B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERIC ELECTIVE (GE) COURSES
Biomolecules (BCH GE-1)
Semester - I

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, focusing on their key properties, biological roles and functions. The course also aims to outline organic and physical aspects of biomolecules.

2.1 Course Learning Outcomes

- Students will acquire knowledge about structure and function of proteins, RNA, DNA, carbohydrates and co-enzymes
- The course will provide an understanding of how structure of biomolecules determine their chemical properties
- Students will develop understanding of biochemistry at atomic level and appreciate the biological importance of each biomolecule

2.2 Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Biomolecules in their cellular environment **No. of hours : 7**

The cellular basis of life, structure and function of a cell and its subcellular components (eukaryotes, prokaryotes); Physical properties and structure of water molecule, pH, Buffers, biological buffer systems (body fluids and their principal buffers)

UNIT II: Amino Acid and Peptides **No. of hours : 11**

Introduction, general nature of amino acids, classification of amino acids, importance of amino acids, modified and standard amino acids, physical and optical properties of aminoacids, ionization of amino acids, buffering of amino acids, peptide bond, biologically important peptides. Introduction to chromatography, separation of amino acid by paper chromatography

UNIT III: Carbohydrate Chemistry **No. of hours : 11**

Introduction; Definition, classification and functions of carbohydrates, monosaccharides, disaccharides, polysaccharides, homo polysaccharides, hetero polysaccharides; Structure of glucose, isomerism; keto aldo, D-and L- isomerism, optical isomerism, epimerism, anomerism, Mutarotation, chemical properties of monosaccharides, action of strong acids, alkalis,

oxidation, reduction, osazone formation glycoside formation; Derivatives of monosaccharides, phosphoric acid ester, amino sugar, deoxy sugar, sugar acids, sugar alcohols, disaccharides maltose, lactose, sucrose. Homo polysaccharides - starch, glycogen, cellulose, dextrin; Hetero polysaccharides - types of glycosoaminoglycans and functions of glycoproteins

UNIT IV: Chemistry of Lipids **No. of hours: 11**

Introduction; Definition, classification and functions of lipids; Fatty acids; Essential fatty; acids; Reactions of lipids; Triacylglycerol or neutral fat; phospholipids glycolipids; cholesterol; Eicosaanoids; prosatglandins; lipoprotein

UNIT V: Chemistry of Nucleic Acid **No. of hours : 11**

Introduction, nucleic acid, nucleotide, biologically important nucleotides, synthetic analogues of nucleotides or antimetabolites; DNA structure and function; Types of DNA; Organization of DNA; RNA structure and function

UNIT VI: Vitamins and Coenzymes **No. of hours : 8**

Definition and classification of vitamins, water soluble vitamins, fat soluble vitamins, occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomoleculeus (heme, porphyrins and cyanocobalamine) and their biological role

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**

1 Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates, and nucleic acids.
6. Separation of amino acids/ sugars/ bases by thin layer chromatography

2.3 References

1. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
2. Nelson, D.L. and Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7^{th} ed.). W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No	Course Learning Outcomes	Teaching & Learning Activity	Assessment Tasks
I	Student will learn the fundamental concepts of cellular basis of life, cellular structure of prokaryotes and eukaryotes. They will also learn the role of water in design of these molecules.	Chalk and board method will be used and power point presentation for depicting the structure of cells and role of water in design of these molecules.	Students will be asked to correlate the importance of these molecules from their cells by take home assignments.
II	Students will gain insight into basic structures, chemistry and property of amino acids along with derivatives of amino acids. They will be introduced to chromatography	Chalk and board method will be used. Power point presentation for understanding these structure and their role.	MCQ based assignments will be given to students to check their understanding.
III	Understanding of the basic chemistry, structure and classification of all types carbohydrates, along with their biological role.	Chalk and board method and power point presentation will be used for describing these structures distribution &their biological role.	MCQ based assignment will be given to students. Structures will be shown for them to identify the type and class of carbohydrate
IV	Students will learn about the basic building blocks of lipids and the different categories of lipids in the body with main emphasis being on understanding their structure. They will also be exposed to some aspects of function of the different lipids in the body including their role as cofactors, pigments and signaling molecules.	Learning of individual students will be conducted by a traditional chalk and board method and supported by power point slides wherever appropriate.	Multiple choice questions, take home assignments and regular Q&A sessions during class.
V	Students will learn the basic aspects of the structure of DNA and RNA along with unusual structures of DNA. Students will also be made aware of the other roles that nucleotides can play in the body.	Regular question answer sessions in the class to encourage student participation. Regular chalk and board teaching will be used.	Students' knowledge will be assessed via regular quizzes and take home assignments

