UNIVERSITY OF DELHI

CNC-II/093/1(22)/2022-23/223
Dated: 11.10.2022

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 18-1-5 dated 18.08.2022]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-I of the following departments under Faculty of Interdisciplinary & Applied Sciences based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

DEPARTMENT OF BIOCHEMISTRY
BSc (H) Biochemistry
Category-I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1) – : Biomolecules

Credit distribution, Eligibility and Prerequisites 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		
Biomolecules DSC 1	4	2	0	2	Class XII Science Combination I: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry +	NIL

					Physics OR Combination II: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry + Mathematics	

Learning Objectives

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

Learning outcomes

On successful completion of the course students will be:

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

SYLLABUS OF DSC - 1

THEORY

Unit – 1 **(07 Hours)**

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

Unit – 2 **(08 Hours)**

Carbohydrates: Introduction, classification and importance of carbohydrates. Monosaccharides - the structure of aldoses and ketoses; Optical properties of sugars: conformations of sugars, mutarotation, anomers, epimers and enantiomers; Chemical properties (Oxidation and reduction of sugars); reducing and non-reducing sugars; Glycosidic linkages (O- and N-type), formation of disaccharides (sucrose, maltose, lactose, trehalose), tri- and oligosaccharides (raffinose, rhamnose, and stachyose) Polysaccharides: homo- and heteropolysaccharides, structural (cellulose and chitin) and storage polysaccharides (starch and glycogen); Role of glycoconjugates with examples - proteoglycans, glycoproteins and glycolipids; Carbohydrates as recognition molecules.

Unit –3 **(07 Hours)**

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

Unit – 4 **(05 Hours)**

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

Unit – 5 **(03 Hours)**

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

PRACTICAL

(60 Hours)

1) Laboratory safety and standards (precision, accuracy and sensitivity). Preparation of solutions (w/w, w/v, Molar, Normal)
2) Concept of buffer, buffering capacity and Henderson-Hasselbalch equation. Preparation of acetate buffer/phosphate buffer
3) Titration graph of acetic acid and Glycine.

4) Qualitative analysis of Amino acids (Ninhydrin, Xanthoproteic, Millon's, and lead acetate test)
5) Qualitative test for Carbohydrates: monosaccharides, disaccharides, and polysaccharides (Molisch, Fehling/ Benedict, Barfoed, Seliwanoff's, Osazone and Iodine test)
6) To determine the Iodine Number of oil/fat.
7) Qualitative test for Nucleic acid (Orcinol and DPA).

ESSENTIAL/RECOMMENDED READINGS

1) 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.
2) Berg, J. M., Tymoczko J. L. and Stryer L. (2011) 7th Edition. Biochemistry. New York, USA: W. H. Freeman and Co. ISBN-13: 978142927635.
3) An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

SUGGESTIVE READING:

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

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

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): Proteins

Credit distribution, Eligibility and Prerequisites 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		
Proteins DSC 2	4	2	0	2	Class XII Science (Combination I: Chemistry + Biology/ Biological Studies/ Biotechnology/	NIL

Biochemistry + Physics OR

Combination II: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry + Mathematics)

Learning Objectives

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

Learning Outcomes

After completion of the course, a student will

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

SYLLABUS OF DSC - 2

THEORY

Unit – 1 **(2 Hours)**

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

Unit – 2 **(12 Hours)**

Hierarchy of protein structure organization: Organization of protein structure into primary, secondary, tertiary and quaternary structures. Forces stabilizing the protein structure - covalent

(disulfide bridges) and non-covalent (electrostatic interactions and salt bridges, hydrophobic, hydrogen bonding, van der Waals). The peptide bond, dihedral angles psi and phi, helices, sheets, turns and loops, Ramachandran map. Motifs and domains. Structural proteins - α-keratin, silk fibroin, collagen. Globular and fibrous proteins, membrane proteins.

