**A.C.-03.08.2022**
**Appendix-91**

# UNIVERSITY OF DELHI

## DEPARTMENT : BIOCHEMISTRY

## COURSE NAME: BSc. Hons.

## (SEMESTER -I)

Based on
Undergraduate Curriculum Framework 2022 (UGCF)
(Effective from Academic Year 2022-23)

**DSC & GE**

| Course Title | Nature of the Course | Total Credits | Components | | | Eligibility Criteria/ Prerequisite | **Contents of the course and reference is in** |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| Biomolecules | DSC (Core) | 4 | 2 | 0 | 2 | | Annexure-I |
| Proteins | DSC (Core) | 4 | 2 | 0 | 2 | | |
| Biochemical Techniques | DSC (Core) | 4 | 2 | 0 | 2 | | |
| Molecules of Life | GE | 4 | 2 | 0 | 2 | Class XII Science | Annexure-II |
| Techniques in Biochemistry | GE | 4 | 2 | 0 | 2 | Class XII Science | |
| Public Health Biology | GE | 4 | 2 | 0 | 2 | Open to all | |

**B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)**
**BCH-DSC-101 : BIOMOLECULES**
**SEMESTER - 1**

## 1. Course Objectives

This paper will provide an understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties of molecules, biological roles and functions for students. Emphasis will be on the association between structure and function of various biomolecules at a chemical level with a biological perspective and hands-on approach and laboratory techniques.

## 2.1 Course Learning Outcomes

On successful completion of the course students will be:

- Able to comprehend the structure, function and acid-base properties of amino acids.
- Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
- Aware of the importance of vitamins in biological systems.
- Able to independently identify various biomolecules in the laboratory by qualitative test methods.
- Acquainted with chemical and molecular foundations of life and appreciate the role of buffer in biological systems.

## 2.2 Course Content

**THEORY**

**CREDITS: 2** **TOTAL HOURS: 30**

### UNIT I: Amino Acids — No. of hours: 7

Amino acids as bifunctional molecules and their biological significance; Classification of amino acids (Standard, Semi-standard, Non-standard; Proteinogenic, Non-proteinogenic; Essential, Non-essential; Polar, Non-polar). Physical properties (variations in structures, sizes, polarity, charges; resonance hybrid), optical properties (stereoisomerism; chirality; R- and S-; D- and L-; light absorption); and chemical properties (protonation/deprotonation; zwitterions; acid base properties, titration curve, pH and pKa, pI; reactivity of side chains) of amino acids, Amino acids as constituents of proteins, peptide bond. Uncommon amino acids and their functions.

### UNIT II: Carbohydrates — No. of hours: 8

Introduction, classification and importance of carbohydrates. Monosaccharides - the structure of aldoses and ketoses; Optical properties of sugars: conformations of sugars, mutarotation, anomers, epimers and enantiomers; Chemical properties (Oxidation and reduction of sugars); reducing and non-reducing sugars; Glycosidic linkages (O- and N-type), formation of disaccharides (sucrose, maltose, lactose, trehalose), tri- and oligosaccharides (raffinose,

rhamnose, and stachyose ) Polysaccharides: homo- and heteropolysaccharides, structural (cellulose and chitin) and storage polysaccharides (starch and glycogen); Role of glycoconjugates with examples - proteoglycans, glycoproteins and glycolipids; Carbohydrates as recognition molecules.

**UNIT III: Lipids** **No. of hours: 7**

Introduction, importance, and classification of lipids (simple, complex and derived lipid); Structure, properties, and classification of fatty acids (based on chain length and degree of unsaturation); Storage lipids- triacylglycerol and waxes. Structural lipids in membranes– glycerolipids, glycerophospholipids, galactolipids, ether-lipids, sphingolipids, and sterols; Importance of eicosanoids. Role of lipids as storage, signals, hormones, pigments, and in membranes.

**UNIT IV: Nucleic Acids** **No. of hours: 5**

Structure and properties of bases (purines and pyrimidines). Formation of nucleosides and nucleotides (phosphodiester and glycosidic bond); Nucleic acid structure: Watson-Crick model of DNA double helix, comparison of different forms of DNA (A, B and Z DNA); Structure and functions of major species of RNA (mRNA, tRNA and rRNA). Nucleic acid chemistry - UV absorption, the effect of acid and alkali on DNA; Biologically important nucleotides (source of energy, a component of coenzymes and second messengers)

**Unit V: Vitamins** **No. of hours: 3**

Active forms and major functions of water-soluble and fat-soluble vitamins; Major dietary sources, deficiency diseases, symptoms, and hypervitaminosis.

