INDEX

DEPARTMENT OF BIOCHEMISTRY

SEMESTER-II

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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

Pool of Generic Electives (GE) Courses
Offered by Department of Biochemistry
Category-IV

GENERIC ELECTIVES (GE-2)

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
		Lecture	Tutorial	Practical/ Practice		
Techniques in Biochemistry	04	02		02	-	-

Learning 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.

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.

SYLLABUS OF GE-2

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

2.2 Course Contents

THEORY

Credit: **2** **Total weeks : 15**

Unit I: **Separation techniques** **(4 weeks)**

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 **(4 weeks)**

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

Unit III: Electrophoretic techniques **(3.5 weeks)**

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 **(3.5 weeks)**

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 weeks : 15**

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 (λ_{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. 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. 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. 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. 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. Internal assessment tests will be conducted.

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

4. Keywords

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

GENERIC ELECTIVES (GE-3)

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
		Lecture	Tutorial	Practical/ Practice		
Public Health Biology	04	02		02	-	-

Learning Objectives

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.

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.

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-3 : PUBLIC HEALTH BIOLOGY

2.2 Course Contents

Theory

Credits: 2 **Total weeks : 15**

Unit 1: Understanding public health issues **(2 weeks)**

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 **(5 weeks)**

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 **(3 weeks)**

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 **(5 weeks)**

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 weeks : 15**

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. 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. 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

GENERIC ELECTIVES (GE-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
		Lecture	Tutorial	Practical/ Practice		
Protein and Enzymes	04	02		02	-	-

Learning Objectives

The objective of this course is to provide an overview of protein biochemistry to undergraduate students with diverse science backgrounds, since proteins 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 will be introduced in this course. The course also aims to provide knowledge about enzyme kinetics, regulation of enzyme activity and diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

Learning outcomes

On successful completion of the course students will be:

- Familiar with unique features and characteristics of proteins.
- Aware of the relationship between three-dimensional structure of proteins and their functions.
- Gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity.
- Understand the kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors.
- Also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell.
- Gain insight into the applications of enzymes in research and medicine.

B.Sc. (HONOURS) BIOCHEMISTRY (NEP FRAMEWORK)
BCH-GE- 4: PROTEINS AND ENZYMES

2.2 Course Contents

THEORY

CREDITS: 2 **TOTAL WEEKS: 15**

UNIT I: Introduction to proteins **(4 weeks)**

Amino acids and their properties. Peptides and their biological significance - hormones, antibiotics and growth factors. Diversity of proteins and their functions. Conjugated proteins, multimeric proteins and metalloproteins. Organization of protein structure - primary, secondary, tertiary and quaternary structures. Bonds in protein structures - covalent and non-covalent. Dihedral angles. Ramachandran map, Secondary structure - alpha-helices, beta-strands, beta-sheets and turns.

UNIT II: Three-dimensional structures and protein folding **(3.5 weeks)**

Characteristics of tertiary and quaternary structures. Structure-function relationship in proteins. 3D structures of globular and fibrous proteins – myoglobin, hemoglobin, collagen and keratin. Protein folding - denaturation and renaturation (Ribonuclease A). Role of chaperones. Protein misfolding diseases - Alzheimer's and Cruetzfeldt-Jakob disease.

UNIT III: Introduction to enzymes and enzyme kinetics **(4 weeks)**

General characteristics of enzymes; nature of enzymes - protein and non-protein. Cofactor and prosthetic group, apoenzyme, holoenzyme. Classification and nomenclature of enzymes. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. Relationship between initial velocity and substrate concentration, equilibrium constant, steady state kinetics. Michaelis-Menten equation, Km and Vmax, Lineweaver-Burk plot. Enzyme inhibition, reversible inhibition

(competitive, uncompetitive, non-competitive and mixed) and irreversible inhibition. Examples - FdUMP and penicillin.