Unit – 3 **(05 Hours)**

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

Unit – 4 **(05 Hours)**

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

Unit – 4 **(6 Hours)**

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

PRACTICAL

(60 Hours)

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

ESSENTIAL/ RECOMMENDED READINGS

1) Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman and Company. ISBN13: 9781464126116, ISBN10: 1464126119
2) Schulz, G.E., Schirmer, R.H. (1979). Principles of protein structure. Springer, ISBN 978-1-4612- 6137-7
3) Scopes, R.K. (1994) Protein Purification. Principles and Practice (3rd ed). Springer, ISBN 978-1-4737-2333-5

4) Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.). New York, WH:Freeman ISBN-13: 9781319114671
5) Voet. D., Voet. J.G. (2013) Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN : 978-1-11809244-6.

SUGGESTIVE READING:

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

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

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): Biochemical Techniques

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		
Biochemical Techniques DSC 3	4	2	0	2	Class XII Science (Combination I: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry + Physics OR Combination II: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry + Mathematics)	NIL

Learning Objectives

The objective of the course is to introduce various techniques to students that are used in a biochemistry lab. It will provide them an understanding of the principles underlying various

techniques. They will develop skills in the form of practical exercises and gain knowledge, which can be applied to pursue research and will be helpful in getting a suitable placement.

Learning Outcomes

On successful completion of this course, the students will

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

SYLLABUS OF DSC – 3

THEORY

Unit – 1 **(07 Hours)**

Spectroscopic Technique: Introduction to electromagnetic radiation. Principle of UV-visible absorption spectrophotometry. Working, instrumentation and applications of spectrophotometer, Lambert's law, Beer's law. Factors affecting UV-vis absorption, bathochromic shift and hypsochromic shift. Fluorescence spectrophotometry: Phenomena of fluorescence, stoke's shift, quantum yield, intrinsic and extrinsic fluors with example, working and applications of fluorimeter.

Unit – 2 **(06 Hours)**

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

Unit – 3 **(09 Hours)**

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

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

Unit – 4 **(08 Hours)**

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

PRACTICAL

(60 Hours)

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

ESSENTIAL/RECOMMENDED READINGS

1) Wilson, K. & Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8.
2) Boyer, R. F. (2012) Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027.
3) Sheehan, D. (2010). Physical biochemistry: Principles and applications (2nd ed.). Chichester: Wiley-Blackwell.
4) Plummer, D.T. (1998). An Introduction to Practical Biochemistry (3rd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

SUGGESTIVE READING:

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

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

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES
OFFERED BY DEPARTMENT OF BIOCHEMISTRY
Category-IV

GENERIC ELECTIVE (GE-1: MOLECULES OF LIFE)

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		
Molecules of Life GE 1	4	2	0	2	Class XII Science	NIL

Learning Objectives

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

Learning outcomes

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

SYLLABUS OF GE - 1

THEORY

Unit – 1 **(2 Hours)**

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

Unit – 2 **(6 Hours)**

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

Unit – 3 **(7 Hours)**

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

Unit – 4 **(7 Hours)**

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

Unit – 5 **(8 Hours)**

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

PRACTICAL **(60 Hours)**

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

ESSENTIAL/ RECOMMENDED READINGS

1) 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.
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) Pratt, C.W. and Cornely, K. (2017). Essential Biochemistry (4th ed.) John Wiley& Sons, Inc.ISBN:9781119012375

SUGGESTIVE READING:

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

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

GENERIC ELECTIVES (GE-2): TECHNIQUES IN BIOCHEMISTRY

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	4	2	0	2	Class XII Science	NIL

GE 2

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

Unit - 1 **(8 Hours)**

Separation techniques: 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 – 2 **(8 Hours)**

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

Unit - 3 **(7 Hours)**

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

Unit - 4 **(7 Hours)**

Spectroscopic techniques: 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.

Practical

(60 Hours)

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 (λmax).
5) Calculate molar extinction coefficient of the given sample.
6) Demonstration of PAGE and Agarose gel electrophoresis.

ESSENTIAL/RECOMMENDED READINGS

1) Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8.
2) Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027.

3) 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.