## 2.3 PRACTICALS

**CREDITS: 2** **TOTAL HOURS: 60**

1. Laboratory safety and standards (precision, accuracy and sensitivity). Preparation of solutions (w/w, w/v, Molar, Normal)
2. Concept of buffer, buffering capacity and Henderson-Hasselbalch equation. Preparation of acetate buffer/phosphate buffer
3. Titration graph of acetic acid and Glycine.
4. Qualitative analysis of Amino acids (Ninhydrin, Xanthoproteic, Millon's, and lead acetate test)
5. Qualitative test for Carbohydrates: monosaccharides, disaccharides, and polysaccharides (Molisch, Fehling/ Benedict, Barfoed, Seliwanoff's, Osazone and Iodine test)
6. To determine the Iodine Number of oil/fat.
7. Qualitative test for Nucleic acid (Orcinol and DPA).

## 2.4 Essential reading:

- Nelson, D.L. and Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7th ed.). W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
- Berg, J. M., Tymoczko J. L. and Stryer L. (2011) 7th Edition. Biochemistry. New York, USA: W. H. Freeman and Co. ISBN-13: 978142927635.
- 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.


**Suggested Reading:**


- Devlin, T.M., (2011). *Textbook of Biochemistry with Clinical Correlations.* 7th edition John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
- Campbell, M.K. and Farrel, S.O. (2017). 9th Edition. Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN-13: 978-1305961135


## 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes****

| Unit No. | Course Learning Outcomes | Teaching and Learning Activity | Assessment Tasks |
|---|---|---|---|
| I | Ability to comprehend the structure, function, optical and acid-base properties of amino acids. | Classroom teaching of structures and properties of amino acids and laboratory experiments on the identification of functional groups. | Quiz on amino acid properties and structure. Students will be shown three-dimensional structures of amino acids in power points, which they will identify and relate to properties |
| II | Introduction to the structure, properties, stereoisomerism and roles of carbohydrates. | Traditional chalk and board teaching; learning properties of carbohydrates through laboratory by qualitative tests. | Test on structure and functions of carbohydrates |
| III | Appreciation of the varied roles of lipids such as distribution in different biological membranes, storage lipids, and signaling lipids. | Traditional teaching of structures of lipids and video presentation of membrane lipids: learning structure and function of lipids and membranes through discussion and PowerPoint presentations. Learning properties of lipids through laboratory-based examination. | Test and MCQ on lipids |

| | | | |
|---|---|---|---|
| IV | Understanding nucleic acid chemistry, physical properties and structure. | Chalk and board teaching and presentation on the double-helix model of the nucleic acid structure. Qualitative identification of nucleic acid through laboratory-based experiments | Test and quiz on nucleic acids. Discussion on the history of discovery of double- helix of DNA |
| V | Understanding of the biochemical importance of vitamins and their active forms | Classroom teaching of nutritional roles of vitamins and their active forms. Nutritional importance can be studied by their associated deficiency symptoms and diseases | Quiz on vitamins, their active forms and deficiency diseases. Revision of the entire course |

**(**Assessment tasks enlisted here are indicative in nature)**

## 4. Keywords

Carbohydrates; Lipids; Nucleic acids; Amino acids; Vitamins.

**B.Sc. (HONOURS) BIOCHEMISTRY (NEP FRAMEWORK)**
**BCH-DSC-102 : PROTEINS**
**Semester – I**

## 1. Course Objectives

The course aims to introduce "proteins" and their importance to modern biochemistry, highlighting their structural features and unique characteristics that help them participate in every physiological process in life, thus also playing an important role in disease manifestation and their interventions.

## 2.1 Course Learning Outcomes

After completion of the course, a student will

- Understand the diverse functions of proteins in a cell
- Understand the hierarchy of protein architecture – primary, secondary, tertiary & quaternary structure, with the ability to distinguish features of globular & fibrous proteins
- Be able to comprehend the fundamental mechanisms of protein folding and stability and their relation to conformational diseases
- Understand specialized proteins like structural proteins
- Gain comprehension of structure-function relationship of proteins and their significance in physiology, diseases and applications in industry and medicine.

## 2.2 Course Contents

**THEORY**

**CREDITS: 2** **TOTAL HOURS: 30**

**UNIT I: Introduction to proteins** **No. of hours: 2**

Introduction to peptides and proteins. Structural and functional diversity. Classification of proteins – simple and conjugated proteins; monomeric and multimeric proteins.