VI	Students will learn about the nutritional roles of all water soluble and lipid soluble vitamins in the body along with their occurrence. They will also be made aware of how vitamins are crucial in metabolism of the body.	Students will be communicated to mainly using chalk and board method with occasional support taken from structures projected on transparencies or power point slides	Assessment of the student learning will be done by home exams, multiple choice quizzes and take home assignments. They will review research papers as well.

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

4. Keywords

Buffer, Amino Acids, Glucose, Disaccahrides, Polysaccharides, Lipids, Nucleic Acids, Vitamins, Chromatography

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERIC ELECTIVE (GE) COURSES
Techniques in Biochemistry (BCH GE-2)
Semester – I / II

1. Course Objectives

The objective of the course is to introduce various techniques to students that are used in biological research as well as to provide them with an understanding of the underlying principles of these techniques. 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 execution of these techniques.

2.1 Course Learning Outcomes

- Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.
- Students will learn about the principle and application of electrophoresis, centrifugation techniques, cell culture and microscopic techniques.
- It will also give them an opportunity to get hands on experience to develop their experimental skills expected from any biochemist working in a research lab.

2.2 Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS:60**

UNIT I: Spectroscopic Techniques **No. of hours: 15**

Electromagnetic radiation, interaction of radiation with biomolecules, principle of UV-visible absorption spectrophotometry, Lambert's Law, Beer's Law, working of a spectrophotometer. Applications of UV-visible absorption spectrophotometry in biochemistry. Fluorescence spectrophotometry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence, applications of fluorescence in biochemistry.

UNIT II: Chromatography **No. of hours: 15**

Preparation of sample, different methods of cell lysis, salting out, dialysis. Introduction to chromatography. Different modes of chromatography: paper, thin layer and column. Preparative and analytical applications. Principles and applications of: Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography, Molecular Sieve Chromatography, Affinity Chromatography.

UNIT III: Electrophoresis **No. of hours: 12**

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel

electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weight determination, isoelectric focusing of proteins.

UNIT IV: Centrifugation **No. of hours: 8**

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient. Various types of centrifuges, low speed centrifuge, high speed centrifuge and ultracentrifuge, types of rotors. Application of centrifugation, differential centrifugation, density gradient centrifugation- zonal and isopycnic.

UNIT V: Microbiological/Cell culture techniques **No. of hours: 5**

Types of media, selective and enrichment media, sterilization methods, bacterial culturing, CFU determination, growth curves, Generation/doubling times, cell counting, viable and non-viable. Growth and maintenance of cultures, biosafety cabinets, CO_2incubator. Staining procedures, plating and microtony.

UNIT VI: Microscopy **No. of hours: 5**

Principle of light microscopy, phase contrast microscopy, fluorescence microscopy. Permanent and temporary slide preparation, histology and staining.

