals, metatarsals and phalanges)	
3	Measurement of weight, height, Body surface area (by Nomogram), Body fat (Skin fold calliper method), Measurement of body mass index, waist and hip circumference	
4	Senses and reflexes: Spinal reflex- Patellar reflex; autonomic reflex: pupillary; Sensation and receptor physiology: tactile localization; sound localization, tests of balance and equilibrium	
5	Study of blood pressure, pulse rate and oxygen saturation	
6	Study of electrocardiogram	

References for Semester III (SIUBCCC212 and SIUBCCCP212)

1. Principles of Anatomy and Physiology; Gerard J 12th Edition, John Wiley and Sons
2. Human Physiology Chatterjee CC, CBS Publishers & Distributors
3. Textbook of Physiology, 7th Edition, Dr. A. K Jain, Avichal Publishing Company
4. Textbook of Medical Physiology (2011), 10th Guyton A.C. and Hall J.E. Elsevier's India Pvt Limited (New Delhi)
5. Textbook of Medical Biochemistry by M.N Chatterjee and Rana Shinde, 8th Edition, Jaypee Publication

Semester IV
Syllabus- Core Course-1 Theory

Course Title: Bioanalytical techniques	**Course code: SIUBCMJ221**
Credits: 03	**Hours/week: 02**

Expected Course Outcomes:

On completion of this course, learner should be able to

1. *Explain the principle of bioanalytical techniques*
2. *Discuss the applications of centrifugation, Chromatography and electrophoresis in biochemical investigations*
2. *Solve related analytical problems*

Total hours: 45	**Bioanalytical techniques**	**Credit: 3**
Unit 1	**Spectroscopy & Centrifugation** **1.1 Spectroscopy** 1.1.1 General Principle, Beer-Lambert law and its limitations, significance of Lambda max, molar extinction coefficient. 1.1.2 Numerical problems based on above concepts. **1.2 Centrifugation** 1.2.1 General principle, rpm, RCF, derivation of equation relating RCF and rpm. Types of centrifuges: Clinical, high speed, ultracentrifuge- preparative and analytical. Rotors: Fixed angle and swing out 1.2.2 Applications of centrifugation- Use of preparative centrifuge in the separation of cell organelles by differential centrifugation, proteins by rate zonal centrifugation and nucleic acids by isopycnic density gradient. 1.2.3 Numerical problems based on above concepts	**15L**

Unit 2	**2.1Electrophoresis** 2.1.1 Principles of electrophoresis, factors affecting electrophoretic mobility. 2.1.2 Types of electrophoresis: Moving boundary, zone electrophoresis (horizontal) set up, support media (paper, cellulose-acetate, agar, agarose and polyacrylamide0, techniques, detection and recovery. 2.1.3 PAGE: Native and SD, discontinuous electrophoresis for separation of proteins. 2.1.4 Applications of electrophoresis: Separation of proteins and nucleic acids, purity determination, molecular weight determination using PAGE, isoelectric focussing.	**15L**
Unit 3	**3.1Chromatography** 3.1.1 Principle, technique and biochemical applications of- Ion exchange chromatography (Column) and Gel filtration chromatography and affinity chromatography. 3.1.2 Introduction to GLC, HPLC Chromatography- Principles only. 3.1.3 Numerical problems based on the above concepts.	**15L**

Semester IV
Syllabus- Core Course-1 Practical (Major)

Course Title: Bioanalytical Techniques Practical	**Course code: SIUBCMJ212**
Credits: 01	**Hours/week: 02**

Expected Course Outcome:

On completing the Course, the learner should be able to

1. *Employ centrifugation for separation of cells and serum and plasma*
2. *Understand the concept of absorption spectra and use it for identification of compounds*
3. *Experimentally determine extinction coefficient of compounds*
4. *Estimate compounds colorimetrically*
5. *Separate biomolecules by chromatography*
6. *Separate serum proteins by electrophoresis*
7. *Determine viscosity by Ostwald's viscometer*