**UNIT II: Hierarchy of protein structure organization** **No. of hours: 12**

Organization of protein structure into primary, secondary, tertiary and quaternary structures. Forces stabilizing the protein structure - covalent (disulfide bridges) and non-covalent (electrostatic interactions and salt bridges, hydrophobic, hydrogen bonding, van der Waals). The peptide bond, dihedral angles psi and phi, helices, sheets, turns and loops, Ramachandran map. Motifs and domains. Structural proteins - α-keratin, silk fibroin, collagen. Globular and fibrous proteins, membrane proteins.

**UNIT-III: Protein sequencing and Databases** **No. of hours: 5**

Sequencing techniques - N-terminal and C-terminal amino acid analysis, Edman degradation. Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Solid phase peptide synthesis. Protein databases – sequence and structure based.

**UNIT IV: Protein folding and conformational diseases** **No. of hours: 5**

Denaturation and renaturation of Ribonuclease A – discovery of protein folding. Introduction to thermodynamics of protein folding. Assisted folding by molecular chaperones, chaperonins and PDI. Diseases associated with protein misfolding – Alzheimer's and Creutzfeldt-Jakob disease.

**UNIT V: Specialized proteins** **No. of hours: 6**

Transport protein: myoglobin and haemoglobin - Oxygen binding curves, influence of 2,3-BPG, CO2 and $H^+$; Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders – Sickle cell anemia.

**PRACTICALS**

**CREDITS: 2** **TOTAL HOURS: 60**

1. Scanning of proteins using UV-visible absorbance method
2. Solvent perturbation and denaturation studies of a protein
3. Estimation of proteins using Biuret method.
4. Estimation of proteins using Lowry/Bradford method.
5. Determination of isoelectric point of protein
6. Understanding protein sequence databases and homology modeling of proteins
7. Molecular Visualization Softwares: Pymol and Rasmol for protein structures from PDB

## 2.3 Essential Readings


1. Nelson, D.L., Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7th ed.). New York, WH: Freeman and Company. ISBN13: 9781464126116, ISBN10: 1464126119
2. Schulz, G.E., Schirmer, R.H. (1979). *Principles of protein structure*. Springer, ISBN 978-1-4612- 6137-7
3. Scopes, R.K. (1994) *Protein Purification. Principles and Practice* (3rd ed). Springer, ISBN 978-1-4737-2333-5
4. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). *Biochemistry* (9th ed.). New York, WH:Freeman ISBN-13: 9781319114671
5. Voet. D., Voet. J.G. (2013) Bi*ochemistry* (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN : 978-1-11809244-6.


**Suggested Readings**

1. Whitford, D. (2004). *Protein Structure and function.* Southern Gate, Chichester, West Sussex: John Wiley & Sons, Inc. ISBN-13: 978-047149894 ISBN-10: 0471498947.

## 2. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes****

| Unit No. | Course Learning Outcomes | Teaching and Learning Activities | Assessment Tasks |
|---|---|---|---|
| I | Appreciation of the significance of proteins in life; Understanding of the classification and diversity of functions of proteins; Knowledge of hierarchy of protein structures and various aspects of structures; Students will learn about protein databases and tools available in public domain. | Outlining history of development of proteins through power point presentations and landmark publications; Classification and diversity will be taught by chalk and board method; Traditional chalk and board method will be employed along with powerpoint presentations on 3D structures, Ramachandran Map and hierarchy of protein structures; Videos will be shown | Students will download 3D structures from PDB and visualize several aspects of structures using softwares; Assignments and quiz on databases and tools used in protein sequence and structure analysis; Students will be assigned the task of identifying new databases and tools by browsing papers and internet. |
| II | Sequencing methods to study primary structure of proteins | Traditional chalk and board method will be employed along with powerpoint presentations | Numerical problems on Sequencing will be assigned; |
| III | Basic concepts as to how proteins fold and what challenges they face during folding; Knowledge about chaperones that help in protein folding and diseases caused due to protein misfolding | Appropriate mix of chalk and board teaching as well as use of Power point presentations for clarity of concepts with images; Research papers will be discussed | Class presentations and case studies will help students understand misfolding diseases; They will be asked to match a few proteins with the diseases they cause due to misfolding. Each student will review a paper on the biotechnological importance of refolding of proteins in vitro |
| IV | Concepts of subunits with reference to hemoglobin and myoglobin structure; Students will learn about the structural | Traditional chalk and board method will be employed along with powerpoint presentations | Images of proteins to identify globular and fibrous proteins will be provided. |

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|---|---|---|---|
| | features and functional differences | | |

**(**Assessment tasks enlisted here are indicative in nature)**

## 4. Keywords

Peptides; Globular and Fibrous proteins; Protein structure; Denaturation and Renaturation; Protein Folding & Diseases; Protein Databases

# B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
# BCH-DSC-103: BIOCHEMICAL TECHNIQUES
# Semester – I

## 1. Course Objectives

The objective of the course is to introduce various techniques to students that are used in a biochemistry lab. It will provide them an understanding of the principles underlying various techniques. They will develop skills in the form of practical exercises and gain knowledge, which can be applied to pursue research and will be helpful in getting a suitable placement.