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**

1. Verification of Beer's Law
2. Estimation of proteins by Biuret/Lowry method
3. Separation of amino acid acids by TLC/paper chromatography
4. To perform agarose gel electrophoresis
5. To isolate mitochondria by differential centrifugation
6. Visualization of cells by methylene blue

2.3 References

1. Boyer, R.F. (2012). *Biochemistry Laboratory: Modern Theory and Techniques* (6th ed.). Boston, Mass: Prentice Hall. ISBN-13: 9780136043027.
2. Plummer, D. T. (1998). *An Introduction to Practical Biochemistry*. (3rd ed.). Tata McGraw Hill Education Pvt. Ltd. (New Delhi). ISBN: 13: 9780070994874 / ISBN:10: 0070994870.
3. Wiley, J.M., Sherwood, L.M., Woolverton, C.J. (2017). *Prescott's Microbiology*. (10th ed.). McGraw Hill Higher Education. ISBN13: 9781259657573.
4. Wilson, K., Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology*, (7th ed.). Cambridge University Press. ISBN 9780521516358.

Additional Resources:

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: 0716713152 / ISBN:0716714442.

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 learn about the principle and applications of spectrophotometry and flourimetry.	Teaching using chalk and board; Oral discussion sessions in the class. Powerpoint presentations.	Problems will be assigned related to Beer's Law and Lambert's Law to test the understanding of students.
II	Students will learn the principle of various chromatographic techniques like gel filteration, Ion exchange.	Previous classes will be revised. Group discussion sessions in the class. Powerpoint presentations.	Practical exercises are designed whereby the students get hands on experience with these chromatography techniques.
III	Students will learn about electrophoretic techniques, their principle and applications in analyzing proteins and nucleic acids	Oral discussion sessions in the class. Chalk and board teaching.	Various analytical problems will be assigned to students related to electrophoretic separation.
IV	Students will learn about the basic rules of sedimentation, various types of centrifuges and rotors.	Revision of the previous classes for a better understanding of the students. Demonstration of various centrifuges. Chalk and board teaching.	Demonstration with the help of centrifuges and rotors to improve their understanding.
V	Students will learn and understand the different cell culture and microbiological techniques used in biochemistry.	Power point presentations; Teaching using chalk and board; Oral discussion sessions in the class	Various analytical problems will be assigned to students related to cell counting.
VI	Students will learn about various microscopes and slide preparation, histology and staining techniques.	Group discussion sessions will be held in the class along with powerpoint presentations	Various analytical problems will be assigned to students related to working of microscope.

4. Keywords

Spectrophotometry, Chromatography, Proteins, Nucleic Acids, Centrifugation and Electrophoresis

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERIC ELECTIVE (GE) COURSES
Proteins and Enzymes (BCH GE-3)
Semester – II / III

1. Course Objectives

The objective of this course is to provide overview of protein biochemistry and enzymology to undergraduate students with diverse science backgrounds, since proteins and enzymes are the most versatile functional entities in life with applications in various life sciences research as well as in industry and biomedicine. The biochemical, structural, functional and aspects of interaction of proteins and enzymes will be introduced in this course.

2.1 Course Learning Outcomes

On successful completion of the course students will be:

- Familiar with unique features and characteristics of proteins and enzymes and their applications in research, medicine and industry.
- Aware of the relationship between three-dimensional structure of proteins and enzymes and their functions.
- Able to comprehend the basic mechanism of action of enzymes and their remarkable regulation
- Aware of the principles of protein isolation, purification and characterization
- Able to gain hands-on-experience in handling proteins and enzymes from various sources, thus improving their ability of learning and imbibing the basic concepts.

2.2 Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to proteins and their structural organization No. of hours :10

Amino acids and their properties. Peptides and their biological significance - hormones, antibiotics and growth factors. Diversity of proteins and their functions. Protein sequence - Edman degradation. Solid phase peptide synthesis. Organization of protein structure - primary, secondary, tertiary and quaternary structures. Conjugated proteins, multimeric proteins and metalloproteins. Bonds in protein structures - covalent and non-covalent. Dihedral angles. Ramachandran map, Secondary structure - helices, sheets and turns.