Bioanalytical techniques Practical syllabus

1. Centrifugation: separation of RBCs, yeast and bacterial cells, Separation of plasma and serum
2. Absorption spectra of Universal indicator/ CuSO4/K3FeCN6/Methyl orange and Vanillin
3. Determination of molar extinction coefficient of potassium ferricyanide
4. Estimation of compounds by colorimetric method (Maltose by DNSA)
5. Separation of sugars by radial and ascending paper chromatography
6. Separation of amino acids by radial and ascending paper chromatography
7. Extraction of pigments and their separation by column chromatography
8. Extraction of lipids and their separation by TLC
9. Agarose and PAG electrophoresis of serum proteins
10. Viscosity determination of starch gel by Ostwald's viscometer

References for Semester IV (SIUBCCC221 & SIUBCCP221)

1. Upadhyay, A. (2009). Biophysical chemistry. Himalaya Publishing House
2. Wilson, K., & Walker, J. (Eds.). (2000). Principles and techniques of practical biochemistry. Cambridge University Press
3. Principles of Instrumental Analysis by Douglas A. Skoog , F. James Holler and Stanley R. Crouch.

Semester IV
Syllabus- Core Course-2 Theory (Major+Minor)

Course Title: Membrane Biology
Course code: SIUBCMJ222 and SIUBCMN222
Credits: 03 **Hours/week: 02**

Expected Course Outcomes:

On completion of this course, learner should be able to

1. *Discuss the composition of biological membranes and their function in transport*
2. *Recognize the applications of artificial membrane vesicles*
3. *Explain the role of endomembrane system in a cell*
4. *Explain the role of ETC in energy transfer*

Total hours: 45	**Membrane Biology**	**Credit: 3**
Unit 1	**1.1Membrane structure and function** 1.1.1 Biological membrane: Membrane constituents and properties, Fluid mosaic model, 1.1.2 Membrane lipids -asymmetric distribution of lipids; influence of lipids on membrane properties 1.1.3 Membrane proteins: integral/ transmembrane, lipid-linked and peripheral. 1.1.4 Membrane carbohydrates and Sterols 1.2 Membrane dynamics; factors affecting membrane fluidity 1.3 Specialized membrane structures- Lipid rafts 1.4 Artificial membranes- liposomes -general method of synthesis and applications.	**15L**
Unit 2	**Membrane Transport** 2.1 Membrane transport: Types of transport 2.2 Facilitated diffusion: uniport, antiport, symport, GLUT, SGLT, Na+/Ca++ antiport 2.3 Ion channels: Voltage- gated and ligand- gated; role in nerve impulse transmission; Na+/K+ channels, nAch receptor 2.4 Active transport: Na^+ K^+ pump-proposed mechanism, inhibitors	**15L**
Unit 3	**Bioenergetics** 3.1 Endomembrane system: Role of endoplasmic reticulum and Golgi complex, lysosomes and vacuoles 3.2 Role of mitochondria and chloroplast in energy transfer 3.3 Principles of bioenergetics 3.4 Mitochondrial ETC and oxidative phosphorylation 3.5 Photophosphorylation	**15L**

Semester IV
Syllabus- Core Course-2 Practical (Major + Minor)

Course Title: Membrane biology and Microbiology Practical
Course code: SIUBCMJ222 and SIUBCMN222
Credits: 01 **Hours/week: 02**

Expected Course Outcomes:

On completion of this course, learner should be able to

1. *Explain experimentally the membrane properties of RBCs*
2. *Use hemocytometer to count cells*
3. *Employ aseptic techniques for preparation of media*
4. *Use techniques of preservation of microorganisms*
5. *Isolate microorganisms from samples*
6. *Enumerate bacteria in the given sample*
7. *Use staining techniques for studying organisms*
8. *Determine motility of bacteria by hanging drop technique*
9. *Determine sensitivity of bacteria to antibiotics*

