SYLLABUS

BIOCHEMISTRY

UNDER CURRICULUM AND CREDIT FRAMEWORK

KAZI NAZRUL UNIVERSITY ASANSOL, WEST BENGAL

With effect from 2023-2024 Academic Session

Syllabus of Biochemistry

Semester- I

Major Paper

Course Name: Molecules of Life

Course Code: BSCBCMMJ101

Course Type: MAJOR(MJC)	Course Details: **MJC-1**		L-T-P: **3-0-4**	
Credit: 5	Full Marks: 100..	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

MOLECULES OF LIFE (THEORY)

CREDIT: 3 (Marks 50)

Course Learning Outcomes:

- Exposure with the nature of various biomolecules present in living cells.
- Get exposed to key contributions of scientists such as Hans Kreb, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, HarGobind Khorana, Watson and Crick and Venky Ramakrishnan, etc. in order to create scientific interest amongst students in life processes.
- To understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems.
- To understand the process of fermentation and manufacture of Biodiesel.
- To develop skills to determine amino acid and nucleotide sequences of proteins and DNA respectively.

Students will be exposed to the history of Biochemistry and key contributions of scientists such as Hans Kreb, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, HarGobind Khorana, Watson and Crick and Venky Ramakrishnan. They will study the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems. They will understand the process of fermentation and manufacture of Biodiesel. They will understand the methods of determination of amino acid and nucleotide sequence of proteins and DNA respectively.

Course Content:

The foundations of biochemistry

Cellular and chemical foundations of life

Water

Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

Carbohydrates and glycobiology

Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates

Lipids

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments

Amino acids

Structure and classification, physical, chemical and optical properties of amino acids

Nucleic acids

Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Vitamins

Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis

MOLECULES OF LIFE (PRACTICALS)

CREDIT: 2 (Marks 50)

Course Learning Outcomes:

- Exposure to basic reactions of biomolecules.
- Determine presence of biomolecules like carbohydrates, proteins, lipids, etc. in known and unknown samples.
- Determine the extent of adulteration in samples containing biomolecules.

The student will gain awareness about basic reactions of biomolecules and their utility in identification of adulterants.

Course Content:

1. Safety measures in laboratories.
2. Preparation of buffers.
3. Determination of pKa of acetic acid and glycine (pH metric titration).
4. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
5. Separation of amino acids/ sugars/ bases by thin layer chromatography.
6. Estimation of vitamin C (Iodimetric method).

References/ Suggested Readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 /ISBN:10:1-4292-3414-8
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

Semester- II

Major Paper

Course Name: Cell Biology

Course Code: BSCBCMMJ201

Course Type: MAJOR(MJC)	Course Details: **MJC-2**			L-T-P: **3-0-4**	
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

CELL BIOLOGY (THEORY)

CREDIT: 3 (Marks 50)

Course Learning Outcomes:

- Understanding of the structure of cell and various cellular events.
- Understanding of the function of various subcellular organelles.
- Students will learn about cell theory and techniques for fractionation of sub-cellular organelles.
- They will be acquainted to various microscopic techniques to visualize subcellular organelles.
- Students will have an understanding of the composition of cytoskeleton and extracellular matrix.
- Students will acquire knowledge of cell cycle, cell division and cell death mechanisms.

This course will provide an understanding of the structure of cell and function of various subcellular organelles. Students will learn about cell theory, basic cell structure, cell fractionation and cell visualization techniques. Besides, students will have an understanding of the composition of cytoskeleton and extracellular matrix. Students will acquire knowledge of cell cycle, cell division and cell death mechanisms.

Course Content:

Introduction to cell biology

Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models.

Tools of cell biology

Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for subcellular fractionation.

Structure of different cell organelles

Structure of nuclear envelope, nuclear pore complex. ER structure. Organization of Golgi. Lysosome. Structure and functions of mitochondria, chloroplasts and peroxisomes.

Zellweger syndrome.

Protein trafficking

Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins.

Cytoskeletal proteins

Structure and organization of actin filaments. Treadmilling and role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly and intracellular organization. Assembly, organization and movement of cilia and flagella.

Cell wall and extracellular matrix

Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cellcell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata.

Cell cycle, cell death and cell renewal

Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Salient features of a transformed cell.

CELL BIOLOGY (PRACTICAL)

CREDITS: 2 (Marks 50)

Course Learning Outcomes:

- Students will learn the handling of microscope.
- Obtain hands-on training in basic separation techniques in biochemistry
- Gain expertise in the isolation of various cell organelles and staining of cellular biomolecules.

Students will learn thehandling of microscope. They will gain knowledge about the structure and function of various cell organelles. The students will obtain hands-on training in basic separation techniques in biochemistryand gain expertise in the isolation of various cell organelles and staining of cellular biomolecules.

Course Content:

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Identification of different stages of meiosis in grasshopper testis / onion flower bud.
4. Visualization of nuclear fraction by acetocarmine stain.

References/ Suggested Readings:

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.

2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10: 1-4641-0981-8.