UNIT II: Three-dimensional structures and protein folding No. of hours: 12

Characteristics of tertiary and quaternary structures. Motifs and domains. Structure-function relationship in proteins. 3D structures of myoglobin and hemoglobin. Oxygen binding curves, influence of pH and effector molecules. Concerted and sequential models for allosteric

proteins. Hemoglobin disorders. Protein folding - denaturation and renaturation. Role of chaperones. Protein misfolding and aggregation diseases.

UNIT III: Isolation, purification and analysis of proteins No. of hours: 8

Ammonium sulphate fractionation, centrifugation dialysis. Ion-exchange chromatography, molecular sieve chromatography, affinity chromatography. HPLC and FPLC. Gel electrophoresis: SDS-PAGE, IEF and 2-D electrophoresis.

UNIT IV: Introduction to enzymes, their characteristics and kinetics No. of hours: 12

Nature of enzymes - protein and non-protein (ribozyme, abzymes). Cofactor and prosthetic group, apo- and holo-enzymes. Features of enzyme catalysis. Classification of enzymes and nomenclature. Fischer's lock & key and Koshland's induced fit hypothesis. Enzyme specificity. Enzyme kinetics- Michaelis-Menten equation, Lineweaver-Burk plot. Determination of K_m, V_{max}, K_{cat}. Factors affecting enzyme activity. Enzyme inhibition- Reversible (competitive, uncompetitive, non-competitive) and irreversible inhibition. Mechanism based inhibitors.

UNIT V: Mechanism of enzyme action and enzyme regulation No. of hours: 10

General mechanisms of action. Acid-base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes. Allosteric regulation and feedback inhibition (ATCase). Reversible covalent modification (glycogen phosphorylase). Proteolytic cleavage-zymogen. Multienzyme complex. Coenzymes.

UNIT VI: Applications of enzymes No. of hours: 8

Isoenzymes. Applications of enzymes in research. Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase), Enzyme immunoassay (HRP), Enzyme therapy (Streptokinase). Enzyme immobilization and its applications. Industrial applications.

PRACTICALS

CREDITS: 2 TOTAL HOURS:60

1. Estimation of proteins by Biuret and Lowry methods
2. Ammonium sulphate fractionation of crude homogenate from germinated mung beans
3. Enzyme activity assay (acid phosphatase)
4. Progress curve of enzyme
5. Effect of pH / temperature on enzyme activity
6. Determination of K_m and V_{max} using Lineweaver-Burk plot.

2.3 References

1. Cooper, T. G. (2011). *The Tools of Biochemistry* (2nd ed.). Wiley-Interscience Publication (New Delhi). ISBN: 13:9788126530168.
2. 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.

3. Nicholas, C.P., Lewis, S. (1999). *Fundamentals of Enzymology* (3rd ed.). Oxford University Press Inc. (New York), ISBN: 0 19 850229 X.
4. Sheehan, D. (2009). *Physical Biochemistry* (2nd ed.). Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
5. Voet, D., Voet, J., Pratt, C. (2013). *Biochemistry* (4th ed.) Wiley & Sons, Inc. (New Jersey). ISBN: 978-1-11809244-6.

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 gain knowledge about the building blocks of proteins i.e. amino acids and understand about the structural organization of proteins.	Students will be taught using power point presentations, chalk and board. In class oral discussion sessions will be conducted.	Oral questions will be asked in the class. Assignment and tests will be given.
II	Students will understand about the characteristics of tertiary and quaternary structures, 3D structure of Hemoglobin and Myoglobin. They will also understand the concept of protein folding (denaturation and renaturation).	They will be taught using power point presentations, chalk and board. The use of E-learning through online Web and Video courses will be included.	Internal assessment will be done on the basis of quiz and class tests.
III	Students will acquire knowledge about the basic concepts of various techniques used for isolation, purification and analysis of proteins.	Students will be taught using chalk and board. A visit to a Research Lab. for the demonstration/ hands-on-experience of protein purification techniques will be planned to enhance their ability of learning and imbibing the basic concepts.	Students will be assigned different techniques and will be asked to deliver a power point presentation. Various analytical problems will be assigned to students related to purification of proteins.
IV	Students will learn about enzyme catalysis, role of coenzymes, cofactors and different aspects of enzyme kinetics. They will understand about different types of enzyme inhibitors, role of drugs as	They will be shown power point presentations and will be taught using chalk and board. The use of E-learning through online Web and Video courses will be included for the	Regular question- answer sessions in class will be conducted. Internal assessment will include problems/ numericals based on enzyme kinetics.

