AC/24/09/2022/RS1

SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

SIES College of Arts, Science and Commerce (Autonomous)

Affiliated to University of Mumbai

Syllabus effective from June 2022

Programme: B.Sc. Double Majors (3+3 Units)

(3 Units of Biochemistry with
3 Units of Botany/Chemistry/Microbiology/Zoology)

Subject: Biochemistry (3 Units)

Class: T.Y.B.Sc. Semester : V and VI

Choice Based Credit System (CBCS)

Content

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 that explores the intricate world of biomolecules and their applications and elucidates underlying molecular mechanisms.

The BSc double majors' program (3+3 Units) offers at the third year of BSc, 3 Units of Biochemistry with 3 Units of either Microbiology, Botany, Zoology or Chemistry. The students get an opportunity to hone their skills in two major subjects, one of which being Biochemistry.

In this program, we will embark on a comprehensive journey to unravel the molecular mysteries of life. The key concepts covered in the syllabus include Human Nutrition, Study of macromolecules, Metabolism, Biochemical signaling, Genetic information flow, Bioinformatics and Pharmaceutical Biochemistry

The objectives of this BSc (Double majors) Biochemistry program are-

1. *Foundational knowledge: To build the foundation of Biochemistry and encourage the student to pursue Biochemistry for further studies.*
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.*

To conclude, this syllabus is framed with a belief that it will not only equip the learner for in-depth understanding of life processes but also inspire the curious mind to enquire and indulge in finding solutions to issues concerning human health and welfare.

TYBSc Biochemistry (3 Units) syllabus for BSc Double Majors with Biochemistry

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 and Rational Thinking and Analytical skills • Develop critical thinking and a sense of inquiry for 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 Skill • 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 a nd 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 *(R, U, Ap, An)* • 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.
PSO2	Critical thinking and analytical skills *(U, An, E)* • 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.

PSO3	Experiential learning and Laboratory Skills *(R, U, Ap, An, C)* • 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
PSO4	Research Aptitude and Interdisciplinary Approach *(Ap, An, E, C)* • 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 • Demonstrate awareness of research ethics, research policies and laws related to copy rights, Intellectual Property Rights, plagiarism, use of animals in research, and accessing research resources.

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

Course Outcomes for TYBSc Biochemistry (3 Units)

Course code: SIUSBCH51 **Course Title:** Nutrition, Biomolecules & Biophysical Chemistry- I

The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1: 1.1.1	CO1**:** *Discuss concepts in nutrition and express the physiological significance of components of nutrition*	R, U	PO1, PO4/ PSO1
1.1.2	CO2: *Compute calorific value, RQ, BMR and deduce their significance*	U, An, Ap	PO2/PSO1, PSO2
1.2	CO3: *Describe the structure and properties of carbohydrates, proteins and nucleic acids and correlate them with their biochemical role*	R, U, Ap	PO1, PSO1
Unit 2:	CO3: *Describe the structure and properties of carbohydrates, proteins and nucleic acids and correlate them with their biochemical role*	R, U, Ap	PO1, PSO1
Unit 3:	CO3 *Describe the structure and properties of carbohydrates, proteins and nucleic acids and correlate them with their biochemical role*	R, U, Ap	PO1, PSO1
	CO4 *Classify enzymes, discuss enzyme kinetics and recognize their importance*	R,U,E	PO1, PO4/ PSO1,PSO2
Unit 4	CO5 *Employ techniques of Chromatography and Spectroscopy in biochemical investigations and solve related analytical problems*	U, An, Ap,	PO2/PSO1, PSO2,PSO3

Course Outcomes for TYBSc Biochemistry (3 Units)

Course code: SIUSBCH52 **Course Title:** Physiology, Metabolism & Applied Biochemistry- I

The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1:	CO1 *Explain the biochemical steps of metabolism of carbohydrates and amino acids/proteins*	R, U	PO1, PO4/ PSO1
Unit 2:	CO1: *Explain the biochemical steps of metabolism of carbohydrates and amino acids/proteins* CO2: *Discuss the energy synthesis pathways in plants and animals*	R, U R, U	PO1, PO4/ PSO1 PO1, PO4/ PSO1
Unit 3:	CO3: *Describe the role of growth regulators/hormones in plants and animals and correlate it to physiological disorders*	R, U,	PO1, PO4/ PSO1
Unit 4	CO4 *Explain the processes of information transfer in prokaryotic cell and recognize these as target sites for drugs*	R, U, Ap, E	PO1, PO4/PSO1

Course Outcomes for TYBSc Biochemistry (3 Units)

Course code: SIUSBCH61 **Course Title:** Nutrition, Biomolecules & Biophysical Chemistry- II