SUGGESTIVE READING:

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

2) Freifelder, D. (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (2nd ed.), W.H. Freeman and Company (New York); ISBN:0-7167- 1315-2 / ISBN:0-7167-1444-2.

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

GENERIC ELECTIVES (GE-3): PUBLIC HEALTH BIOLOGY

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 GE 3	4	2	0	2	Open to All	NIL

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

On successful completion of the course

- 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.

SYLLABUS OF GE – 3

THEORY

Unit – 1 **(04 Hours)**

Understanding public health issues: 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 **(10 Hours)**

Public Health Nutrition: 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 – 3 **(06 Hours)**

Infectious biology and sanitation: 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 **(10 Hours)**

Environmental Health & Community Health: 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

PRACTICAL

(60 Hours)

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.

ESSENTIAL/ RECOMMENDED READINGS

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.

SUGGESTIVE READING:

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.

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

UNIVERSITY OF DELHI

CNC-II/093/1(23)/2022-23/
Dated: 14.03.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 38-1/ (38-1-5) dated 08.12.2022]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-II of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

DEPARTMENT OF BIOCHEMISTRY

Category-I

BSc. (Hons.) Biochemistry

DISCIPLINE SPECIFIC CORE COURSE – 4: Enzymes

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	0	02	Class XII passed with Biology	NIL

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.

Unit I: Introduction to enzymes and features of catalysis **(6 Hours)**

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 **(8 Hours)**

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 **(8 Hours)**

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 **(08 Hours)**

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: 60 Hours

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.

2. 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	0	02	Class XII passed with Biology	NIL

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.

Unit 1 - Glycolysis and Gluconeogenesis **(12 Hours)**

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 **(04 Hours)**

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 **(06 Hours)**

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

Unit 4 - Citric acid cycle **(08 Hours)**

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: 60 Hours

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. Keywords

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

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

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	0	02	Class XII passed with Biology	NIL

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

Theory

Unit 1: Tools of cell biology **(04 Hours)**

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

Unit 2: Structure and Function of Cell Organelles **(12 Hours)**

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 **(06 Hours)**

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 **(08 Hours)**

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

2.3 Practical: 60 Hours

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. Keywords:

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

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

Category-IV

Pool of Generic Electives (GE) Courses

Offered by Department of Biochemistry

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	0	02	Class XII passed with Biology	NIL

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

Unit I: Separation techniques **(08 Hours)**

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 **(08 Hours)**

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

Unit III: Electrophoretic techniques **(07 Hours)**

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 **(07 Hours)**

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 – 60 Hours

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. Keywords

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

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

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	0	02	Class XII passed with Biology	NIL

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.

2.2 Course Contents

Theory

Unit 1: Understanding public health issues **(04 Hours)**

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 **(10 Hours)**

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 **(06 Hours)**

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 **(10 Hours)**

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: 60 Hours

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. Keywords

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

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

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

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	0	02	Class XII passed with Biology	NIL

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.

2.2 Course Contents

THEORY

UNIT I: Introduction to proteins (08 Hours)

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 (07 Hours)

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 (08 Hours)

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 (07 Hours)

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 - 60 Hours

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.

2. 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	0	02	Class XII pass	NIL

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

2.2 Course Contents

Theory

Unit 1 –Basics of Food Science and Nutrition **(05 Hours)**

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 **(10 Hours)**

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 **(10 Hours)**

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 **(05 Hours)**

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 – 60 Hours

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.

2. 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.

UNIVERSITY OF DELHI

CNC-II/093/1(25)/2023-24/79
Dated: 15.06.2023

N O T I F I C A T I O N

Sub: Amendment to Ordinance V

[E.C Resolution No. 60/ (60-1-4) dated 03.02.2023]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-III of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

DEPARTMENT OF BIOCHEMISTRY

Category-I

BSc. (Hons.) Biochemistry

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 Lipids	04	02	0	02	Class XII with Science	NIL

Learning Objectives

The aim of this course is to give students an exhaustive understanding of lipid metabolism, enzymes involved in various catabolic and anabolic pathways of lipids, and their regulation. The course will also discuss the significance of such pathways in the context of metabolic disorders.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the concepts of metabolism of lipids, characteristics of metabolic pathways and strategies used to study these pathways.
- Apply the knowledge of various catabolic and anabolic pathways in lipid metabolism and their regulation.
- Describe the diseases caused by defects in metabolism with emphasis on metabolic control.