## 2.1 Learning Course Outcomes

- Acquire knowledge about the principles and applications of spectrophotometric and chromatographic techniques used in a biochemistry lab.
- Learn about the principle and applications of electrophoresis and centrifugation techniques.
- Will be able to identify biochemical techniques for separation and purification of biomolecules.
- Students will obtain hands-on experience to develop their experimental skills expected from any biochemistry student working in a research lab.

## 2.2 Course Contents

**THEORY**

**Credit: 2** **TOTAL HOURS: 30 hours**

**Unit I:Spectroscopic Technique** **No. of hours: 7**

Introduction to electromagnetic radiation. Principle of UV-visible absorption spectrophotometry. Working, instrumentation and applications of spectrophotometer, Lambert's law, Beer's law. Factors affecting UV-vis absorption, bathochromic shift and hypsochromic shift. Fluorescence

spectrophotometry: Phenomena of fluorescence, stoke's shift, quantum yield, intrinsic and extrinsic fluors with example, working and applications of fluorimeter.

**Unit II:Centrifugation** **No. of hours: 6**

Principle of centrifugation, basics of sedimentation, svedberg unit, correlation of 'rpm' with 'g' value, factors affecting sedimentation (density, viscosity, size and shape). Types of rotors (fixed angle, vertical and swinging bucket rotors) and relevant applications. Differential centrifugation and density gradient centrifugation - zonal and isopycnic.

**Unit III:Chromatography** **No. of hours: 9**

Introduction to chromatography, Principle and applications of partition chromatography: Paper and thin layer chromatography. Concept of mobile phase, stationary phase, partition coefficient, retention factor, factors affecting separation. Types of partition chromatography: Ascending and descending chromatography. Methods of detecting separated samples.

Principle and applications of ion exchange, molecular sieve and affinity chromatography. Concept of distribution coefficient, types of matrix, mesh size, water regain value, packing of the column, void volume, elution volume, theoretical plates, exclusion limit and resolution. Factors affecting binding, elution and resolution. Methods of detecting eluted samples.

**Unit IV:Electrophoresis** **No. of hours: 8**

Principle of electrophoresis. Factors affecting the mobility of molecules: Buffer, electrical field strength and charge. Types of electrophoresis: Polyacrylamide gel (native), SDS PAGE, isoelectric focusing and agarose gel electrophoresis. Continuous and discontinuous buffer systems in electrophoresis. Staining, detection, identification and molecular weight determination of molecules.

## 2.3 PRACTICALS

**Credits: 2** **Total hours: 60**

1. Determination of absorption maxima ($\lambda_{max}$).
2. Verification of Beer's Law and calculation of molar extinction coefficient.
3. Preparation of cell free extract from a biological sample.
4. Separation and identification of amino acid acids by thin layer chromatography.
5. Separation of molecules by Ion-exchange chromatography.
6. Separation of molecules by gel filtration chromatography.
7. To perform PAGE (native) / SDS-PAGE.

## 2.4 Essential Readings

1. Wilson, K. & Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology, ($7^{th}$ ed.), Cambridge University Press; ISBN 978-0-521-51635-8.

2. Boyer, R. F. (2012) Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027.
3. Sheehan, D. (2010). *Physical biochemistry: Principles and applications* (2nd ed.). Chichester: Wiley-Blackwell.
4. Plummer, D.T. (1998). An Introduction to Practical Biochemistry (3rd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

**Suggested Readings**

1. Cooper, T.G. (2011). The Tools of Biochemistry (2nd ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168.
2. Freifelder, D. (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (2nd ed.), W.H. Freeman and Company (New York); ISBN:0-7167- 1315-2 / ISBN:0-7167-1444-2.