3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M.,Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

Semester- I

Minor Paper

Course Name: Molecules of Life

Course Code: BSCBCMMN101

Course Type: MINOR(MNC)	Course Details: **MNC-1**		L-T-P: **3-0-4**	
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

MOLECULES OF LIFE (THEORY)

CREDIT: 3 (Marks 50)

Course Learning Outcomes:

- Exposure with the nature of various biomolecules present in living cells.
- Get exposed to key contributions of scientists such as Hans Kreb, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, HarGobind Khorana, Watson and Crick and Venky Ramakrishnan, etc. in order to create scientific interest amongst students in life processes.
- To understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems.
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Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

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Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates

Lipids

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments

Amino acids

Structure and classification, physical, chemical and optical properties of amino acids

Nucleic acids

Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Vitamins

Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis

MOLECULES OF LIFE (PRACTICALS)

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Course Learning Outcomes:

- Exposure to basic reactions of biomolecules.
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1. Safety measures in laboratories.
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Semester- II

Minor Paper

Course Name: Cell Biology

Course Code: BSCBCMMN201

Course Type: MINOR(MNC)	Course Details: **MNC-2**		L-T-P: **3-0-4**	
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

CELL BIOLOGY (THEORY)

CREDIT: 3 (Marks 50)

Course Learning Outcomes:

- Understanding of the structure of cell and various cellular events.
- Understanding of the function of various subcellular organelles.

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Zellweger syndrome.

Protein trafficking

Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins.

Cytoskeletal proteins

Structure and organization of actin filaments. Treadmilling and role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly and intracellular organization. Assembly, organization and movement of cilia and flagella.

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CELL BIOLOGY (PRACTICAL)

CREDITS: 2 (Marks 50)

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3. Identification of different stages of meiosis in grasshopper testis / onion flower bud.
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Semester- I

SEC

Course Name: TOOLS AND TECHNIQUES IN BIOCHEMISTRY

Course Code: BSCBCMSE101

<table>
<tr><td>Course Type: SEC</td><td colspan="2">Course Details:SEC-1</td><td>L-T-P: 0-0-6</td></tr>
<tr><td rowspan="3">Credit: 2</td><td rowspan="3">Full Marks: 50</td><td>CA Marks</td><td>ESE Marks</td></tr>
<tr><td>Practical</td><td>Practical</td></tr>
<tr><td>30</td><td>20</td></tr>
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TOOLS AND TECHNIQUES IN BIOCHEMISTRY

(PRACTICALS) CREDIT: 2 (Marks 50)

Course Learning Outcomes:

1. Understanding Good laboratory practices in a chemistry/biochemistrylaboratory.
2. Learn safety and precautionary measures for working in alaboratory.
3. Develop skill and proficiency in preparation of laboratoryreagents.
4. Use of handling of glass wares, minor equipment for conductingexperiments.
5. Develop skills to prepare standard chemical solutions and secondarystandards.
6. Demonstration of basic oxidation and reductionreactions.

Content/ Syllabus: Unit wise course content distribution:

Unit 1 Biochemical reagents and solutions

Safety practices in the laboratory. Preparation and storage of solutions. Concepts of solution concentration and storing solutions. Quantitative transfer of liquids. Concept of a buffer, Henderson-Hassel Bach equation, working of a pH meter.

Exercise

Preparation of a buffer of given pH and molarity.

Unit 2 Spectrophotometric techniques

Principle and instrumentation of UV-visible and fluorescence spectroscopy.

Exercises

Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule).
Measurement of fluorescence spectrum.
Determination of concentration of a protein solution by Lowry/BCA method.

Unit 3 Introduction and importance of virtual labs in biochemistry.

References/ Suggested Readings:

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.

2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D.,W.H. Freeman and Company (New York), ISBN:0-7167-1315-2/ISBN:0-7167-1444- 2.
3.An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10:0-07-099487-0.

Semester- II

SEC

Course Name: PROTEIN PURIFICATION TECHNIQUES

Course Code: BSCBCMSE201

Course Type: SEC	Course Details: SEC-2		L-T-P: 0-0-6
Credit: 2	Full Marks: 50	CA Marks	ESE Marks
		Practical	Practical
		30	20

Course Learning Outcomes:

On successful completion of this course, students will be able to:

1. Demonstrate sound knowledge of current protein purification techniques used in biomedical research and the biotechnology industry
2. Demonstratepracticallaboratoryskillsinchromatographyandproteinpurification.
3. Documentlaboratoryproceduresanddataeffectivelyinanelectronicnotebook.
4. Interpretandcriticallyanalyzeexperimentaldatarelatingtoproteinpurification.
5. Effectively communicate results and conclusions to a broadaudience.

Content/ Syllabus: Unit wise course content distribution:

Unit 1 Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques

Exercises

Preparation of the sample.
Ion-exchange chromatography.
Gel filtration chromatography.
Affinity chromatography.
Electrophoresis.

Unit 2 Demonstration of High Performance Liquid Chromatography (HPLC)

References/ Suggested Readings:

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D.,Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 /ISBN:978-0-470-85603-1.
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3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07- 099487-0.