BSc. (Hons.) Biochemistry
Category-I

DISCIPLINE SPECIFIC CORE COURSE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Enzymes	04	02	-	02	-	-

Learning Objectives

The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life, so as to develop an understanding of enzyme kinetics, mechanism of enzyme action and their regulation. The course also aims to outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

Learning outcomes

- Students will learn the nature and importance of enzymes in living systems
- Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity
- Students will understand the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors
- Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
- The course will introduce students to the applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.

SYLLABUS OF DSC-4

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-DSC-201: ENZYMES
Semester – II

2.2 Course Contents

Theory

Credits: 2 **Total weeks : 15**

Unit I: Introduction to enzymes and features of catalysis (3 weeks)

General characteristics of enzymes; nature of enzymes - Ribozymes. apoenzyme, holoenzyme, Cofactor and prosthetic group. Classification and nomenclature of enzymes. Types of Enzyme assays - discontinuous, continuous, coupled assays; Enzyme activity, specific activity, units to express enzyme activity. Features of enzyme catalysis, factors affecting the rate of enzymatic reactions, activation energy and transition state theory. Catalysis, reaction rates. Catalytic power and specificity of enzymes, Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. Metal activated enzymes and metalloenzymes.

Unit II: Enzyme kinetics and inhibition (5 weeks)

Relationship between initial velocity and substrate concentration, equilibrium constant, steady state kinetics, mono-substrate reactions. Derivation of Michaelis-Menten equation; other enzyme plots like Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Determination of K_m V_{max} and K_{cat}, specificity constant. Types of bisubstrate reactions (sequential-ordered and random, ping pong reactions), examples.
Reversible inhibition (competitive, uncompetitive, non-competitive and mixed) and irreversible inhibition. Structural analogs (allopurinol, methotrexate). Mechanism based inhibitors (β-lactam antibiotics).

Unit III: Mechanism of action of enzymes and Regulation of enzyme activity (5 weeks)

General features - proximity and orientation, strain and distortion, acid-base and covalent catalysis (chymotrypsin). Coenzymes (TPP, NAD, pyridoxal phosphate) in enzyme catalyzed reactions.

Control of activities of single enzymes and metabolic pathways, feedback inhibition, allosteric modulation (aspartate transcarbamoylase), regulation by covalent modification (glycogen phosphorylase), Zymogen (chymotrypsinogen)**.** Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit IV: Applications of enzymes (2 weeks)

Enzymes as reagents (glucose oxidase, cholesterol oxidase); Marker enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); Enzyme linked immunoassay; Enzyme therapy (streptokinase); Enzymes in research. Immobilized enzymes.

2.3 Practical:

Credits: 2 Total weeks : 15

1. Assay to determine activity and specific activity of an enzyme.
2. Progress curve for an enzyme.
3. Partial purification of an enzyme using Ammonium sulfate fractionation.
4. Effect of pH on enzyme activity.
5. Effect of temperature on enzyme activity.
6. Determination of K_m and V_{max} of an enzyme using Lineweaver-Burk plot.

7. Calculation of inhibitory constant (Ki) for an enzyme.
8. Immobilization of enzyme using calcium alginate beads.

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman and Company. ISBN: 13: 978-1-4641-2611-6 / ISBN:10:1-46412611-9.
2. Nicholas, C.P., Lewis, S. (1999). Fundamentals of Enzymology (3rd ed.). New York, Oxford University Press Inc. ISBN:0 19 850229 X.
3. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.). New York, WH: Freeman. ISBN-13: 9781319114671

Suggested reading:

1. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. 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 be introduced to Enzymes. They will also gain insight into features of enzyme catalysis and factors affecting the rate of enzymatic reactions	Teaching will be conducted both through black board mode and power point presentation mode.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.
II	Knowledge about the kinetics of enzymatic reactions by understanding different plots and calculating the parameters. They will understand the mechanism of bisubstrate reactions, inhibitions in enzymes.	Classical chalk and board teaching, oral discussions and power point presentation whenever needed. Practical knowledge of enzyme kinetic reactions by determination of Km, Vmax and other values.	Students will be asked to analyze case studies. Written tests will be held to promote self-learning. Practical related oral questions will be asked.
III	Students will gain insight into regulation of activities of single enzymes and metabolic pathways	Teaching will be conducted both through black board mode and power point	Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentations on

	by feedback inhibition, allosteric modulation, covalent modification, zymogen and isoenzymes	presentation mode. Practical assessment	any topic of interest relating to Enzymes. Internal assessment tests will be conducted.
IV	Students will learn applications of enzymes as reagents, markers in diagnostics, ELISA; Also use of enzymes in therapy, research and industries as immobilized enzymes	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity.	Regular oral evaluation will be done. Internal assessment tests will be conducted

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

4. Keyword

Enzymes, Catalysis, Specific activity, Mechanism of action, Isoenzymes.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Metabolism of Carbohydrates	**04**	**02**	**-**	**02**	**-**	**-**

Learning Objectives

The objective of this course is to provide an understanding of metabolism of carbohydrates and the enzymes involved in various metabolic pathways and regulation of carbohydrate metabolism in cells. The course also aims to outline the importance of such pathways in relation to metabolic defects.