SYLLABUS OF DSC-7

2.2 Course Contents

Theory

Unit 1. Digestion absorption and transport of lipids (04 Hours)

Digestion and absorption of lipids, Structure, classification and biogenesis of lipoproteins, Endogenous and exogenous pathways, Lipoprotein cycle.

Unit 2. Degradation of lipids (10 Hours)

Fatty acid oxidation: Activation of fatty acids, transport to mitochondria, β oxidation of saturated, unsaturated, odd and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal β oxidation, ω oxidation and α oxidation. Ketone-body synthesis and utilization and its regulation. Ketone body metabolism in diabetes and starvation.

Unit 3. Synthesis of lipids (12 Hours)

Transport of mitochondrial Acetyl groups to cytosol, Fatty acyl synthase complex, Synthesis of saturated and unsaturated fatty acids, Regulation of fatty acid metabolism. Fatty acid elongation systems, role of mixed function oxidases in fatty acid desaturation. Synthesis of triacylglycerol, glycerophospholipids and sphingolipids.

Unit 4. Cholesterol metabolism (4 Hours)

Biosynthesis of cholesterol and its regulation. Fates of cholesterol, cholesterol transport. Familial Hypercholesterolemia, Dyslipidemia, and atherosclerosis.

2.3 Practical: 60 Hours

1. Isolation of lipids and determination of phospholipid/ cholesterol ratio from egg yolk
2. Separation of Phospholipids by TLC
3. Estimation of Ketone bodies in blood/urine
4. Total Cholesterol estimation and HDL-Cholesterol estimation
5. Triglyceride estimation and lipid profile
6. Case studies: Obesity, Dyslipidaemia, Metabolic syndrome, Fasting, Ketosis

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8th ed.). New York, WH: Freeman and Company. ISBN-10: : 1319381499 ISBN-13-978 1319381493
2. Devlin, T.M. (2011). Textbook of Biochemistry with Clinical Correlations (7th ed.). New York, John Wiley & Sons, Inc. ISBN:978-0-470-28173-4.
3. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN:978-1-11809244-6.

Suggested readings:

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). *Biochemistry* (9th ed.). New York, WH: Freeman ISBN-13: 9781319114671
2. Denise R Ferrier (2018) Lippincott Illustrated Reviews Biochemistry, 7th Edition Publisher. Wolter Kluwer; ISBN-10. 8184739141.

4. Keywords

Lipids, Lipoproteins, triacylglycerol, Fatty acid oxidation, multienzyme complex, desaturases, ketone bodies, cholesterol

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

DSC-8 : BIOENERGETICS

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		
Bioenergetics	04	02	00	02	Class XII with Science	NIL

Learning Objectives

The objective of the course is to provide students with the basic understanding of thermodynamic principles, bioenergetics and the roles of high energy compounds in metabolism. The course will also provide an understanding of the biological oxidation reduction reactions. The course will introduce students to the detailed molecular mechanisms of oxidative phosphorylation and structural as well as functional aspects of ATP synthase. The course will provide an in-depth knowledge of photophosphorylation.

Learning outcomes

On successful completion of the course students will be able to:

- Describe the basic tenets of thermodynamics and energy transformations that are taking place in the cell
- Explain the biological oxidation-reduction reactions and the mechanisms of electron transfer by electron carriers.
- Appreciate the concept of chemiosmotic theory and the mechanism of oxidative phosphorylation and ATP synthesis.
- Elaborate the basic mechanisms photophosphorylation in plants and microbes.