Membrane Biology and Microbiology Practical:

1. Osmotic fragility and permeability properties of RBCs (urea, ethylene glycol, glucose and NaCl)
2. Cell count using haemocytometer (yeast cell count)
3. Preparation of media and aseptic techniques
4. Preservation of microorganisms
5. Techniques of isolation of microorganisms
6. Enumeration of bacteria from soil/water
7. Simple staining techniques: Gram and Endospore staining/wet mount of fungi
8. Study of bacterial motility- Hanging drop
9. Bioassay: Antibiotic sensitivity assay

References for semester IV (SIUBCCC222 & SIUBCCP222)

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry. Macmillan.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: life at the molecular level. John Wiley & sons.
3. Zubay, G. (1993). Biochemistry, Wm. C. Brown Publishers, Dubuque, 302312223, 2.
4. Berg, J. M., Tymoczko, J. L., Stryer, L., & Clarke, N. D. (2002). Biochemistry. 2002. New York, New York, 10010.

General Scheme of Examination

Credits	Course Type	Distribution of Credits	Sem end	Internal	Practical	Total
4	Core I with Practical (Major+ Minor)	with Practical 3T+1P	50	25	25	100
4	Core 2 with Practical (Major)	with Practical 3T+1P	50	25	25	100
2	VSC/ SEC	without sem end exam	---	50	---	50
2	Field project		Presentation and Viva voce (30M)	-	Field work 20M	50

Semester end, Internal and Practical as in the above Table, will be separate heads of passing.

1. Details for Internal Assessment:

Weightage for Internal (marks)	Min. marks required for passing	Pattern of Evaluation
40 (Core)	16	20 marks- class test (No retest) + 20 marks- Assignment/ Project/ Viva
25 (Core)	10	10 marks- class test (No retest) + 15 marks- Assignment/ Project/ Viva
50 (with sem end exam) OE	20	20 marks- class test (No retest) + 30 marks- Assignment/ Project/ Practical exam/ Open to Department
50 (without sem end exam) VSC, SEC	20	20 marks- class test (No retest) + 30 marks- Open to Department OR 50 marks from Practical- journal+ viva+ exam etc (continuous evaluation)

20 (IKS/ VEC/ AEC)	8	Open to Conveners of IKS, VEC, AEC
50 Field Project	20	20M Field Project; 30 M Report, presentation and Vive voce

Internal evaluation: Quizzes, Presentations, Surveys, Internship, Tutorials, Role Play

2. Details for Semester End Exam:

- For semester end exam, Two types of Patterns are given.
- Any one pattern can be adapted depending on the number of units in the syllabus.
- Arts and Commerce faculty will follow Type II.
- Students should be informed by the concerned department about the pattern.
- Questions of Objective type (MCQ/ Fill in the blanks/ match the following pairs etc) should not be asked in semester end exam.

Sem End	Min. Re.	Duration	Pattern	
			Type I	Type II
60	24	2 hrs.	• 4 units: 4 questions of 15 marks each on each unit. • 3 units: 3 questions of 15 marks on each unit and one question of mixed type for 15 marks.	4 questions for 10 marks each and 5th question is 4 Short Notes for 5 marks each.
50	20	2 hrs.	• 4 units: 4 questions of 12, 13, 12, 13 marks on 4 units. • 3 units: 3 questions on 3 units of 12 marks each and 4th question of mixed type for 14 marks. • 2 units: 2 questions of 20 marks each on each unit and one question of mixed type for 10 marks.	4 questions for 10 marks each and 5th question is 2 Short notes for 5 marks each.
30	12	1 hr.	• 3 units: 3 questions of 10 marks each on each unit. • 2 units: 2 questions of 15 marks each on each unit / 2 questions of 10 marks each on each unit and one question of mixed type for 10 marks.	2 questions for 10 marks each and 3rd question is 2 Short Notes for 5 marks.