UNIT IV: Regulation of enzyme activity and applications of enzymes (3.5 weeks)

Control of activities of single enzymes and metabolic pathways: feedback inhibition, allosteric modulation (aspartate transcarbamoylase). Regulation by reversible covalent modification (glycogen phosphorylase). Zymogens (chymotrypsinogen). Enzymes as reagents (glucose oxidase), marker enzymes in diagnostics (SGPT, SGOT); Enzyme therapy (streptokinase); Enzymes in research (Taq polymerase, restriction endonucleases).

PRACTICALS

CREDITS: 2 **TOTAL WEEKS : 15**

1. Estimation of proteins by Biuret method.
2. Estimation of proteins by Lowry's method.
3. Determination of isoelectric pH of casein.
4. Determination of activity of an enzyme by continuous assay.
5. Determination of activity of an enzyme by discontinuous assay.
6. To plot a progress curve for an enzyme.
7. Determination of K_m and V_{max} of an enzyme using Lineweaver-Burk plot.

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. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). *Biochemistry* (9th ed.). New York, WH: Freeman ISBN-13: 9781319114671
3. Voet. D., Voet. J.G. (2013) Bi*ochemistry* (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN : 978-1-11809244-6.
4. 2. Nicholas, C.P., Lewis, S. (1999). *Fundamentals of Enzymology* (3rd ed.). New York, Oxford University Press Inc. ISBN:0 19 850229 X.

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. Schulz**,** G.E., Schirmer**,** R.H. (1979). *Principles of protein structure*. Springer, ISBN 978-1-4612- 6137-7.

3. 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	Students will gain knowledge about the building blocks of proteins i.e. amino acids and	Students will be taught using power point presentations, chalk and	Oral questions will be asked in the class. Assignment and tests

	understand about the structural organization of proteins.	board. In class oral discussion sessions will be conducted.	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	Knowledge about the basic properties and characteristics of enzymes and their action; insights into the factors affecting enzyme activity. Students will learn about the kinetics of enzyme catalyzed reactions and bisubstrate reactions	Historical perspectives; Powerpoint presentations; Teaching using chalk and board method	Oral questions will be asked in the class. Assignments to classify enzymes, determine specific activity and reaction rates
IV	Students will learn how enzymes are regulated and the importance of enzyme regulation in the cellular context. Detailed knowledge of the various applications of enzymes in medicine and research	Teaching using chalk and board method along with powerpoint presentations and video tutorials	Problems will be assigned to test student's analytical ability; Students will discuss methods of regulation in groups

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

4. Keywords

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

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

GENERIC ELECTIVES (GE-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
		Lecture	Tutorial	Practical/ Practice		
Nutrition and Food Science	04	02		02	-	-

Learning Objectives

The course aims to provide the basic knowledge of food and its importance in nutrition. The students will understand the importance of a balanced diet and the association of life style disorders with unhealthy food eating habits. They will be able to understand the concept of under and over nutrition and the deficiency diseases that result due to deficiency of micronutrients in diet.

Learning outcomes

Students will learn about

- The importance of food in our life
- How food is spoiled and learn about some common food borne diseases/ food allergies
- The functions of macro and micronutrients in our body
- The diseases associated with malnutrition/ overnutrition and deficiency diseases

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-5 : NUTRITION AND FOOD SCIENCE

2.2 Course Contents

Theory

Credits: 2 **Total weeks : 15**

Unit 1 –Basics of Food Science and Nutrition **(2.5 weeks)**

Definition of Food, Nutrition, Nutrient, Nutritional status

Energy value of foods, determination, physiological fuel values, SDA of foods, BMR & RMR, factors influencing BMR. Recommended allowance-RDA for Indians, basis for requirement, energy allowance for different growth pattern of children, energy allowance for various activities and different age groups