SYLLABUS OF DSC-8

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-DSC-302: BIOENERGETICS
Semester – III

Unit I: Principles of Thermodynamics **(6 Hours)**

Laws of thermodynamics, Thermodynamic quantities: Gibbs free energy, enthalpy, entropy, Free energy change. Standard free energy change, equilibrium constant, actual free energy change, coupled reactions, energy charge, phosphorylation potential, ATP cycle. Chemical

basis of high standard free energy change of hydrolysis of ATP, phosphoenolpyruvate, 1,3 bisphosphoglycerate, phosphocreatine and thioesters. Bioluminescence.

Unit II: Biological Oxidation-reductions (4 Hours)

Redox reactions, reduction potentials, standard reduction potential and its relationship with standard free energy change, Nernst equation. Universal electron carriers-NADH and $FADH_2$.

Unit III: Oxidative phosphorylation (10 Hours)

Mitochondria as the site of oxidative phosphorylation, electron carriers in mitochondria, structural and functional organization of the mitochondrial respiratory chain, proton motive force, chemiosmotic hypothesis, inhibitors and uncouplers of mitochondrial electron transport chain. Structure of FoF1 ATP synthase and mechanism of ATP synthesis. Shuttle systems in mitochondria: Malate-aspartate and Glycerol 3-phosphate. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis Alternative respiratory pathways in plants.

Unit VI: Photophosphorylation (10 Hours)

Harvesting light energy. General features of photophosphorylation, historical background and Hill's reaction. Role of photosynthetic pigments and light harvesting systems in plants and microbes. Photophosphorylation in purple and Green sulfur bacteria. Photophosphorylation in plants. Molecular architecture of Photosystem I and Photosystem II. The Z-scheme of photosynthetic electron flow. Oxygen evolving complex, cyclic photophosphorylation and its significance, ATP synthesis by photophosphorylation, efficiency of photophosphorylation, Bacteriorhodopsin.

2.3 Practical: - 60 Hours

1. Study the photosynthetic O_2 evolution in hydrilla plant.
2. Isolation of chloroplast from spinach leaves.
3. Estimation of chlorophyll content.
3. Study the Hill reaction by using artificial electron acceptor.
4. Estimation of the activity of PS-II.
5. Separation of photosynthetic pigments by TLC.
6. Isolation of mitochondria from liver and assay of mitochondrial marker enzyme SDH.

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8^{th}ed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN-10:1319381499.
2. Berg, J.M., Tymoczko, J.L., Gatto G.J., Stryer L. (2019) *W.H:* Freeman and Company, ISBN:10: 1319114679, ISBN:13:978-1319114671

3. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6thed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205

Suggested readings:

1. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). New York, WH: Freeman & Company. ISBN-13: 978-1319208523, ISBN-10:1319208525.
2. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN : 978-1-11809244-6.

3. Keywords

Thermodynamics, free energy, oxidative phosphorylation, ATP synthase, photophosphorylation

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

DSC-9: MEMBRANE BIOLOGY

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		
Membrane Biology	04	02	00	02	Class XII with Science	NIL

Learning Objectives

The objective of the course is to provide students with the basic understanding of membrane composition, structure-function relationship and properties of membranes. The course will also provide an understanding of the various types of membrane transporters and their molecular mechanisms. This course also provides understanding of molecular mechanisms involved in vesicular transport processes and membrane fusion.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the general composition and structure of biomembranes.
- Describe the basic properties of membranes such as membrane fluidity.
- Elaborate various types of membrane transport mechanisms.
- Apply the knowledge gained about the molecular mechanism of vesicular transport and membrane fusion to understand the functioning of cells.

SYLLABUS OF DSC-9

Theory

Hours – 30 Hours

Unit I: Membrane composition and structure (10 Hours)

Composition of membranes: Lipids -Phospholipids, Glycolipids, sterols; Proteins - Peripheral Proteins, Integral Membrane Proteins and Lipid-Anchored proteins, and carbohydrates.

Historical background and various membrane models. Overview of membrane functions.

Comparison of the composition of various cellular and subcellular membranes. Lateral and transverse asymmetry in membranes. Role of Flippase, Floppase and Scramblase.

Model systems to study membranes - Lipid Monolayers, Planar Bilayer and Liposome, and their application. Polymorphic Lipid-Water Systems. The various determinants of polymorphic phases: CMC, lipid shape, critical packing parameter.