Learning outcomes

Carbohydrates major biomolecules as building blocks in any organism. An understanding of the metabolism of these groups of molecules will help students to know the functioning of an organism as a whole. There are various degradation and synthesis pathways these molecules undergo based on the energy requirement of an organism so as to maintain body homeostasis. Detailed analysis of the pathways will provide an insight into the diseases caused by defects in metabolism highlighting the importance of the same. The metabolism of carbohydrate course will provide to undergraduate students:

- Concept of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
- Detailed knowledge of various pathways involved in carbohydrate metabolism with the enzyme involved and regulation.
- Diseases caused by defects in metabolism with emphasis on the metabolic control and cure of diseases.
- Understanding of various metabolic pathways in animals.

SYLLABUS OF DSC- 2

B.Sc. (HONORS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-DSC-202: METABOLISM OF CARBOHYDRATES
SEMESTER – II

2.2 Course Contents

Theory

Credits: 2 **Total weeks : 15**

Unit 1 - Glycolysis and Gluconeogenesis **(6 weeks)**

Autotrophs, Heterotrophs, Metabolic pathways: catabolism, anabolism, ATP as energy currency, Glycolysis: overview, reactions, Regulation, inhibitors; feeder pathways for glycolysis, Galactosemia, Lactose intolerance. Cori and Cori cycle. Gluconeogenesis. Reciprocal regulation of Glycolysis and Gluconeogenesis.

Unit 2 - Fates of Pyruvate and Pentose phosphate pathway **(2 weeks)**

Fates of pyruvate: Anaerobic ATP production, fermentation. Pentose phosphate pathway: oxidative and non-oxidative arm and its importance. Relationship between glycolysis and pentose phosphate pathway.

Unit 3 - Glycogen metabolism **(3 weeks)**

Glycogen synthesis, glycogen breakdown, regulation of glycogen metabolism, glycogen storage diseases; Von Gierke, Pompe, Cori and McArdle.

Unit 4 - Citric acid cycle **(4 weeks)**

Overview of citric acid cycle, synthesis of acetyl Coenzyme A, Regulation of Pyruvate Dehydrogenase complex, enzymes of citric acid cycle, regulation of citric acid cycle, inhibitors, anaplerotic reactions, amphibolic nature. Diseases associated with metabolic irregularities. Overview of Starve feed cycle.

2.3 Practical:

Credits: 2 **Total weeks : 15**

1. Estimation of blood glucose in serum using ortho toluidine method
2. Estimation of blood glucose in serum using GOD-POD method (Glucose oxidase-Peroxidase)
3. Sugar fermentation by microorganisms.
4. Assay of salivary amylase.
5. Estimation of G-6 P by G6PDH
6. Continuous assay of Lactate Dehydrogenase

2.4 Essential readings

1. 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:10:1-4641-0962-1.
2. Principles of Biochemistry (2013) 4th ed., Voet, Donald,Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.
3. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.

Suggested readings

Berg, J.M., Tymoczko, J.L. and Stryer L., (2012) W.H. Biochemistry (7th ed.), Freeman and Company (New York), ISBN:10: 1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

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 the concepts of metabolism with an emphasis on glycolysis and gluconeogenesis	Traditional chalk and black board method, Audio visual presentation. Classroom discussion	Assignment, unit -test and practical assessment through experiment and case studies.
II	Students will learn about the fates of pyruvate and pentose phosphate pathways.	Traditional chalk and black board method with examples and reactions and experiments	MCQ based assignments, unit test and practical assessment through experiment

III	Students will learn about glycogen synthesis, breakdown and glycogen storage diseases.	Traditional chalk and black board method, Audio visual presentation. Classroom discussion	Internal assessment tests will be conducted, presentations will be assessed along with practical assessment.
IV	The students will learn about overview, enzymes and regulation of citric acid cycle. They will also learn briefly about hormonal regulation of carbohydrate metabolism and diseases associated with metabolic irregularities.	Revision of the previous classes will be conducted. Traditional chalk and black board method, Audio visual presentation	Assessment through midterm examination and internal assessment test.

