AC/27/06/2023/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 under NEP effective from June 2023

Programme: B.Sc.

Subject: Biochemistry

Core Course, Vocational Skill Enhancement Course
and
Skill Enhancement Course

Class: F.Y.B.Sc. **Semester : I and II**

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 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 first-year level, along with 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 encourage the student to pursue Biochemistry at 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.*

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

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.

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

Semester	Core I	Core II	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC	Credits/ semester	Degree/ cumulative credits
I	4C	4C	4C	VSC-2C SEC-2C	AEC-2C VEC-2C IKS-2C	Nil	22C	**UG Certificate 44C**
II	4C	4C	4C	VSC-2C SEC-2C	AEC-2C VEC-2C	CC-2C	22C	
Total Credits	8C	8C	8C	8C	10C	2C	44C	

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 F.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**
FYBSc	I	SIUBCCC111	Foundations of Biochemistry	03	03	75
		SIUBCCCP111	Biochemistry Practical	01	02	25
		SIUBCVS111	Basic tools & techniques in Biochemistry	02 (01Th + 01P)	03 (01Th + 02P)	50
		SIUBCSE111	Good Laboratory Practices & Soft Skills	02 (01Th + 01P)	03 (01Th + 02P)	50
FYBSc	II	SIUBCCC121	Cell Biology	03	03	75
		SIUBCCCP121	Cell Biology Practical	01	02	25
		SIUBCVS121	Basic tools & techniques in Biochemistry	02 (01Th + 01P)	03 (01Th + 02P)	50
		SIUBCSE121	Good Laboratory Practices & Soft Skills	02 (01Th + 01P)	03 (01Th + 02P)	50

SI: SIES
U: Undergraduate
BC: Biochemistry
CC: Core Course
VS: Vocational Skill Course
SE: Skill Enhancement Course

Summary of syllabus

SEMESTER I

Course Title & Course Codes	Units	Topic Headings	Credits	Hours/Week
Foundations of Biochemistry SIUBCCC111	I	Introduction to Biochemistry	3	3
	II	Basic Concepts in Nutrition		
	III	Carbohydrates		
	IV	Amino Acids		
	V	Lipids		
Core Practical SIUBCCC111		Biochemistry Practical-I	1	2
VSC SIUBCVS111		Basic tools & techniques in Biochemistry	2	1 +2(Practical)
SEC SIUBCSE111		Good Laboratory Practices & Soft Skills	2	1+2 (Practical)

Semester I
Syllabus- Core Course Theory

Course Title:	**Foundations of Biochemistry**	**Course code: SIUBCCC111**
Credits: 03		**Hours/week: 03**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Understand cell as a unit of life. Classify organisms broadly.*
2. *Co-relate the properties of biomolecules to their functional groups.*
3. *Discuss the structure of water and its properties and co-relate its role as biological solvent.*
4. *Discuss concepts in nutrition and express the physiological significance of macro and micro-nutrients.*
5. *Compute calorific value, RQ, BMR and deduce their significance.*
6. *Identify the basic building blocks of macromolecules.*
7. *Understand the structure and properties of carbohydrates, lipids, and amino acids, and correlate them with their biochemical role.*

Unit 1 **Introduction to Biochemistry** **5L**

1.1 Cells: Functional and structural unit of all living organisms. Broad classification of organisms- eubacteria, archaebacteria and eukaryotes; Classification of organisms based on energy and carbon source
1.2 Biochemically important elements, functional groups, introduction to stereochemistry.
1.3 Water -structure and its properties, its interactions in biological systems, ionization of water, concept of buffers, Henderson-Hasselbach equation.

Unit 2 **Basic concepts in human nutrition** **15L**

2.1 Function of food, essential nutrients- Macro and Micro-nutrients; calorific value of foods, RQ.
2.2 Energy expenditure: (BMR, physical activity and thermic effect of food/SDA);
2.3 Macronutrients:
2.3.1Nutritional significance of carbohydrates: Sources, Role of carbohydrates; RDA; Concept of glycaemic index
2.3.2 Nutritional significance fats and lipids: sources; essential fatty acids, saturated fatty acids, cholesterol.
2.3.3 Nutritional significance of proteins: N balance, nutritional value, sources and RDA
2.4 Balanced diet food pyramid; Anthropometric measurements: BMI and WHR