The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1: 1.1	CO1 *Express nutritional significance of vitamins and minerals and associated physiological disorders.*	R, U	PO1, PO4/ PSO1
1.2	CO2 *Describe the structure and properties of lipids and correlate them with their biochemical functions*	U, An	PO2/PSO1, PSO2
1.4	CO3: *Compute body mass indicators and deduce their significance.*	R, U, E	PO1, PO2, PSO1, PSO2
Unit 2:	CO4: *Discuss the composition of biological membranes, their function in transport and recognize the applications of artificial membrane vesicles*	R, U, E	PO1, PSO1, PSO2
Unit 3:	CO5 *Recognize and express the role of biomolecules as pharmaceuticals* CO6 *Explain the steps in discovery and development of a drug/biopharmaceutical*	R, U, E R, U	PO1, PSO1, PSO2 PO1, PSO1
Unit 4	CO7 *Employ techniques of centrifugation and electrophoresis in biochemical investigations and solve related analytical problems.*	U, An, Ap,	PO2/PSO1, PSO2,PSO3

Course Outcomes for TYBSc Biochemistry (3 Units)

Course code: SIUSBCH62 **Course Title:** Physiology, Metabolism & Applied Biochemistry- I

The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1:	CO1 *Explain the biochemical steps of metabolism of lipids*	R, U	PO1, PO4/ PSO1
Unit 2:	CO2: *Discuss the basics of immunology and appreciate their application in diagnosis of diseases*	R, U, E	PO1, PO4/ PSO1, PSO2
Unit 3:	CO3: *Articulate steps in bioprocess technology and recognize its applications* CO4 *Describe the basic technique of tissue culture and identify its applications*	R, U, E R, U,	PO1, PO4/ PSO1, PSO2 PO1/ PSO1
Unit 4	CO5 *Explain the steps in recombinant DNA technology and recognize its applications* CO6 *Express the scope, applications and potentials of bioinformatics.*	R, U, Ap, E R, U, Ap	PO1, PO4/PSO1 PO1, PO4/PSO1

Course Outcomes for TYBSc Biochemistry (3 Units)

Course code: SIUSBCHP5 **Course Title:** Practical of course SIUSBCH51 & SIUSBCH52

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1:	CO 1. *Develop analytical skills and proficiency in preparation of standard solutions and buffers* 2. *Gain expertise in the isolation of biomolecules from their natural source.* 3. *Employ the basic reactions of biomolecules for their identification.* 4. *Develop competence in estimation of biomolecules by Spectroscopy* 5. *Acquire training to estimate activity of enzymes anddetermine the kinetic parameters, Km and Vmax* 6. *To employ basic statistics for analyzing and presenting experimental data*	R, U, An, Ap, E	PO1, PO2, PO4, PO5, PO6/ PSO1, PSO2, PSO3,

Course Outcomes for TYBSc Biochemistry (3 Units)

Course code: SIUSBCHP5 **Course Title:** Practical of course SIUSBCH51 & SIUSBCH52

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
	1. *Gain expertise in the isolation of biomolecules from their natural source* 2. *Recognize plants as models for studying cytotoxicity of drugs* 3. *Employ the chemical properties of biomolecules for their estimation in food sample* 4. *Develop competence in separation and estimation of biomolecules* 5. *Acquire training in basic microbiology techniques* 6. *Employ basic statistics for analyzing experimental data.* 7. *Employ basic bioinformatics tools in the subject of biochemistry*	R, U, An, Ap, E	PO1, PO2, PO4, PO5, PO6/ PSO1, PSO2, PSO3,

Overall Credit Structure for T.Y. B.Sc (3+3 Units; Double Majors)

Semester	Major 1	Major 2	Applied Component	Credits/Semester	Degree/ cumulative credits
V	8C	8C	4C	20C	**BSc Double Majors (3+3 units) 40C**
VI	8C	8C	4C	20C	
Total Credits	16C	16C	8C	40C	

Major 1: Biochemistry
Major 2: Microbiology/ Botany/ Zoology/ Chemistry
Applied Component: Fishery Biology/Drugs & dyes/ Horticulture

Credit Structure of courses offered by Biochemistry department for T. Y. B.Sc. Biochemistry (3+3 Units; Double Majors)

Name of the Program: B.Sc. Double Majors (3+3 Units)
Name of Department: Biochemistry

Class	Semester	Course Code	Course Title	Credits	No. of lectures/ week	Marks
TYBSc	V	SIUSBCH51	Nutrition, Biomolecules & Biophysical Chemistry- I	2.5	4	100
		SIUSBCH52	Physiology, Metabolism & Applied Biochemistry- I	2.5	4	100
		SIUSBCHP5	Practical of course SIUSBCH51 & SIUSBCH52	3	8	100
TYBSc	VI	SIUSBCH61	Nutrition, Biomolecules & Biophysical Chemistry- II	2.5	4	100
		SIUSBCH62	Physiology, Metabolism & Applied Biochemistry- II	2.5	4	100
		SIUSBCHP6	Practical of course SIUSBCH61 & 62	3	8	100