## 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes****

| Unit No. | Course Learning Outcomes | Teaching and Learning Activity | Assessment Tasks |
|---|---|---|---|
| 1. | Students will learn about the principle and applications of spectrophotometry and fluorescence spectrophotometer. | Teaching using chalk and board.<br>Oral discussion sessions in the class and use of Power point presentations. | Problems will be assigned related to Beer's Law and Lambert's Law to test the understanding of students.<br>Internal assessment tests will be conducted. |
| 2. | Students will be introduced to centrifugation, sedimentation coefficient, various types of centrifuges and rotors. | Demonstration of various centrifuges and their working will be explained.<br><br>Teaching will be conducted using black board and Power point presentation mode. | Various analytical problems will be assigned to students related to centrifugation to improve their understanding. |
| 3. | Understand the principle and applications of various chromatographic techniques like Thin layer, gel filtration, ion | Teaching will be conducted using black board and Power point | Practical exercises will be designed whereby the students get hands-on experience with these |

| | | | |
|---|---|---|---|
| | exchange and affinity chromatography. | presentation mode.<br><br>Group discussions and quizzes will be conducted in the class. | chromatography techniques.<br>Internal assessment tests will be conducted. |
| 4. | Students will learn about electrophoretic techniques, their principle and applications in analysing proteins and nucleic acids. | Teaching will be conducted using black board and Power point presentation mode.<br>Oral discussion sessions in the class. | Various analytical problems will be assigned to students related to electrophoretic separation.<br>Internal assessment tests will be conducted. |

**(**Assessment tasks enlisted here are indicative in nature)**

## 4. Keywords

Spectrophotometry, Centrifugation, Chromatography, Electrophoresis, Proteins, Nucleic Acids and Isoelectric focusing.

# B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
# BCH GE-1: MOLECULES OF LIFE

## 1. Course Objectives

The objective of the course is to provide students with an understanding of biomolecules, the basic building blocks that are vital for various life forms. The course emphasizes on studying the importance of water as a biological solvent, different types of molecules of life, focusing on their key properties, biological roles and functions. The course also aims to outline chemical and physical aspects of biomolecules by hands on approach through laboratory experiments.

## 2.1 Course Learning Outcomes

- The course will provide an understanding of how the structures of biomolecules determine their chemical properties and functions.
- Students will develop understanding of biochemistry at atomic level and appreciate the biological importance of molecules of life.
- Students will gain insight into basic structures, classification, and biological importance of amino acids, carbohydrates, lipids and nucleic acid.

## 2.2. Course Contents

**THEORY**

**CREDITS: 2** **TOTAL HOURS: 30**

**UNIT I: Water and Concept of Buffer** **No. of Hours: 2**

Chemistry of water and biological importance of water, Henderson-Hasselbalch equation, concept of buffer and buffering capacity.

**UNIT II: Structure and functions of Amino Acids** **No. of Hours: 6**

Introduction and classification of amino acids, peptide bond, zwitterions, L and D form of amino acids, standard and non-standard amino acids and their biological importance.

**UNIT III: Biochemistry of Carbohydrates** **No. of Hours: 7**

Introduction, and classification of carbohydrates. Monosaccharides, disaccharides, polysaccharides (glycogen, starch, cellulose and chitin). D-and L- isomerism, epimers, and anomers. Carbohydrates as fuel and structural molecules, antigens and cell recognition unit.

**UNIT IV: Lipids in Biological system** **No. of Hours: 7**

Introduction and classification of lipids. Fatty acids (PUFA, MUFA) triacylglycerol, phospholipids, sphingolipids, glycolipids, and cholesterol. Role of lipids as storage fuel, hormones, vitamins, in signaling and in membranes.

**UNIT V: Structure and Organization of Nucleic acids** **No. of Hours: 8**

Introduction, purine and pyrimidine bases, nucleosides, nucleotides, and nucleic acid. Structure and functions of DNA (B form), organization of DNA into chromatin; RNA structure and functions. Biologically important nucleotides (cAMP and ATP).

## 2.3 PRACTICALS

**CREDITS: 2** **TOTAL HOURS: 60**

1. Laboratory safety and preparation of solutions (molar, normal and %).
2. Concept of pH and working of pH meter
3. Preparation of acetate buffer and phosphate buffer.
4. Properties and analysis of amino acids (Ninhydrin, and Xanthoproteic)
5. Test for carbohydrates (Molisch, Fehling/ Benedict, Seliwanoff's)
6. Qualitative analysis of nucleic acids (Orcinol and Diphenyl amine)

## 2.4 Essential readings:


- Nelson, D.L. and Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7th ed.). W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
- Plummer D.T. (1998). *An Introduction to Practical Biochemistry* (3rd ed)., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.
- Pratt, C.W. and Cornely, K. (2017). *Essential Biochemistry* (4th ed.) John Wiley& Sons, Inc.ISBN:9781119012375


**Suggested Readings**


- Berg, J.M., Tymoczko J.L. and Stryer L. (2011). 7th Edition. Biochemistry. New York, USA: W. H. Freeman and Co. ISBN-13: 978142927635.
- Campbell, M.K. and Farrel, S.O. (2017). 9th Edition. Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN-13: 978-1305961135.