Unit II: Membrane dynamics (5 Hours)

Membrane fluidity: lateral, transverse and rotational motion of lipids and proteins. Factors affecting membrane fluidity- composition, barriers (tight junctions), cytoskeleton interactions,
microdomains – rafts, caveolae. Fence and gate model. Study of RBC membrane architecture.
Homeoviscous Adaptation. Techniques to study membrane dynamics: FRAP, TNBS, SPT.

Unit III: Membrane transport (9 Hours)

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport glucose transporter and anion transporter. Primary active transporters- P-type ATPases, V-type ATPases, F-type ATPases. Secondary active transporters - lactose permease, Na+ - glucose symporter. ABC family of transporters – MDR and CFTR. Group translocation and bacteriorhodopsin. Ion channels: voltage-gated ion channels (Na+ and K+ channel) and ligand-gated ion channels (acetylcholine receptor), and aquaporins. Ionophores: valinomycin, gramicidin. Relationship of membrane transport and diseases.

Unit IV: Vesicular transport and membrane fusion (6 Hours)

Vesicular transport. Vesicles, Clathrin-Coated Vesicles and COP-Coated Vesicles (COPI and COPII). Molecular Mechanism of Vesicular Transport. Membrane Fusion (dynamin protein, Rab proteins, NSF/ SNAP complex, SNARE proteins). Receptor Mediated Endocytosis: LDL, Transferrin

2.3 Practical:

Total Hours : 60 Hours

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Isolation of membrane phospholipids and separation by TLC.
3. Effect of temperature, pH, detergents, and ionic strength on Tonoplast membrane of beetroot.
4. Determination of CMC of detergents, neutral and ionic
5. Preparation of RBC ghost cell.
6. Separation of RBC membrane proteins by SDS-PAGE.
7. Demonstration of Histidine uptake from the intestinal membrane.

2.4 Essential readings:

1. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6thed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205

2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9thed.). New York, WH: Freeman & Company. ISBN-13: 978-1319208523, ISBN-10:1319208525.
3. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8thed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN-10:1319381499.
4. Voet, D., Voet. J. G. (2013). Biochemistry (4thed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN: 978-1-11809244-6.
5. Wardhan, R., Mudgal, P. (2017). Text Book on Membrane Biology (1sted.). Singapore, Springer. ISBN-10: 9811071004, ISBN-13: 978-9811071003

3. Keywords:

Membrane structure composition, membrane fluidity, membrane transport, vesicles, membrane fusion

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

COMMON POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSEs)

DISCIPLINE SPECIFIC ELECTIVE (DSE-1)

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		
Environmental Biochemistry	**04**	**02**	**00**	**02**	**Class XII with Science**	**NIL**

Learning Objectives

This course will provide understanding of environment around and which pollutants are of concern to us. It will provide knowledge of sustainability and methods which can help to improve the sustainability. It will also make students understand how toxicity can be monitored in our body and how our body copes to detoxify its internal system. It will also introduce methods which can be used to monitor the pollutants in various samples.

Learning outcomes

On successful completion of the course students will be able to:

- Describe various components of the environment.
- Evaluate the local and global scale of environmental problem.
- Explain the biological, chemical and physical processes relevant to environmental problems.
- Apply the hands on experience of some quantitative and qualitative research tools gained to assess and analyse the environmental problems

Theory

Credits: 2 **Total Hours- 30**

Unit 1: Introduction to Environment and the Pollutants **(9 Hours)**

Components of Environment - Atmosphere, Hydrosphere, Lithosphere and Biosphere. Global Warming and Climate change. Ozone depletion. Normal Chemistry of - Air, Water, Soil. Environmental Toxins-Physical Pollutants- Noise, Light and Radiation and Air Pollutants- Carbon Monoxide, Lead, Nitrogen Oxides, Ozone, Particulate Matter, Sulphur Dioxide, Methane Volatile Organic Chemicals (VOC); Water Pollutants - Volatile Organic Chemicals (VOC), Heavy Metals, Insecticides, Herbicides/ Endocrine Disruptors; Soil Pollutants-

Heavy metals, Herbicides/pesticides, Polyaromatic Carbon (PAH), Microplastics; Source, Effect and Impact on Flora, Fauna including Human Beings. Definition of Terminologies: Air Quality Index (AQI) Suspended Particulate matter (SPM), Water Quality Index (WQI), Air Pollution Tolerance Index (APTI), Anticipated Performance Index (API).