SI: SIES
U: Undergraduate
S: Science stream
BCH: Biochemistry

Summary of Syllabus

SEMESTER V

Course Title & Course Codes	Units	Topic Headings	Credits	Hours/Week
Nutrition, Biomolecules & Biophysical Chemistry- I **SIUSBCH51**	I	Basic concepts in nutrition; Carbohydrates	2.5	4
	II	Amino acids and Proteins		
	III	Nucleic acids; Enzymes		
	IV	Chromatography; Spectroscopy		
Physiology, Metabolism & Applied Biochemistry- I **SIUSBCH52**	I	Carbohydrate metabolism	2.5	4
	II	Amino acid metabolism; Bioenergetics		
	III	Plant growth regulators; Endocrinology		
	IV	Fundamentals of Molecular Biology		
SIUSBCHP5		Practical of course SIUSBCH51 and SIUSBCH52	3	8

Semester V
Syllabus- Paper 1 Theory

Course Title: Nutrition, Biomolecules & Biophysical Chemistry- I	**Course code: SIUSBCH51**
Credits: 2.5	**Hours/week: 04**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Discuss concepts in nutrition and express the physiological significance of components of nutrition.*
2. *Compute calorific value, RQ, BMR and deduce their significance.*
3. *Describe the structure and properties of carbohydrates, proteins and nucleic acids and correlate them with their biochemical role.*
4. *Classify enzymes, discuss enzyme kinetics and recognize their importance*
5. *Employ techniques of Chromatography and Spectroscopy in biochemical investigations and solve related analytical problems.*

Unit I **Basic Concepts in Nutrition; Carbohydrates** **15L**

1.1 Basic Concepts in Human Nutrition

1.1.1 Proximateprinciples, energy content of food, Units of energy, and calorific value

1.1.2 Utilization of energy, BMR, factors affecting BMR andits significance. Concept of thermic effect of food (SDA), Physicalactivity and energy requirements of man.

1.1.3 Nutritional importance of carbohydrates
Functions of carbohydrates, Requirement, Dietary sources, Glycemic index, Significance of fiber

1.2 Carbohydrates

1.2.1 Polysaccharides- Starch and Glycogen, Action of amylase on starch, Structural polysaccharides- Cellulose, Chitin

1.2.2 Bacterial cell wall polysaccharide: Peptidoglycan framework (with structures of NAG & NAMA), beta lactam antibiotics- Penicillin and cephalosporin.

Extracellular matrix proteoglycan- Hyaluronate, Chondroitin sulphate and Heparin (monomers/ Biomedical significance)

1.2.3 Commercial importance of carbohydrates:
Starch, Dextran. Cyclodextrin, Chitosan, Modified Cellulose, Pectin, Agar

Unit II **Amino Acids and Proteins** **15L**

2.1 Nutritional significance of proteins
Functions of proteins, requirement, dietary sources, essential and non-essential amino acids. Nutritive value of proteins: BV and PER

2.2 Proteins: Classification of proteins based on their shape and function.

2.3 Structural hierarchy of proteins
Primary structure: Formation and characteristics of peptide bond, phi and psi angles
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 (DNAbinding)

2.4 Tertiary structure - forces stabilizing, example myoglobin, Function of myoglobin
Quaternary structure - forces stabilizing, examplehemoglobin, Function of hemoglobin

2.5 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.
2.6 Protein denaturation

2.7 Diseases resulting from altered protein conformation: Prion and Alzheimer's

Unit III **Nucleic acid; Enzymes** **15L**

3.1 Nucleic acids

3.1.1 DNA: Structure elucidation: Rosalind Franklin- X-raydiffraction pattern (Physical evidence), Chargaff's rules (Chemical evidence). A, B and Z forms of DNA, Organization of DNA as Chromatin.

3.1.2 Effect of heat on DNA: Hypochromism, Hyperchromism, Denaturation of DNA, Tm.
3.1.3 RNA: rRNA, t-RNA, m-RNA, hnRNA, snRNA, miRNA. Catalytic role of RNA

3.2 Enzymes & Enzyme Kinetics

3.2.1 General properties of enzymes, Classification ofenzymes- IUB/EC classification (up to I digit)

3.2.2 Active site of enzyme, mechanism of action: lock andkey, induced fit, transition state theory. Cofactors, Coenzymes (role of vitamins), Prosthetic groups, Apoenzyme and Holoenzyme

3.2.3 Enzyme kinetics
Factors affecting enzyme-catalysed reaction Derivation of Michaelis-Menten equation, Km, Lineweaver Burk plot, Catalytic efficiency- turn over number, Enzyme activity: Katal, IU
Specific activity of enzyme.