Balanced diet, fad diets

Unit 2– Macronutrients **(5 weeks)**

Introduction to macronutrients and their function, digestion, absorption and assimilation of carbohydrates, lipids and proteins, Glycemic response and glycemic index of foods, dietary fiber- types, properties, sources and its role, importance of essential fatty acids, their requirements and deficiency, role & nutritional significance of PUFA, MUFA, SFA, omega-3/omega 6 fatty acid, essential amino acids, dietary protein quality- PER, NPU, BV, chemical score and PDCAAS. Factors affecting protein bio-availability including anti-nutritional factors, protein toxicity, amino acid complementation and Supplementation in foods

Unit 3 – Micronutrients **(5 weeks)**

Fat soluble vitamins: Sources, physiological importance and deficiency diseases

Water soluble vitamins: Sources, physiological importance and deficiency diseases

Minerals: Sources, physiological importance and diseases due to excess or deficiency of Ca, P, Na, K, Fe, Zn, S, Mg, Se, Cu.

Unit 4 – Food and Health **(2.5 weeks)**

Food as medicine: medicinal value of functional foods such as garlic, ginger, turmeric, tulsi, fenugreek, ajwain, aloe vera, moringa, role of Gut microbiome in maintaining health, pre and probiotics, various types of food additives: emulsifiers, preservatives and food colors, benefits and risks associated with these, food allergies, food spoilage, food poisoning, food borne diseases, Cholera, Hepatitis, Typhoid, Botulism

2.3 Practicals
Credits: 2 **Total weeks : 15**

1. Analysis of food labels for the presence of nutrients and other additives.
2. Estimation of carbohydrate content in food
3. Degree of unsaturation of any three different oils using Bromine test
4. Acid value / peroxide value of oil
5. Estimation of vitamin E / vitamin C in food
6. Morphological identification of important yeast and mold in foods (slides and culture)-
7. Assessment of diet chart for the presence/absence of nutrients
8. Case studies: PEM (Marasmus and Kwashiorkor), Diabetes, Obesity, Vitamin and mineral deficiency

2.4 Essential readings:

1. Mahan, L.K., Strings, S. E., Raymond, J. (2012) *Krause's Food and Nutrition Care process.* Elsevier's Publications. ISBN: 978-1-4377-2233-8.
2. Rosalind Gibson (2005). *Principles of Nutritional Assessment.* Oxford University Press. ISBN: 978019517169
3. Nelson, D.L., Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7th ed.). New York, WH: Freeman and Company. ISBN13: 9781464126116, ISBN10: 1464126119
4. Vasudevan, D.M., & Das, K.S. (2020). *Practical textbook of biochemistry for medical students* (3rd ed.). Jaypee Brothers Medical

Suggested readings:

1. Practical Biochemistry, Damodaran Geetha K, Jaypee Brothers Medical Publishers Private Limited; 1st edition (1 January 2011), ISBN: 9789350251416, 9789350251416
2. 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.
3. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

4. Coombs Jr. G.F., (2008). *The vitamins, Fundamental aspects in Nutrition and Health.* Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
5. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

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 be taught the importance of food and balanced diet and the energy values associated with food	Teaching will be conducted both through black board mode and power point presentation mode. The students will be asked to make a note of their diet and the calories associated with the food intake	Students will be asked questions related to the topic and class discussion will be held
2	Students will learn about the macronutrients in diet and how they are digested and assimilated, the importance of micronutrients in health will be discussed	Teaching will be conducted both through black board mode and power point presentation mode. The students will perform some practical to determine macronutrients in food	Assignment will be given
3	Students will learn about the role of Ca, P, Fe, Zn etc in the diet	Teaching will be conducted both through black board mode and power point presentation mode. The students will perform some practical to determine micronutrients in food	Quiz and classroom discussions will be held, they will be asked to present a paper
4	They will learn about the importance of food as medicine and about food spoilage, food allergies, food poisoning, pro/prebiotics	Teaching will be conducted both through black board mode and power point presentation mode.	Mid semester test will be held and assignments will be given

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

4. Keywords:

Food, Nutrition, macronutrients, micronutrients, food as medicine, food spoilage, food allergies

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