Unit 2: Environment and Xenobiotics (7 Hours)

Understanding the principle of Toxicity. Concept of Dose and Response (LD50). Process of Bioaccumulation, Bioaugmentation and Biotransformation. Impact of pollutants on human health Mammalian Detoxification by Liver to Organic Chemicals (Heavy Metals, Endocrine Disruptors, Microplastics).

Unit 3: Sustainability and its Enhancement (8 Hours)

Concept of Sustainability and Enhancement of Sustainability, Waste Management (Refuse, Reduce, Reuse and Recycle), Sewage treatment and Industrial effluents (tanning and electroplating), Bioremediation- Introduction and Types of Bioremediations- Phytoremediation, Microbial Bioremediation, In-situ Remediation, Ex-situ Remediation.

Unit 4: Techniques to Analyse Pollutants (6 Hours)

Determination of pollutants in soil, water, air, blood by following Analytical Techniques: Flame Photometer; Atomic Absorption Spectroscopy (AAS); Inductive Coupled Plasma (ICP -OES & MS); Gas Liquid Chromatography (GC-MS); Ion Chromatography; High Performance Liquid Chromatography (HPLC); UV spectrophotometer; Biosensors and its application in pollution detection; Metagenomics.

2.3 Practical:

Credits: 2 Total Hours - 60

1. Evaluating APTI and API of Herbs/Shrubs/Trees
2. Evaluating seasonal variations of AQI and SPM
3. Evaluating C/N/P/K content of soil by Spectrophotometry/Titrimetric method
4. Detecting Microbial Contamination of water
5. Composting of waste (Leaf/Kitchen Waste/Cow dung) and Detecting Maturity by pH and Electric conductivity (EC) content changes
6. Studying Enzymatic Activity (amylase/urease) in the soil sample due to microbial activity
7. Student Environment Projects.

2.4 Essential readings:

- Basic Concepts on Environmental Chemistry by Des. W. Conwell (2005) 2nd edition, CRC press, ISBN 9781498770484
- Environmental Chemistry by Stanley E Manahan, 11th Edition, Taylor and Francis,2022, ISBN 9780367560546
- Biodegradation and Bioremediation by Alexander Martin, 2nd Edition, Academic Press, ISBN 978-0-12-049861-8

- Fundamentals of Ecology author Eugene Odum, Cary W. Barrett, 5th edition Cengage learning India. ISBN 9788131500200
- Environment and Ecology author P.D. Sharma, 12th Edition, Rastogi Publication. ISBN 978-93-5078-068-8

3. Keywords

Environment, Climate Change, ozone depletion, Waste Management, Bioremediation, Toxicity, Bioaccumulation, Bioaugmentation, Biotransformation, Detoxification, Biosensors.

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

DISCIPLINE SPECIFIC ELECTIVE (DSE-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 (if any)
		Lecture	Tutorial	Practical/ Practice		
Biochemical Applications in Forensic Sciences	**04**	**02**	**00**	**02**	**Class XII with Science**	**NIL**

Learning Objectives

The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidence, which will help students develop analytical and problem-solving skills for real life situations. With a background of the DSC of Biochemistry, the students get an insight into a major area of application of Modern Biology. The course will keep abreast with all recent developments and emerging trends in forensic science like DNA fingerprinting, brain mapping and facial reconstruction; thus, helping interested students take up forensic science as a future course of study.