3.2.4 Enzyme inhibition: Competitive (allopurinol and Sulphonamides, Methotrexate) and Noncompetitive(Iodoacetate and Diisopropyl fluorophosphate).

3.2.5 Applications of enzymes in therapy (Streptokinase,Hyaluronidase), diagnosis (Creatine kinase, LDH), industry (Amylase, Protease, lipase)

Unit IV **Chromatography; Spectroscopy** **15L**

4.1 Chromatography

4.1.1 Principle, technique and applications of -
Ion exchange chromatography (Column) and Gelfiltration chromatography.

4.1.2 Introduction to GLC, HPLC and Affinity Chromatography -Principles only.

4.1.3 Numerical problems based on above concepts.

4.2 Spectroscopy

4.2.1 General Principle, Beer-Lambert law and its limitations, significance of Lambda max, molar extinction coefficient

4.2.2 Numerical problems based on above concepts

Semester V
Syllabus- Paper 2 Theory

Course Title: Physiology, Metabolism & Applied Biochemistry- I	**Course code: SIUSBCH52**
Credits: 2.5	**Hours/week: 04**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Explain the biochemical steps of metabolism of carbohydrates and amino acids/proteins*
2. *Analyse the concepts of thermodynamics and deduce their application in living system*
3. *Discuss the energy synthesis pathways in plants and animals*
4. *Explain the processes of information transfer in prokaryotic cell and recognize these as target sites for drugs*
5. *Describe the role of growth regulators/hormones in plants and animals and correlate it to physiological disorders.*

Unit I **Carbohydrate metabolism** **15L**

1.1 Digestion and absorption of carbohydrates, Role of GLUT, Lactose intolerance.

1.2 Introduction to metabolism: Catabolism, anabolism, role ofhigh energy phosphates viz. ATP and thioesters, role of reduced coenzymes NADH and NADPH.

1.3 Overview of catabolism, Glycogenolysis (Schematic) Catabolism of glucose: Glycolysis- cellular location, sequence of reactions, products, energetics. Fate of pyruvate in aerobic and anaerobic conditions, Cori cycle, Kreb's cycle: cellular location, sequence of reactions,

1.4 Anabolism - HMP Shunt (Synthesis of pentose phosphates) -Cellular location, sequence of reactions,oxidative and non-oxidative phases of pathway and multifunctional nature.
Gluconeogenesis
Glycogenesis (Schematic), Anaplerotic reactions – Role of Pyruvate carboxylase, PEP carboxykinase, Malic enzyme.

Unit III **Amino acid metabolism; Bioenergetics** **15L**

2.1 Amino acids and protein metabolism

2.1.1 Digestion and absorption of proteins & amino acids

2.1.2 Catabolism- reactions- Transamination (AST/ALT), Clinical significance

2.1.3 Decarboxylation of His, Trp, Glu and physiological significance of the products.

2.1.4 Deamination: Oxidative (NAD, FAD, FMN- linked oxidases) & Non-oxidative- Asp, Cys, Ser.

2.1.5 Urea Cycle- Cellular location, sequence of reactions, labelling of N-atom, formation and transport of ammonia.

2.2 Bioenergetics

2.2.1 Mitochondrial ETC
Free energy, free energy change, exergonic and endergonic reactions.
High energy compounds, ATP, Synthesis of ATP, Substrate level and oxidative phosphorylation
2.2.2 Oxidative Phosphorylation

Electron transport chain: electron carriers, redox potentials, basic chemistry, sequence and location of these electron carriers in mitochondrial membrane, Qcycle.
Inhibitors of ETC: Antimycin A, Amytal, Rotenone, CN.
2.2.3 Mechanism of ATP synthesis: Chemiosmotic hypothesis, Proton motive force.
Structure of ATP synthase (FoF1 ATPase)

2. 3 Photosynthesis

2.3.1 Light-dependent and light-independent reactions.

Light dependent reactions, chloroplast, role of reaction center and accessory pigments.

2.3.2 Photophosphorylation: Linear ETC/ Z scheme, two reaction centers, production of oxygen and NADPH, proton gradient and ATP synthesis.

Cyclic ETC in purple bacteria.
2.3.3 Light independent reactions: Calvin cycle (schematic representation only)

Unit III **Plant growth regulators, Endocrinology** **15L**

3.1 Plant growth regulators

3.1.1 Role of auxins, cytokinin, abscisic acid, gibberellins and ethylene.

3.2 Endocrinology

3.2.1 Hormones, hormone receptor,
Classification of hormone on the basis of chemistry, organization of the endocrine system.