	enzyme inhibitors and the respective mechanism.	better understanding of the enzyme kinetics.	
V	Students will understand the basic mechanism of enzyme action and enzyme regulation.	Students will be shown power point presentations and will be taught using chalk and board. Oral discussion sessions in the class will be conducted.	They will be assessed on the basis of assignments and class tests.
VI	Students will learn about diverse applications of enzymes in research, diagnostics, therapy and Industry.	Teaching using chalk and board will be done. Oral discussion sessions in the class will be conducted.	Students will undergo internal test for the syllabus covered in Unit 1-V and their answers will be discussed in the following class. Quiz will be conducted. Various analytical problems will be assigned to students based on enzyme applications.

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

4. Keywords

Proteins, Enzymes, Protein structure, Protein folding, Enzyme kinetics, Enzyme regulation

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERIC ELECTIVE (GE) COURSES
Biochemical Correlations of Diseases (BCH GE-4)
Semester – II / IV

1. Course Objective

This course provides students with knowledge and understanding of various human diseases. It will introduce the concepts of a well-balanced diet, healthy lifestyle, biochemical basis of diseases, treatment strategies, mechanism of action of drugs and drug resistance against various antimicrobials. The course also aims to outline the various strategies that are employed for preventing infectious and non-infectious diseases.

2.1 Course Learning Outcomes

- Students will develop understanding about the importance of balanced diet, regular exercises and healthy lifestyle.
- Students will gain insight into various disorders associated with imbalanced diet and poor lifestyle.
- Students will learn various strategies employed for preventing various human diseases.
- Students will understand the molecular basis of microbial pathogenicity, drug resistance and implications in public health management.
- Students should be able to handle and solve analytical problems related to theory classes.

2.2 Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Inherited metabolic diseases **No. of hours: 8**

Alkaptonuria, Phenylketonuria, Glycogen storage diseases: Von Gierke, Cori and McArdle, Lipid storage diseases: Gauchers diseases, Niemann-Pick disease, SCID: Adenosine Deaminase deficiency.

UNIT II : Nutritional deficiency and lifestyle based diseases **No. of hours: 16**

Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindness, Rickets, Osteomalacia, Osteoporosis, Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes Mellitus-II, Inflammatory Bowel Disease (IBD).

UNIT III: Hormonal imbalances **No. of hours : 8**

Hormonal imbalances leading to disease: Diabetes Insipidus, Acromegaly, Gigantism, Dwarfism, Goitre, Cretinism, Cushing and Conn's syndrome, Addison's disease.

UNIT IV: Autoimmune diseases **No. of hours: 8**

Concepts in immune recognition-self and non-self-discrimination, organ specific autoimmune diseases-Hashimoto's thyroiditis, Graves' disease, Myasthenia Gravis, Diabetes Melitus-I, Systemic diseases: Systemic lupus erythematosus (SLE), Rheumatoid arthritis.

UNIT V: Diseases caused due to misfolded proteins **No. of hours: 6**

Alzheimer's, Huntington's diseases, Kuru, Creutzfeldt-Jakob disease, Sickle Cell anaemia, Thalassemia.

UNIT VI: Infectious diseases **No. of hours: 16**

Viral infection: Polio, Measles, Mumps, influenza, HIV. Bacterial infections: Tetanus, Diphtheria, Tuberculosis, Typhoid, Cholera. Protozoan: Malaria and Trypanosomiasis. Parasitic infections: Leishmania.