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

4. Keywords

Metabolism, Carbohydrates, Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogenolysis. Glycogenesis, Pentose Phosphate Pathway

DISCIPLINE SPECIFIC CORE COURSE – 6:

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts of Cell Biology	**04**	**02**	**-**	**02**	**-**	**-**

Learning Objectives

This course will acquaint the students to the subject of Cell Biology and the types of cell divisions seen in the living system. It deals with the details of cell organelles and cell wall. It also explains the molecules which make up the matrix and the proteins which make the framework of the cell as cytoskeleton elements. It also introduces the various tools and techniques of cell biology which are used to study the cell.

Learning outcomes

After the completion of the course, the students will have:

- insights into the basic structure and function of the cell and cellular organelles.
- introduction to the concept of model systems, cell division and cell to cell interaction
- understanding of the structural framework of the cell as cytoskeletal structures
- knowledge of various techniques used in cell biology experiments

SYLLABUS OF DSC-3

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-DSC-203 : BASIC CONCEPTS OF CELL BIOLOGY
SEMESTER - II

2.2 Course Content

Theory

Credits: 2 **Total weeks : 15**

Unit 1: Tools of cell biology **(2 weeks)**

Light microscopy, phase contrast microscopy, Inverted Microscope Histochemical Staining Techniques.

Unit 2: Structure and Function of Cell Organelles **(6 weeks)**

Prokaryotic and eukaryotic cell (Plant and Animal Cell): Structural Features. Nucleus: Nuclear envelope, Nuclear pore complex. Nuclear Import and Export of biomolecules. Rough Endoplasmic Reticulum; Smooth Endoplasmic Reticulum; Golgi Apparatus; Lysosomes; Mitochondria; Chloroplasts and peroxisomes. Cell Division: Mitosis and Meiosis. Types of internalization procedures in the cell: Endocytosis, Pinocytosis and Phagocytosis

Unit 3: Extracellular matrix and Cell Junctions **(3 weeks)**

Cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherens junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata

Unit 4: Cytoskeletal proteins **(4 weeks)**

Introduction to Cytoskeletal Proteins. Structure, assembly and function of Microtubule, Microfilament and Intermediate filament.

2.3 Practical:

Credits: 2 **Total weeks : 15**

1. Differentiate prokaryotic and eukaryotic cells and visualization of animal, plant cell, bacteria cells by light microscope

2. Study of Mitosis and Identification of different stages of mitosis in onion root tip.
3. Study of Meiosis and Identification of different stages of meiosis in grasshopper testis.
4. Micrographs of different cell components (dry lab).
5. Cells as experimental models: Study life cycle of one animal model drosophila/ zebrafish/ nematode.
6. Cytochemical staining of any one biomolecule (Protein/Polysaccharide/RNA)

2.4 Essential readings:

1. The Cell: A Molecular Approach (2013) 6th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
2. Cell and Molecular Biology: Concepts and Experimentation (2016) 8th Edition, Gerald Karp Janet Iwasa and Wallace Marshall, John Wiley and Sons, Singapore, ISBN: 978-1-118-88384-6

Suggested readings:

1. 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.
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. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No	Learning Outcomes	Teaching Methods	Assessment Method
1	Students will understand the principle of functioning of various types of microscopy. They will be able to distinguish between various types of Light microscopy. They will understand how cells can be stained and studied under the microscopy	They will be taught through explanation through lectures, chalk and board explanation, Powerpoint Presentation, Videos, Modelling	Assignments, Quizzes, Research reports.
2	Students will understand cell division in somatic and reproductive cell. They will be able to differentiate one cell organelle to another in terms of structure and function. They will understand different modes of internalization into the cell.	They will be taught through explanation through lectures, chalk and board explanation, Powerpoint Presentation, Videos, Modelling	Assignments, Quizzes, Research reports.
3	Students will be able to distinguish between Cell wall of prokaryotes and eukaryotes. The will understand the composition of Cell Matrix, Understand the structure and function of various cell to cell interactions. They will be able to	They will be taught through explanation through lectures, chalk and board explanation, Powerpoint Presentation, Videos,	Assignments, Quizzes, Research reports.

	differentiate between the different cell junctions.	Modelling	
4	Students will be able to understand the cytoskeletal framework of the cell, the structure and function of three important cytoskeletal proteins, how the organization of these protein change as per the cell division, mobility and transport of organelles, the concept of treadmilling and dynamic instability	They will be taught through explanation through lectures, chalk and board explanation, Powerpoint Presentation, Videos, Modelling	Assignments, Quizzes, Research reports.

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

4. Keywords:

Cell Organelles, Mitosis, Meiosis, Prokaryote, Eukaryote, Cell Wall, Cell Matrix, Cell Junctions, Cytoskeleton Proteins, Treadmilling, Dynamic Stability, Microscopy, Histology