College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Faculty: Science

Program: F.Y. BSc

Subject: BIOCHEMISTRY

Academic Year: 2023 – 2024

(NEP-2020 implementation)

F.Y. B.Sc.

Semester I and II

Credit Based Semester and Grading Syllabi approved by Board of Studies in Biochemistry

with effect from 2023-2024

Content

F.Y.B.Sc. Biochemistry Syllabus
(Credit Based Semester and Grading System under NEP 2020)

To be implemented from the academic year 2023-2024

Preamble

Biochemistry course is offered at the First year of B.Sc. program as an interdisciplinary subject along with either Chemistry/ Microbiology/ Botany/Zoology.

The goal of this interdisciplinary Biochemistry course is to build in the learner, the basic foundation of Biochemistry and encourage the student to pursue Biochemistry at higher level.

By the end of the course, a student should be able to:

- Understand the physical and chemical properties of biomolecules
- Co-relate the structure of biomolecules with their properties and applications
- Explain how biomolecules contribute to structural integrity of the cell
- Detail on cellular components and information pathways
- Comprehend the concepts in nutrition and importance of proper nutrition thus laying a foundation for the field of nutrition and dietetics
- Learn interpersonal and basic experimental skills in biochemistry
- Use basic computational skills in documentation and scientific data presentation
- Apply the knowledge gained for pursuing biochemistry at higher levels
- Appreciate the application of biochemistry in diverse fields of nutrition, clinical biochemistry, genomics, proteomics and bioinformatics.

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

Summary of Courses Offered by the Department

SEMESTER I

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

Semester I
F.Y. B.Sc. Biochemistry (Theory)

Hours/week: 3	**Core Theory: Foundations of Biochemistry**	**Credits: 3** **45 hours**

***Course Outcome**: On completing the course, the 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 corelate 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** 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, chondritin sulphate) Role of proteoglycans, glycoproteins and glycolipids. 3.5 Industrially important carbohydrates: Dextrose, lactulose, Starch, chitosan.	**15 L**
Unit 4	**Amino acids** 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	**5L**
Unit 5	**Lipids** 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.	**5L**

Semester I
F.Y. B.Sc. Biochemistry (Practical)

Hours/week: 2 | **Core Practical: Biochemistry Practical I** | **Credit :1 30 hours**

Course Outcome*: On completing the Course, the 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.

4. Estimate the amount of a biomolecule using titrimetric methods.

Sr No	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 and colour reactions).
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 Courses Offered by the Department

SEMESTER II

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

Semester II
FY B.Sc. Biochemistry (Theory)

Total hours: 45	**Core Theory: Cell Biology**	**Credits: 3**

***Course Outcome**: On completing the course, the 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.*
5. *To analyse host-pathogen interaction and study 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	**Cell Biology of infection** 5.1 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. 5.2 Examples of infections: Tuberculosis, Listeriosis, Taxoplasmosis, Influenza, HIV, COVID, etc. Biochemistry underlying non-infectious diseases: Diabetes and Atherosclerosis.	**10L**

Semester II
FY B.Sc. Biochemistry (Practical)

Total hours per week: 2	**Core Practical: Biochemistry Practical II** ***Course outcome:*** *On completing the course, the learner should be able to:* *1. Acquire basic practical skills in slide preparation.* *2. Identify different types of cells based on morphological characters and differential staining* *2. Prepare a blood smear and compare different cell types. Comprehend the principle of Romanowsky stain* *3. Demonstrate effect of salt concentration on RBCs* *4. Identify different stages of cell division. Understand the effect of cytotoxic drugs on cell division.* *5. Identify the micrographs of subcellular organelles based on their architecture.*	**Credits :1** **30 hours**
Sr No	**Title**	
1.	a. Study the parts of a microscope. b. Preparation of wet and dry mount slides	
2.	Identification of different types of cells using different staining techniques a. Plant and animal cells by methylene blue b. Yeast and microbial cells by crystal violet c. Gram staining d. Differential staining of peripheral blood smear – identification of different cell types. (Romanowsky stain)	
3.	Effect of hyper and hypo- tonic solution on RBCs	
4.	Identification of different stages of mitosis	
5.	Effect of cytotoxic drug on cell division- Demonstration	
6.	Observation of growth & differentiation in single cell (Pollen tube formation).	
7.	Identification of micrographs of sub-cellular organelles and cytoskeleton	
8.	Study of model organisms	

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

F.Y. B.Sc. Biochemistry

VSC – Basic tools & techniques in Biochemistry

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.

Sr no	Title	Theory (T)/ Practical (P)	Credits (1+1)
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.	T + P	
6.	Extraction of pigments from flowers and its separation.	P	
7.	a. Principle, components, and working of a centrifuge- Bench top and high-speed cold. b. Use of density gradient centrifugation.	T + P	
8.	a. Introduction to basics of spectroscopy. b. Components of a colorimeter c. Verification of Beer-Lambert Law	T + P	
9.	Phlebotomy	T + P (demonstration)	

F.Y. B.Sc. Biochemistry

SEC- Good laboratory practices & soft skills

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 equipment 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)	Credits (1+1)
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.

Evaluation Pattern for Examination:

For each course, 33 to 50% continuous internal evaluation and remaining at the end of each semester.