## 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes****

| Unit No. | Course Learning Outcomes | Teaching and Learning Activity | Assessment Tasks |
|---|---|---|---|
| I | Appreciation of the role of water in biological system. | Traditional chalk and board teaching and hands-on experiments with buffers | Unit assessment by multiple choice questions (MCQ) |

| | | | |
|---|---|---|---|
| II | Ability to comprehend the structure, function, optical and acid base properties of amino acids. | Classroom teaching of structures and properties of amino acids and laboratory experiments on titration curves and identification of functional groups. | Quiz on amino acid properties and structure. Students will be shown three-dimensional structures of amino acids in power points, which they will identify and relate to properties |
| III | Introduction to the structure, properties, stereoisomerism and roles of carbohydrates. | Traditional chalk and board teaching; learning properties of carbohydrates through laboratory-based identification | Test on structure and functions of carbohydrates |
| IV | Appreciation of the varied roles of lipids such as distribution in different biological membranes, storage lipids, and signaling lipids. | Traditional teaching of structures of lipids and video presentation of membrane lipids: learning structure and function of lipids and membranes through discussion and powerpoint presentations. learning properties of lipids through laboratory-based examination. | Test and MCQ on lipids |
| V | Understanding nucleic acid chemistry, physical properties and structure. | Chalk and board teaching and presentation on double helix model of nucleic acid structure. Qualitative identification of nucleic acid through laboratory-based experiments | Test and quiz on nucleic acids. Discussion on the history of discovery of double helix of DNA |

**(**Assessment tasks enlisted here are indicative in nature)**

## 4. Keywords

Water; Carbohydrates; Lipids; Nucleic acids; Amino acids

# B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
# BCH-GE-2: TECHNIQUES IN BIOCHEMISTRY

## 1. Course Objectives

The objective of the course is to introduce different biophysical techniques to students that are used in biological research for separation, purification and identification from mixture of biomolecules. The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better utilization of these techniques in research and will also help in their placement.

## 2.1 Course Learning Outcomes

- Students will acquire knowledge about the principles and applications of separation and purification techniques like centrifugation and chromatography used in a biochemistry laboratory.
- Students will learn about the principles and applications of electrophoresis and spectroscopic techniques involved in estimation and identification of biomolecules.
- It will also give them an opportunity to get hands-on experience to develop their experimental skills which are required for biological research lab.

## 2.2 Course Contents

**THEORY**

**Credit: 2** **Total Hours : 30 hours**

**Unit I: Separation techniques** **No. of Hours: 8**

Preparation of sample, different methods of cell lysis, salting out, dialysis. Principle and the factors affecting centrifugation Svedberg coefficient, types of rotors, principle and applications of differential and density gradient centrifugation.

**Unit II: Purification techniques** **No. of Hours: 8**

Classification of chromatographic techniques, principle and applications: Paper, thin layer, molecular sieve, ion exchange, and affinity chromatography.

**Unit III:Electrophoretic techniques** **No. of Hours: 7**

Principle of electrophoresis, various types of electrophoresis: Polyacrylamide gel (native), SDS PAGE and agarose gel, staining procedures for protein and nucleic acids.

**Unit IV: Spectroscopic techniques** **No. of Hours: 7**

Introduction to electromagnetic spectrum, Principle and working of UV-visible absorption spectrophotometer, single & double beam spectrophotometer, Beer's & Lambert's law, application of UV-visible spectrophotometer in biology.

## 2.3 PRACTICALS

**Credits: 2** **Total Hours: 60**

1. Preparation of cell free extract from *E.coli* culture.
2. Separation and identification of amino acid acids by thin layer chromatography.
3. Separation of molecules by gel filtration chromatography.
4. Determination of absorption maxima ($\lambda_{max}$).
5. Calculate molar extinction coefficient of the given sample.
6. Demonstration of PAGE and Agarose gel electrophoresis.

## 2.4 Essential Readings


- Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8.
- Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027.
- Plummer, D. T. (1998). An Introduction to Practical Biochemistry (3rd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.


**Suggested Readings**


- Cooper, T.G. (2011). The Tools of Biochemistry (2nd ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168.
- Freifelder, D. (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (2nd ed.), W.H. Freeman and Company (New York); ISBN:0-7167- 1315-2 / ISBN:0-7167-1444-2.