2.5 Micronutrients: Overview of fat soluble and water-soluble vitamins (biochemical functions, and deficiency disorders), Role of minerals (Na, K, Ca, Fe)

Unit 3 **Carbohydrates** **15 L**

3.1 Definition and Classification
3.2 Monosaccharides –
3.2.1 structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, 3.2.2 structure of biologically important sugar derivatives, oxidation of sugars.
3.3 Disaccharides: Maltose, lactose, sucrose, cellobiose
3.4 Polysaccharides – homopolysaccharides, heteropolysaccharides, structural and storage polysaccharides (Starch, glycogen, cellulose, chitin, hyaluronic acid, chondroitin sulphate) Role of proteoglycans, glycoproteins and glycolipids.
3.5 Industrially important carbohydrates: Dextrose, lactulose, Starch, chitosan.

Unit 4 **Amino acids** **5L**

4.1 Structure and classification of standard amino acids.
4.2 Physical, chemical, and optical properties of amino acids, functions of amino acids.
4.3 Introduction to proteins: Polypeptides- Peptide bond formation and its properties

Unit 5 **Lipids** **5L**

5.1 Building blocks of lipids - fatty acids, glycerol, ceramide.
5.2 Classification of lipids: Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids (lecithin and cephalin), sphingolipids
5.3 Introduction to sterols.
5.4 Role of lipids.

Semester I
Syllabus- Core Course Practical

Course Title: Biochemistry Practical-I	**Course code: SIUBCCCP111**
Credits: 01	**Hours/week: 02**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Calculate and prepare standard solutions. Comprehend the difference between primary and secondary standard.*
2. *Detect and identify biomolecules in samples by simple qualitative tests. Employ the basic reactions of biomolecules for their identification.*
3. *Comprehend dissociation of weak acid in solution and determine its pKa.*
4. *Isolate biomolecules from natural source. Identify and apply the properties of biomolecules in their isolation.*
5. *Estimate the amount of a biomolecule using titrimetric methods.*

Title

Qualitative analysis /Identification of biomolecules

1. a. Preparation of standard solutions (1% Glucose & 1M NaOH).
   b. Concept of primary & secondary standards.
2. Carbohydrates (Benedicts, Iodine, Molisch, Barfoed's, Seliwanoff's, Osazone),
3. Lipids (Phospholipids- Neumann's test),
4. Amino acids (Ninhydrin) and Proteins- Albumin (Biuret Test, ammonium sulphate precipitation).
5. Determination of pKa of acetic acid and pI of glycine

Isolation of biomolecules

6. a. Starch from potato
   b. To study gelatinization of starch.
7. Lecithin and cholesterol from egg yolk.

Estimation of biomolecules: Volumetric analysis

8. Estimation of Glucose by Benedict method
9. Estimation of Vitamin C iodometrically

REFERENCES FOR SEMESTER I

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. Krause's Food and the Nutrition Care Process, 13th Edition, L Kathleen Mahan, Sylvia Escott-Stump, Janice L. Raymond
6. Introductory Practical Biochemistry, SK Sawhney and Randhir Singh
7. Biochemical Methods Edition 3 by Sadasivam and Manickam.
8. An Introduction to Practical Biochemistry, 3rd edition- David T. Plummer.

Summary of syllabus

SEMESTER II

Course Title & Course Codes	Units	Topic Headings	Credits	Hours/Week
Cell Biology SIUBCCC121	I	Introduction to cell biology	3	3
	II	Subcellular organelles		
	III	Cytoskeleton & Extracellular Matrix		
	IV	Cell Division & basics of cancer biology		
	V	Cell Biology of Infection		
Core Practical SIUBCCCP121		Biochemistry Practical -II	1	2
VSC SIUC VS121		Basic tools & techniques in Biochemistry	2	1+2 (practical)
SEC SIUBCSE121		Good Laboratory Practices & Soft Skills	2	1+2(Practical)

Semester II
Syllabus- Core Course Theory

Course Title:	**Cell Biology**	**Course code: SIUBCCC121**
Credits: 03		**Hours/week: 03**

Expected Course Outcomes

On completion of this course, learner should be able to

1. *Discuss the organization, biochemistry, and functions of the cell.*
2. *Describe the structure and significance of biological membranes. Co-relate the properties of membrane components to their role in maintaining the membrane structure.*
3. *Comprehend and discuss the role of cell organelles.*
4. *Understand the importance of cell cycle checkpoints and their role in preventing transformation of cells into cancer.*
5. *To analyse host-pathogen interaction and comprehend its effect in various diseases.*

Unit 1 **Introduction to cell biology** **8L**

1.1 Structure and components of prokaryotic and eukaryotic cell
1.2 Cells as experimental models
1.3 Bacterial and plant cell wall;
1.4 Structure, and composition of cell membrane

Unit 2 **Sub cellular organelles** **8L**

2.1 Structure of nuclear envelope, nuclear pore complex

2.2 ER structure and function, organization, and function of golgi and lysosome.
2.3 Structure and function of mitochondria, peroxisomes, chloroplast.