3.2.2 Chemistry, synthesis, secretion and metabolic effects of thyroxine, insulin.

3.2.3 Chemistry & physiological role of oxytocin and vasopressin. Physiological role of glucocorticoids and epinephrine.
Role of secondary messengers: cAMP, Ca and IP_3

3.2.4 Mechanism of action of epinephrine (on glycogenolysis) and steroid hormone (on gene expression)

3.2.5 Endocrine disorders- Diabetes mellitus, Diabetes insipidus, Hypothyroidism (Cretinism & myxedema), Hyperthyroidism (Goitre- Simple & Toxic)

Unit IV **Fundamentals of Molecular Biology** **15L**

4.1 Cell cycle: phases and significance

4.2 Replication of DNA: modes of DNA replication, experimental evidence for semi-conservative replication, mechanism, discontinuous DNA synthesis, termination of replication.
Antibiotics inhibiting replication of DNA (Quinolones, Methotrexate, 5-Fluorouracil)

4.3 Transcription of DNA- in prokaryotes, prokaryotic RNA polymerase. Steps in transcription, processing of RNA species, concept of split genes, reverse transcription.
Antibiotics inhibiting transcription (Rifamycin, Actinomycin D)

4.4 Translation (protein biosynthesis) in prokaryotes: activation of amin acids, chain initiation, chain elongation, chain termination, post translational modifications of proteins.
Antibiotics that inhibit protein synthesis (streptomycin, tetracyclin, puromycin)

4.5 Gene regulation: Promoters, enhancers, concept of operon.
Lac operon

Semester V
Syllabus- Practical

Course Title: Practical of course SIUSBCH51 & SIUSBCH52	**Course code: SIUSBCHP5**
Credits: 03	**Hours/week: 08**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Develop analytical skills and proficiency in preparation of standard solutions and buffers*
2. *Gain expertise in the isolation of biomolecules from their natural source*
3. *Employ the basic reactions of biomolecules for their identification*
4. *Develop competence in estimation of biomolecules by Spectroscopy*
5. *Acquire training to estimate activity of enzymes anddetermine the kinetic parameters, Km and Vmax*
6. *To employ basic statistics for analyzing and presenting experimental data*

Title

I. Qualitative Analysis:
1. Carbohydrates- Glucose, fructose, maltose, lactose, sucrose, starch and dextrin.
2. Proteins- Albumin, casein, gelatin, peptone.

II Estimation of biomolecules:

Volumetric analysis:
3. Lactose by Cole's method
4. Glucose by Benedict's method

Colorimetric analysis:
1. Proteins by Biuret method
2. RNA by Orcinol
3. Maltose by DNSA

III Isolation (Minimum two)
1. Starch from potato
2. Casein from milk
3. Curcumin from turmeric

IV Enzymology
1. Amylase: Km of amylase

V Biostatistical analysis:
1. Collection of data, types of data and presentation.
2. Frequency distribution
3. Determination of mean, median and mode

VI Demonstration Experiments

1. Preparation of buffers and use of pH meter
2. Titration curve of amino acid
3. Optimum pH of amylase
4. Immobilization of enzyme in alginate beads.
5. Glucose by Folin- Wu method

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Summary of syllabus

SEMESTER VI

Course Title & Course Codes	Units	Topic Headings	Credits	Hours/Week
Nutrition, Biomolecules & Biophysical Chemistry- II **SIUSBCH61**	I	Basic concepts in nutrition; Lipids	2.5	4
	II	Membrane Biochemistry		
	III	Pharmaceutical Biochemistry		
	IV	Centrifugation; Electrophoresis		
Physiology, Metabolism & Applied Biochemistry- II **SIUSBCH62**	I	Lipid Metabolism	2.5	4
	II	Basics of Immunology		
	III	Industrial Biochemistry; Basics of tissue culture		
	IV	Recombinant DNA technology; Introduction to Bioinformatics		
SIUSBCHP6		Practical of course SIUSBCH61 and SIUSBCH62	3	8

Semester VI
Syllabus- Paper I Theory

Course Title: Nutrition, Biomolecules & Biophysical Chemistry- II	**Course code: SIUSBCH61**
Credits: 2.5	**Hours/week: 04**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Express nutritional significance of vitamins and minerals and associated physiological disorders.*
2. *Describe the structure and properties of lipids and correlate them with their biochemical functions.*
3. *Compute body mass indicators and deduce their significance.*
4. *Discuss the composition of biological membranes, their function in transport and recognize the applications of artificial membrane vesicles*
5. *Employ techniques of centrifugation and electrophoresis in biochemical investigations and solve related analytical problems.*
6. *Recognize and express the role of biomolecules as pharmaceuticals*
7. *Explain the steps in discovery and development of a drug/biopharmaceutical*

Unit I **Nutrition; Lipids** **15L**

1.1 Nutritional significance of
1.1.1 Vitamins and their deficiency disorders
1.1.2 Minerals: Fe, Ca, P, Mg
1.2 Lipids

1.2.1 Fatty acids and TAG
Saturated fatty acids- classification, C2 to C20 (onlu even C chain fatty acids)
Unsaturated fatty acids- MUFA, PUFA (2,3,4 double bonds)
Omega 3, Omega 6 and Omega 9 fatty acids.
Triacylglycerols- simple & mixed.