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**

1. Determination of blood Lipid Profile: Triglyceride, Cholesterol
2. Anthrompometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA).
3. Haemoglobin estimation
4. Blood pressure measurement
5. Calcium estimation in serum
6. Estimation of blood glucose

2.3 References

1. Berg, J.M., Tymoczko, J. L., Stryer, L. (2012). *Biochemistry* (7th ed.). W.H Freeman and Company (New York).
2. Coico, R., Sunshine, G. (2009). *Immunology: A Short Course* (6th ed.). John Wiley & Sons, Inc (New Jersey). ISBN; 978-0-470-08158-7.
3. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
4. Prescott, Harley, Wiley, J.M., Sherwood, L.M., Woolverton, C.J. (2008). *Klein's Microbiology*. (7th ed.). Mc Graw Hill International Edition (New York) ISBN: 978-007-126727.
5. Snustad, D.P., Simmons, M.J. (2012). *Genetics* (6th ed.). John Wiley & Sons. (Singapore) ISBN: 978-1-118-09242-2.

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
I.	The students will understand the concepts of metabolism of macromolecules and the diseases related to metabolic errors. Biochemical basis of diseases related to inherited metabolic disorders will also be learned.	Traditional chalk and board method and illustrations through powerpoint presentations. Discussion of case studies. Estimation of Glucose, Calcium and Blood pressure measurement will be taught in the practicals.	Students will be assigned the task of identifying examples of abnormal enzymes that directly relate to each feature of metabolic disorders. A host of characteristics and features will be provided to students and they will need to match them with the type of metabolic disorder. They will encouraged to participate in group discussions related to topics thought in class.
II.	Develop understanding of the importance of balanced diet, regular exercises and healthy lifestyle and disorders associated with imbalanced diet and poor lifestyle. Appreciate the importance of micronutrients and disorders associated with deficiency of minerals and vitamins The students will also learn about life style disorders.	Explaining each topic through power point presentations / chalk and board teaching. Discussion of case studies.	Group discussions and class tests will be held. Assignments on classification of diseases in various macromolecule and micromolecule deficient disorders. Signs and symptoms of diseases will be provided and students will be asked to match them with the type of nutrient disorders. Students will also be given assignments on matching the symptoms with the diseases.
III.	Learn about role of hormones in our daily life and gain insight into various diseases associated with hormonal imbalance.	Class teaching using chalk and board and power point presentations.	Students will be given assignments to match symptoms with the correct disease/ disorders. Group discussions and Tests will be held.
IV	The students will learn about induction of an appropriate immune response and the	Traditional chalk and board method with powerpoint presentations. Few case studies will also	Pre-lecture quiz to evaluate student's understanding of previous lecture. Signs and

	associated disorders, also understand the concept of immune recognition - self and nonself.	be discussed.	symptoms of diseases will be provided and students will be asked to classify them in various types of autoimmune diseases.
V.	Understand the significance of appropriate folding of proteins and the diseases caused due to misfolding of proteins.	Illustrations through power point presentations and through regular chalk and board method. Discussion of case studies.	Group discussions. Quiz, Assignments. Signs and symptoms of diseases will be provided and students will be asked to classify them in diseases caused by misfolding of proteins. Internal assessment test.
VI.	Gain knowledge about various microbial infectious agents that cause diseases in humans. Students will gain insight into host immune responses that ensue following infection.	Traditional chalk and board method with powerpoint presentations.	Pre-lecture quiz to evaluate student's understanding of previous lecture. Assessment tests (end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a powerpoint presentation on the assigned topics.

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

4. Keywords

Lifestyle and metabolic disorders, nutritional deficiency, hormonal disorder, autoimmunity and infectious diseases.

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERIC ELECTIVE (GE) COURSES
Intermediary Metabolism (BCH GE-5)
Semester - III

1. Course Objectives

The objective of this course is to provide the students an understanding of the major metabolic pathways associated with biomolecules within a cell and their regulation. It will also provide knowledge about the possible correlation between various metabolic pathways.