## 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes****

| Unit No. | Course Learning Outcomes | Teaching and Learning Activity | Assessment Tasks |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1. | Students will learn about centrifugation, various types of rotors and different applications of centrifugation. | Demonstration of various centrifuges and their working will be explained. Teaching will be conducted using black board and power-point presentation mode. | Various analytical problems will be assigned to students related to centrifugation to improve their understanding. |
| 2. | Students will learn the principle and applications of various chromatographic techniques like paper, thin layer, gel filtration, ion exchange and affinity chromatography. | Teaching will be conducted using black board and power-point presentation mode.<br><br>Group discussions and quizzes will be conducted in the class. | Practical exercises will be designed whereby the students get hands-on experience with these chromatography techniques.<br>Internal assessment tests will be conducted. |
| 3. | Students will learn about electrophoresis, its principle and applications in analysing proteins and nucleic acids. | Teaching will be conducted using black board and power-point presentation mode.<br>Oral discussion sessions in the class. | Various analytical problems will be assigned to students related to electrophoretic separation. |
| 4. | Students will learn about the principle and applications of UV-visible spectroscopy. | Teaching using chalk and board.<br>Oral discussion sessions in the class and use of power-point presentations. | Problems will be assigned related to Beer's and Lambert's law to test the understanding of students.<br>Internal assessment tests will be conducted. |

**(**Assessment tasks enlisted here are indicative in nature)**

## 4. Keywords

Centrifugation, Chromatography, Electrophoresis, Spectrophotometry, Proteins and Nucleic acids.

## B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
## BCH-GE-4 : PUBLIC HEALTH BIOLOGY

### 1. Course Objective:

The present course attempts to provide an interdisciplinary understanding of public health issues in India with a more detailed understanding of the areas pertaining to biological science and epidemiology. Some overview of the social aspects that impact public health will also be discussed and the statistical analysis of public health data will be taught in the practical. The specific objectives of the course are to provide a basic understanding of the scope of public health issues, particularly related to policies on public health, public health nutrition, infectious biology and sanitation, social and preventive medicine, and the environmental issues that affect public health. The practical exercises aim to provide hands-on training in epidemiology and collection of primary and secondary data relevant to public health issues. It also hopes to generate a discussion platform that would encourage a healthy inter- and multidisciplinary interaction amongst the students to get a holistic view of public health. A mini research project on any relevant topic related to public health will be taken up after completing the theory and practical components of the course. Being interdisciplinary in its nature and scope, the course will be equally engaging and beneficial for students of all subject streams. After completing the course, the students can also apply for some higher-level courses in different areas of public health as the course helps in building a basic understanding on different aspects related to public health.

### 2.1 Course Learning Outcomes:

- Students will get a holistic overview of the interdisciplinary nature of Public health
- They will understand public health issues in India particularly related to Malnutrition, sanitation issues and related burden of infectious disease, and the role of pollution as a public health concern.
- The students will also get an understanding of the public policies applicable and implemented in India.
- They will also be able to appreciate the social aspects that govern many public health issues and implementation of policies
- The students will get hands-on training in epidemiology, preparation of questionnaire and collection of primary and secondary data relevant to public health issues.
- They will also learn to present the relevant data after subjecting it to statistical analysis.

### 2.2 Course Contents

**Theory**

**Credits: 2** **Total hours: 30**

**Unit 1: Understanding public health issues** **No. of hours: 04**

Conceptual understanding of public health, terminology, public health- multidimensional problem with Delhi as an example (air pollution, stress, sanitation, urbanization and socioeconomic inequalities) Policies on public health- factors affecting making and implementation of these policies.

**Unit 2: Public Health Nutrition** **No. of hours: 10**

Understanding public health nutrition? Basic nutrition concepts, problems of malnutrition and toxicities, Application of nutrition concepts to design programs of public health concern, focussed on improving or maintaining the optimal health of general populations and targeted groups. Programs that will help prevent ill-health due to over or under nutrition. Mid-day meals in schools

**Unit 3: Infectious biology and sanitation** **No. of hours: 06**

Defining communicable diseases. Understanding the biology, socioeconomic factors and other environmental conditions that influence the transmission and infection by pathogenic (disease-causing) bacteria, viruses, parasites, and fungi. Precautions, prevention strategies and programs for control; sanitation, Swachh Bharat.

**Unit 4: Environmental Health & Community Health** **No. of hours: 10**

Determinants of Environmental Health: factors that affect environmental health; Occupational environment and health concerns; Understanding effect of air, water and soil Pollution on health.

Understanding the definition of community health, Determinants of community health; Define and manage the health problems of the community, Plan, implement and evaluate various health programs of General Health, Reproductive health, Maternal health, Family Welfare and Disease control / eradication.