1.2.2 Chemical reactions: Saponification, iodination, auto-oxidation, rancidity of fats. Definition & significance- acid number, saponification number, iodine number and Reichert- Meissel number.

1.2.3 Compound Lipids:

Structure and functions of glycerophospholipids (cephalin, lecithin and phosphatidyl inositol), action of phospholipases. Functions of phosphosphingolipids (ceramide, sphingomyelin), glycolipids or cerebrosides (galacto and glucocerebrosides)

1.2.4 Steroids and lipoproteins
Steroids- cholesterol structure and biochemical significance
Lipoproteins- types (chylomicron, VLDL, LDL, HDL) and biochemical significance.

1.2.5 Nutritional significance of lipids: Body fat composition, BMI and Waist: Hip ratio

Unit II **Membrane Biochemistry** **15L**

2.1 Biological membrane: Membrane constituents and assembly: Fluid mosaic model, asymmetric distribution of lipids.

2.2 Membrane proteins: integral/ transmembrane, lipid-linked and peripheral.

2.3 Membrane transport:
Passive diffusion
Facilitated diffusion: uniport, antiport, symport, GLUT
Ion channels: Voltage- gated and ligand- gated; role in nerve impulse transmission.
Active transport: Na^+ K^+ pump, inhibitors
2.4 Liposomes and their applications

Unit III **Introduction to Pharmaceutical Biochemistry** **15L**

3.1 Biomolecules as pharmaceuticals: Introduction to terms- drug/ pharmaceutical, biopharmaceutical, biologic

3.1.1 Pharmaceuticals of plant origin: Aspirin (salicylate), Alkaloids: Atropine, morphine, cocaine, ephedrine, papaverine, quinine, vinblastine and vincristine,
Xanthine: Caffeine and theophylline
Terpenes: Taxol
Glycosides: Digoxin and digitoxin
3.1.2 Pharmaceuticals of animal origin:
Hormones: Sex hormones- androgens, progesterone and oestrogen; adrenaline, glucocorticoids and prostaglandins
3.1.3 Pharmaceuticals of microbial origin:
Antibiotics: Penicillin, cephalosporin, tetracyclines, aminoglycosides (streptomycin), ansamycins (rifamycin)
Peptide antibiotics: Bacitracin, Gramicidin and Vancomycin.

3.2 Steps in drug/ biopharmaceutical discovery and development
Introduction to pharmacology, pharmacognosy, pharmacokinetics, pharmacodynamics.

3.2.1 Drug discovery:
Target identification and validation, lead identification (random screening and ration drug design approach) and optimization

3.2.2 Pre-clinical trials: Pharmacokinetic profile, pharmacodynamic profile, bioavailability, bioequivalence, toxicity study.

3.2.3 Clinical trial- phases

3.2.3 Role of regulatory authority: FDA; IND, NDA

Unit IV **Centrifugation; Electrophoresis** **15L**

4.1 Centrifugation

4.1.1 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
4.1.2 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.

4.1.3 Numerical problems based on above concepts

4.2 Electrophoresis

4.2.1 Principles of electrophoresis, factors affecting electrophoretic mobility.

4.2.2 Types of electrophoresis: Moving boundary, zone electrophoresis (horizontal) set up, support media (paper, cellulose-acetate, agar, agarose and polyacrylamide), techniques, detection and recovery.

4.2.3 PAGE: Native and SD, discontinuous electrophoresis for separation of proteins

4.2.4 Applications of electrophoresis: Separation of proteins and nucleic acids, purity determination, molecular weight determination using PAGE, isoelectric focussing.