2.1 Course Learning Outcomes

At the end of the course, the students will be able to:

- Understand the basics of metabolic pathways
- Outline the pathways involved in catabolism and biosynthesis of glucose.
- Describe the mechanism of ATP synthesis.
- Understand the biosynthesis and degradation of glycogen
- Comprehend the metabolism of fatty acids, amino acids, and nucleotides
- Develop an understanding of metabolic integration

2.2 Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Glycolysis and gluconeogenesis **No. of hours: 12**

Nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency. Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis. Pentose phosphate pathway, importance of various pathways and their regulation

UNIT II: Citric acid cycle and oxidative phosphorylation **No. of hours: 12**

Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway. The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

UNIT III: Glycogen metabolism **No. of hours: 8**

Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis. Diseases associated with the abnormal carbohydrate metabolism.

UNIT IV: Fatty acid and amino acid degradation **No. of hours: 12**

TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Fatty acids activation, regulation of fatty acid oxidation, Protein degradation to amino acids, Role of essential and non-essential amino acids in growth and development. Protein calorie malnutrition - Kwashiorkar and Marasmus, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation. Diseases associated with the abnormal metabolism.

UNIT V: Nucleotide metabolism **No. of hours: 10**

Biosynthesis - de novo and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion. Diseases associated with the abnormal metabolism

UNIT VI: Integration of metabolism **No. of hours: 6**

Brief role of hormones - insulin, glucagon; metabolic shifts to provide fuel to brain during fasting and starvation, Increase in gluconeogenesis and muscle protein breakdown.

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**

1. Estimation of blood glucose
2. Demonstration of alcohol fermentation by yeast.
3. Estimation of serum urea.
4. Estimation of serum uric acid.
5. Estimation of serum creatinine

2.3 References

1. Berg, J.M., Tymoczko, J.L., Stryer L., (2012) *Biochemistry*7th ed., W.H. Freeman and Company (New York); ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.
2. Campbell, M.K., Farrel, S.O. (2012) *Biochemistry*7th ed, S.O. Brooks/Cole, Cengage Learning (Boston); ISBN: 13:978-1-111-42564-7 ISBN:10:1-4292-2936-5.

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.	Understanding the concept of metabolism. Understand Glycolysis, gluconeogenesis and Pentose phosphate pathway and their regulation.	Traditional chalk & board method with power-point presentations.	Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts.

II.	Understand the citric acid cycle and ATP synthesis by oxidative phosphorylation.	Revision of the previous classes will be conducted. Teaching will be through traditional chalk & board method and power-point presentations	Pre-lecture quiz to evaluate students understanding of previous lecture. Internal assessment tests will be conducted.
III.	Have knowledge about glycogenolysis and glycogenesis and their reciprocal regulation	Group discussions will be held on various topics of this unit. Blackboard teaching as well as powerpoint presentations will be conducted.	Home assignments and MCQ based questions will be given to students.
IV	Understand the β-oxidation of fatty acids and its regulation.	Traditional chalk & board method with power-point presentations. Oral question-answers will be held.	Pre-lecture quiz to evaluate students understanding of previous lecture. Students will be asked to deliver presentations and will be assessed on that.
V.	Understand de novo and salvage pathways of nucleotide Biosynthesis and Degradation.	Oral revision of the previous classes will be conducted. Teaching will be through traditional chalk & board method with power-point presentations.	Internal assessment test and crossword puzzles will be given to students for their evaluation.
VI.	Understand the concept of metabolic integration.	Overview of all the metabolic pathways will be discussed along with group discussions. Traditional chalk & board method with power-point presentations.	A continuous evaluation based on their class response will be made. End term examination evaluation. MCQ based questions.

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

4. Keywords

Glycolysis, *De novo* salvage pathway, TCA, catabolism, anabolism, integrative pathways, nucleotide metabolism, beta oxidation, glycogen metabolism, gluconeogenesis.