Lifestyle disease or non-communicable diseases- consequence of imbalanced nutrition, environmental and psychological stresses; Etiology and management of diseases like Obesity, Diabetes mellitus, Cardiovascular disorders, sleep disorders and psychological eating disorders. Preventive health checkups (PHC)- important parameters/biomarkers; relevance of PHC in health and disease prevention/early diagnosis

**2.3 Practical:**

**Credits: 2** **Total hours: 60**

1. Assessment of nutritional status using anthropometric indices
2. Assessment of Nutritional status by a survey of clinical and non-invasive biochemical parameters.
3. To determine the potability of water using, pH, BOD, COD and MPN of the water sample from different sources.
4. Collecting secondary data on AQI from different areas and correlate with health indices in that area.

5. Understanding epidemiology: Collection, generation, and analysis of public health data. Application of statistical tools to analyze and present public health data.
6. Case study of a disease (Nutritional, infectious and lifestyle) along with the public health issues associated with that disease.
7. Field visits to nearby health care center to understand health checkups and collect some data on the rate of a particular disease over past few months or years.
8. Data collection from public domain with analysis.

**2.4 Essential reading:**


1. Aschengrau A, Seage G.R., (2013) Essentials of Epidemiology in Public Health Jones and Bartlett Publishers, Inc; 3rd edition
2. Bamji MS, Rao NP, Reddy V. (2017). Textbook of Human Nutrition. (4th ed). Delhi: Oxford and IBH Publishing Co. (P) Ltd.
3. Soil Microbiology by N.S. Subba Rao. 5th edition. Medtech, India. 2017.
4. Environmental Microbiology edited by I.L. Pepper, C.P. Gerba, T.J. Gentry. 3rd edition. Academic Press, USA. 2014.


**Suggested readings:**


1. Sullivan. L.M. (2017) Essentials of Biostatistics in Public Health. Jones and Bartlett Publishers, Inc; 3rd edition.
2. Gibney et al. (2004). Public health nutrition. Hoboken, NJ: Blackwell Publishing
3. N. Okafor. (2011) Environmental Microbiology of Aquatic and Waste Systems by Springer, USA.
4. Waste Water Microbiology by D.H. Bergey. 2nd Edition. Medtech, India. 2019.


## 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes****

| Unit No. | Course Learning Outcomes | Teaching and Learning Activity | Assessment Tasks |
|---|---|---|---|

| | | | |
|---|---|---|---|
| I | Students will be introduced to the term public health. They will gain insight into the significance of the multidimensional problem of public health with an example. They will also understand policies on public health. | Teaching will be conducted both through black board mode and power point presentation mode. Discussions will be conducted on Delhi's problems including air pollution, stress, sanitation, urbanization and socioeconomic inequalities. | Students will be taken to field visits to understand public health. Students shall be asked to collect, generate, analyze and present public health data. Also they shall be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. |
| II | Students will be introduced to public health nutrition. They will gain insight into basic nutritional concepts along with problems of malnutrition and toxicities. They will also understand the policies that operate in India that try to ensure adequate nutrition to all like mid-day meals in schools. | Classical chalk and board teaching, oral discussions and power point presentation whenever needed.<br>Students shall design programs of public health concern, focused on improving or maintaining the optimal health of general populations and targeted groups. | Students will be asked to design and analyze various programs to public health nutrition. Open book tests will be held to promote self-learning. Practical related oral questions will be asked. |
| III | Students shall gain insight of various communicable diseases. Understanding the biology, socioeconomic factors and other environmental conditions that influence the transmission and infection by various pathogens. | Teaching will be conducted both through black board mode and power point presentation mode.<br>Discussions on sanitation measures being implemented and the ongoing Swachh Barath action plan will introduced and analyzed. | Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentations as well as case study on any communicable disease and pathogenic species. Internal assessment tests will be conducted. Discussions using case studies will be conducted. |

| | | | |
|---|---|---|---|
| IV | Understand the determinants of Environmental Health. Gain knowledge about community health. Understand the etiologies and management of various lifestyle disease or non-communicable diseases. | Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity. Practical knowledge to assess portability of water using, pH, BOD, COD and MPN of the water sample from different sources shall be imparted. Also secondary data collection like AQI levels will be conducted. | Case studies of lifestyle diseases shall be done. Field visits to nearby health care centers and data collection from public domain with analysis shall be done. Regular oral evaluation will be done. Internal assessment tests will be conducted |

**(**Assessment tasks enlisted here are indicative in nature)**

## 4. Keywords

Public health, community health, environmental health, public health nutrition, Lifestyle diseases, communicable disease, epidemiology