Semester VI
Syllabus- Paper 2 Theory

Course Title: Physiology, Metabolism & Applied Biochemistry- II	**Course code: SIUSBCH62**
Credits: 2.5	**Hours/week: 04**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Explain the biochemical steps of metabolism of lipids*
2. *Discuss the basics of immunology and appreciate their application in diagnosis of diseases.*
3. *Articulate steps in bioprocess technology and recognize its applications*
4. *Describe the basic technique of tissue culture and identify its applications*
5. *Explain the steps in recombinant DNA technology and recognize its applications*
6. *Express the scope, applications and potentials of bioinformatics.*

Unit I **Lipid Metabolism** **15L**

1.1 Digestion and absorption of lipids

1.2 Catabolism- Knoop's experiment, beta-oxidation of even carbon saturated fatty acids, role of carnitine, energetics from C4 to C20

1.3 Anabolism- Fatty acid biosynthesis (only palmitic acid), fatty acyl synthetase complex.

1.4 Ketone body formation, utilization.
Ketosis, physiological significance in diabetes mellitus, starvation, alcoholism and pregnancy.

1.5 Lipoprotein metabolism

Unit II **Basics of immunology** **15L**

2.1 Immunity, antigen, hapten and antibody.
Types of immunity: Innate, Acquired, Active and Passive
Innate immunity: External barriers, phagocytosis, complement, natural killer cells.
2.2 Acquired immunity: Humoral and cell-mediated
Specificity, self- non-self recognition
Humoral immunity: B cells, plasma cells, functions of antibody.
Cell-mediated: T-cells, subsets- T helper and cytotoxic T cells, MHC Class I and II
2.3 Cells and organs of immune system

2.4 Immunoglobulins general structure, classes and sub-classes- structure and functions

2.5 Antigen- antibody reactions: Precipitation, agglutination. Principle of ELISA, Biotin- avidin system

Unit III **Industrial biochemistry; Tissue culture techniques** **15L**

3.1 Bioprocess technology

3.1.1 Introduction, steps in setting up an industrial process, parameters, selection of organism, screening, types of media, batch and continuous fermentation, basic components of a typical fermenter. Applications.

3.1.2 Fermentation process for production of alcohol/wine/beer

3.2 Plant tissue culture

3.2.1 Requirements: Physical conditions, nutritional requirements. General technique, explant, callus, totipotency, dedifferentiation, redifferentiation, role of plant growth regulators.

3.2.2 Different types of tissue culture techniques, protoplast fusion. Applications of tissue culture.

Unit IV **Recombinant DNA technology; Introduction to Bioinformatics** **15L**

4.1 Recombinant DNA technology

4.1.1 Genetic engineering- Steps in DNA cloning, restriction enzymes, isolation of gene from cellular chromosomes.

Cloning vectors (Plasmid, Phage, Cosmid, Improved vectors and shuttle vectors), transformation and selection of recombinant cells. Cloning of insulin gene.

4.1.2 Transgenic plants- Bt cotton, cloning in plants using Ti plasmid.

4.1.3 Gene libraries, DNA probes

4.1.4 DNA amplification by PCR, applications of PCR.

4.2 Introduction to Bioinformatics

4.2.1 History of bioinformatics, genomics and proteomics

4.2.2 Databases: types- public domain database, sequence database, structural database, motif database, genome database, proteome database, annotated sequence database- GenBank, EMBL, PIR, SWISS PROT, PDB, GDB

4.2.3 Sequence analysis tools: BLAST, FASTA, L- ALIGN, CLUSTAL- X & W, RASMOL, Software for protein sequencing- PROPECT, AMMP, COPIA

4.2.4 Applications of bioinformatics in sequence analysis, molecular modelling and drug designing, phylogeny/ evolution, ecology & population studies, medical informatics and agriculture.

4.2.5 Micro-array analysis

Semester VI
Syllabus- Practical

Course Title: Practical of course SIUSBCH61 & SIUSBCH62	**Course code: SIUSBCHP6**
Credits: 03	**Hours/week: 08**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Gain expertise in the isolation of biomolecules from their natural source*
2. *Recognize plants as models for studying cytotoxicity of drugs*
3. *Employ the chemical properties of biomolecules for their estimation in food sample*
4. *Develop competence in separation and estimation of biomolecules*
5. *Acquire training in basic microbiology techniques*
6. *Employ basic statistics for analyzing experimental data.*
7. *Employ basic bioinformatics tools in the subject of biochemistry*

Title

I. Cell Biology

1. Isolation of DNA and its detection
2. Microscopy of stages of mitosis in actively dividing *Allium cepa* cells.
3. Effect of cytotoxic drug (methotrexate)/ colchicine on actively dividing cells of *Allium cepa*

II Food Analysis:

Mineral estimation:
Preparation of food ash
1. Calcium by EDTA method
2. Phosphorous by Fiske- Subbarow method.
3. Iron by Wong method

Vitamin estimation
1. Estimation of vitamin C iodometrically.