Unit 3 **Cytoskeleton and Extracellular matrix** **9L**

3.1 Cytoskeleton: Components- microfilaments, intermediate filaments and Microtubules- their structure and functions.
3.2 Assembly, organization and movement of cilia and flagella
3.3 Integrating cells into tissues
3.3.1 Cell-cell binding -adhesive interactions, cell adhesion molecules, cell junctions (Overview)
3.3.2 Extracellular matrix (ECM)- components and role of integrin.
3.3.3 Plant tissues

Unit 4	**Cell division and cancer biology**	**10L**
	4.1 Cell division: Mitosis and meiosis 4.2 Cell cycle and overview of cell cycle checkpoints: Cyclins & CDKs 4.3 Cell renewal and regeneration observed in organisms. Brief outline of apoptosis and necrosis 4.4 Characteristics of transformed cells, introduction to cancer cell biology and types of tumours.	
Unit 5	**5.1 Cell biology of infection** 5.1.1 Pathogen, Host-colonization mechanisms, Host-pathogen communication in infections, interaction with host surface molecules, alterations in host, exploitation of host machinery, evolution, or diversification of the pathogen. 5.1.2 Pathogen-host interaction in infectious diseases: Tuberculosis, Listeriosis, Taxoplasmosis, Influenza, HIV, COVID, etc. **5.2 Biochemistry underlying non-infectious diseases:** Diabetes and Atherosclerosis.	**10L**

Semester II
Syllabus- Core Course Practical

Course Title:	**Biochemistry Practical-II**	**Course code: SIUBCCCP121**
Credits: 01		**Hours/week: 02**

Expected Course Outcomes

On completion of this course, learner should be able to

1. Estimate the amount of ion in a given sample by titrimetric methods.
2. Isolate important phytoconstituents from natural sources.
3. Acquire basic practical skills in specimen slide preparation for microscopy. Identify different types of cells based on morphological characters and differential staining.
4. Prepare a blood smear and compare different cell types. Comprehend the principle of Romanowsky stain.
5. Determine the concentration of coloured compounds colorimetrically.
3. Demonstrate the effect of salt concentration on RBCs
4. Identify the micrographs of subcellular organelles based on their architecture.

Practical No	Title
I	Volumetric Analysis: 1. Estimation of calcium by EDTA 2. Estimation of chloride by argentometric titration
II	Isolation of Biomolecules: 3. Isolation of curcumin from turmeric 4. TLC of lipids
III	Cell Biology: 5. Staining of cells using methylene blue stain. 6. Gram staining 7. Differential staining of peripheral blood smear- identification of different cell types. 8. Blood grouping 9. Effect of hyper, hypo and isotonic solutions on RBC.
IV	Colorimetric estimation: 10. Determination of the concentration of unknown $KMnO_4$ solution.
V	Demonstration: 11. Study the parts of a microscope. 12. Identification of micrographs of sub-cellular organelles and cytoskeleton. 13. Observation of growth & differentiation in a single cell. 14. Study of model organisms: Bacteria, Yeast, Roundworm, Drosophila, Zebra fish, Chick embryo, Mice and Plants.

REFERENCES FOR SEMESTER II

1. Molecular Biology of the Cell: Alberts B., Johnson A., Lewis J., Raff M., Roberts K., Walter P.
2. Molecular Cell Biology: Lodish H., Berk A., Darnell J. E, Kaiser C.A, Krieger M., Scott M.P., Matsudaira P.
3. Kuby Immunology 7th edition Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owens.
4. Pharmacology 4th Edition H.P. Rang, M.M. Dale, J.M. Ritter
5. Biochemical Methods Edition 3 by Sadasivam and Manickam.
6. An Introduction to Practical Biochemistry, 3rd edition- David T. Plummer

Semester I and II
Syllabus- Vocational Skill Enhancement Course

Course Title: Basic tools & techniques in Biochemistry
Course code: SIUBCVS111 and SIUBCVS121
Credits: 02 **Hours/week: 01L + 02 P**

Course Outcome:

On completing the Course, the learner should be able to

1. *Understand the various units of concentration. Calculate and interconvert the units of concentration.*
2. *Skilfully carry out serial dilution of a sample.*
3. *Prepare buffers of particular pH and verify using pH paper and pH meter*
4. *Identify the components and understand the working of pH meter*
5. *Comprehend the principle and employ chromatography for separation of biomolecules*
6. *Understand the principle and working of a centrifuge. Apply the principle in separation by density gradient.*
7. *Understand the interaction of electromagnetic radiations with mater. Identify the components of a colorimeter.*
8. *Verify if a coloured solution obeys Beer Lambert law*
9. *Determine the concentration of analyte using Beer-Lambert law by calculation and graphically.*

Sr no	Title	Theory (T)/ Practical (P)
1.	Methods of expressing the concentration of a given solution (mole, molarity, normality, percent solution, ppm & ppb)	T
2.	Introduction to the concept of serial dilution.	T + P
3.	Preparation of buffers	P
4.	a. Preparation of a red cabbage/ turmeric pH indicator. b. Study the components of a pH meter. c. Determine the pH of a solution using a pH strip & a pH meter.	T + P
5.	Chromatographic separation of sugars present in fruit juice (ascending paper chromatography)	T + P
6.	a. Principle, components, and working of a centrifuge- Bench top and high-speed cold. b. Use of density gradient centrifugation.	T + P
7.	a. Introduction to basics of spectroscopy. b. Components of a colorimeter c. Verification of Beer-Lambert Law	T + P
8.	Extraction of pigments from flowers and determination of lambda max	P
9.	Phlebotomy (demonstration)	T + P

Semester I and II
Syllabus- Skill Enhancement Course

Course Title: Good laboratory practices & soft skills	
Course code: SIUBCSE111 and SIUBCSE121	
Credits: 02	**Hours/week: 01L + 02 P**

Course Outcome

On completing the Course, the learner should be able to

1. *Identify and follow good laboratory practices. Implement safety protocols.*
2. *Identify safe handling and storage procedures of chemicals.*
3. *Comprehend the working of common equipments and instruments and employ them in laboratory work.*
4. *Follow and create standard operating procedures for instruments.*
5. *Participate in group discussions. Express and communicate ideas effectively.*
6. *Apply basic MS office tools in scientific writing, data analysis and presentations.*

Sr no	Title	Theory (T)/ Practical (P)
1.	a. Reading & understanding of labels & symbols used on reagent bottles. b. Handling & storage of chemicals. c. Studying the physical & chemical changes that take place in a chemical. d. Safety protocols & hazard management. e. Introduction to MSDS	P
2.	a. Introduction to routinely used apparatus & equipment in a laboratory (Weighing balance, Desiccator, Fumehood, Buchner Funnel, UV Chamber) b. Determination of moisture content of sample.	T + P
3.	a. Sterilization & disinfection. b. Use of an autoclave & hot air oven c. Preparing SOPs	T
4.	Introduction to soft skills a. Oral communication (Group discussions, Presentation) b. Written communication (Email/Letter Writing)	T + P
5.	Introduction to MS Office a. MS Word b. MS Excel (plotting of graph) c. MS Powerpoint	T + P

REFERENCES FOR VSC & SEC

1. Microbiology, 5th edition- Michael Plczar Jr, E.C.S Chan, Noel Krieg.
2. Biophysical Techniques- Upadahyay, Upadhyay & Nath
3. Research Methodology- C.R Kothari
4. Butterfield Jeff Soft Skills for everyone.
5. Communication Skills for Engineers & Scientists- Sharma, Sangita and Binod Mishra.

General Scheme of Examination:

Credits	Course Type	Distribution of Credits	Sem end	Internal	Practical	Total
4	Core with Practical	with Practical 3T+1P	50	25	25	100
4	OE	4 or 2T+2Tut	50	50 (evaluation in Tutorial/ Practical)	---	100
2	VSC/ SEC	without sem end exam	---	50	---	50
2	IKS/ VEC/ AEC	with sem end exam	30	20	---	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

Options for 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 4^{th} 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 5^{th} 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.