III Chromatography

1. Circular paper chromatography of amino acids
2. Circular paper chromatography of sugars
3. TLC of pigments

IV Pharmaceutical Biochemistry
1. Extraction of caffeine
2. Preparation of aspirin

V Microbiology

Concept of pure culture and mixed culture; preparation of media

1. Monochrome, Gram staining, negative staining

2. Isolation and enumeration of bacteria
3. Antibiotic sensitivity test

VI Biostatistical analysis (measures of dispersion)

Determination of SD and variance

VII Demonstration experiments:

1. Separation of DNA/ proteins by agarose gel electrophoresis.
2. Column chromatography- separation of chlorophyll pigments
3. Agglutination reaction: Widal qualitative/ blood grouping
4. Immunodiffusion in gel
5. Bioinformatics: Sequence retrieval, introduction to protein structure database.

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3. Murray, R. K., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2003). Harper's illustrated biochemistry. A Lange medical book. *Section*, *3*, 254.
4. Upadhyay, A. (2009). *Biophysical chemistry*. Himalaya Publishing House.
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8. Srilakshmi, B. (2006). *Nutrition Science*. New Age International.
9. Lewin, B. (2004). *genes VIII* (No. 04; QH430, L4.
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OVERALL SCHEME OF EXAMINATION

Credits	Course code & course title	Internal assessment	Semester end marks	Total
SEMESTER V				
2.5	SIUSBCH51 (Nutrition, Biomolecules & Biophysical Chemistry I)	40	60	100
2.5	SIUSBCH52 (Physiology, Metabolism & Applied Biochemistry- I)	40	60	100
3	SIUSBCHP5 (Practical of course SIUSBCH51 & SIUSBCH52)	-	100	100
Total: 8 Credits (300 Marks)				
SEMESTER VI				
2.5	SIUSBCH61 (Nutrition, Biomolecules & Biophysical Chemistry- II	40	60	100
2.5	SIUSBCH62 (Physiology, Metabolism & Applied Biochemistry- II	40	60	100
3	SIUSBCHP6 (Practical of course SIUSBCH61 & SIUSBCH62)	40	60	100
Total: 8 Credits (300 Marks)				

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	16	20 marks- class test (No retest) + 20 marks- Assignment/Presentation/ Project/ Viva

3. Details for Semester End Examination

1. Each theory paper shall carry 60 marks and will be conducted for a duration of 2 hrs.
2. Each theory paper shall contain 4 questions of 15 marks each as follows:
   Q1 based on Unit I
   Q2 based on Unit II
   Q3 based on Unit III
   Q4 based on Unit IV
3. Each main question of 15 marks can be further divided into sub questions. Maximum mark for a sub question should be 6 marks.

Weightage for Semester end (marks)	**Min. marks required for passing**	**Pattern of Evaluation**
60	24	4 main questions of 15 marks each based on all four units.

3. Details for Practical Examination

Weightage for Practical (marks)	**Min. marks required for passing**	**Pattern of Evaluation**
100	50	80M Laboratory 10M Journal 10M Viva

SCHEME OF PRACTICAL EXAMINATION

SEMESTER V

Course	**Experiments**	**Marks**
SIUSBCHP5	a. Isolation	20
	b. Estimation of biomolecules: Colorimetry/ Volumetry	15
	c. Enzymology	20
	d. Spots (Statistical analysis: 10M, Qualitative and demonstration experiments: 15M)	25
	e. Certified journal	10
	F Viva voce	10
	TOTAL	100

1. Candidate without a duly certified journal shall not be allowed to appear for the practical examination.
2. The Semester V practical examination shall be conducted by the college.
3. There shall be two examiners to conduct the practical examination- one internal examiner and other external examiner.

4. The external examiner shall be on the panel of examiner.
5. The college shall invite one such examiner from the approved panel as an external examiner.
6. Duration of the practical examination:
   a) One day of two sessions (3 ½ hr each)
   b) Morning session: 9:00 am to 12:30 pm
      Afternoon session: 1:00 pm to 4:30 pm

SCHEME OF PRACTICAL EXAMINATION

SEMESTER VI

Course	**Experiments**	**Marks**
SIUSBCHP6	a. Chromatography	20
	b. Colorimetric analysis/ isolation	15
	c. Volumetric analysis	15
	d. Spots (Statistical analysis: 15M, Microbiology, Immunodiffusion and demonstration experiments: 15M)	30
	e. Certified journal	10
	F Viva voce	10
	TOTAL	100

1. Candidate without a duly certified journal shall not be allowed to appear for the practical examination.
2. The Semester VI practical examination shall be conducted by the college.
3. There shall be two examiners to conduct the practical examination- one internal examiner and other external examiner.
4. The external examiner shall be on the panel of examiner.
5. The college shall invite one such examiner from the approved panel as an external examiner.
6. Duration of the practical examination:
   a) One day of two sessions (3 ½ hr each)
   b) Morning session: 9:00 am to 12:30 pm
      Afternoon session: 1:00 pm to 4:30 pm