Learning outcomes

On successful completion of the course students will be able to:

- Describe the fundamental concepts and principles of forensic science and their significance.
- Explain how a forensic investigation is initiated through preservation of evidences, as well as chemical, physical and biological methods of their analysis
- Identity an individual by document evaluation, fingerprints, footprints and DNA analysis and identify the accurate age, sex and identity of an individual and identify time and cause of death in a forensic investigation.
- Explain the importance of precision, reproducibility and accuracy in identification of a biological sample.
- Elaborate the methods used to analyze samples for drug testing, ink and stain testing and document and handwriting verification.
- Describe the physiology and biochemistry behind tests like Narco Analysis, polygraphy, lie detection and facial reconstruction.
- Apply the knowledge gained from hands-on-experience in some of the basic biochemical processes involved in forensic investigation.

2.2 Course Contents

Theory

Unit I: Introduction to forensic science and application of biological sciences to forensic investigation (10 Hours)

History and Development of Forensic Science, Biochemical analysis of various biological evidences: blood, semen, viscera, bite marks, and hair. Establishment of identity of individuals: fingerprints, footprints, blood and DNA. Anthropology – skeletal remains, Odontology. Time of death - rigor mortis, liver mortis, algor mortis, forensic entomology. Biochemical basis for determination of cause of death. case studies

Unit II: Application of chemical sciences to forensic investigation (6 Hours)

Detection of drugs of abuse and narcotics in biological samples, Toxicological examination of viscera, detection of petroleum products and food adulteration. Analysis of inks and their use in questioned document identification. Blood spatter analysis, Case studies

Unit III: DNA Fingerprinting (6 Hours)

Introduction to DNA-and source of DNA in Forensic case work, Techniques of DNA fingerprinting-RFLP, STR, PCR, DNA fingerprinting in paternity disputes, mass disaster and other forensic case work, studying kinship by DNA profiling: Related individuals have similar DNA profiles, DNA profiling and the remains of the Romanovs. Sex identification by DNA analysis: PCRs directed at Y chromosome-specific sequences, Amelogenin gene typing. Case studies

Unit IV: Recent advances in forensics (8 Hours)

Narco analysis: theory, forensic significance, future prospect, *Brain mapping:* introduction, EEG, P-3000 wave, forensic applications, limitation of technique, *Polygraph*: Principle and technique, polygraph as forensic investigative tool, use of psychoactive drugs in forensic analysis. NHRC guidelines for polygraph test. *Facial reconstruction*: Method and technique, facial reconstruction in forensic identification, Case studies.

2.3 Practicals – 60 Hours

1. Definition, Identification and Mapping of Crime scene
2. Collection, Preservation, Packaging, and Labeling of biological evidence for their forensic investigation.
3. Preliminary and Confirmatory test for blood/semen/saliva
4. Examination of Micro Evidences: fiber, hair, pollen and soil
5. Fingerprint development from various surfaces and their microscopic and chemical examination
6. Handwriting identification based on class characteristic and individual characteristics
7. Identification of dyes, drugs and ink by TLC

8. Blood spatter analysis
9. DNA Fingerprinting: Sex determination through Y specific STRs and Maternal lineage identification through mitochondrial DNA comparisons.
10. Field trip to a forensic laboratory

2.4 Essential readings:

- James, S.H., Nordby, J.J. & Bell, S. (2014). *Forensic Science: An Introduction to Scientific and Investigative Techniques, Fourth Edition*: Taylor & Francis. ISBN 9781439853832
- Jones, P., & Williams, R.E. (2009). *Crime Scene Processing and Laboratory Workbook First Edition*: CRC Press. ISBN 9780429249976
- Saferstein, R. (2018). *Criminalistics: An Introduction to Forensic Science, Twelveth edition*: Pearson Education. ISBN 10:0134477596, ISBN 13: 9780134477596
- Veeraraghavan, V. (2009). *Handbook of Forensic Psychology, First Edition*: Selective & Scientific Books, ISBN 13: 9788189128166.

Suggested readings:

- Lee, H., Palmbach, T. & Miller, M. (2001). *Henry Lee's crime scene handbook, First Edition*: Academic Press ISBN 9780080507989
- Parikh, C.K. (2016). *Parikh's textbook of medical jurisprudence, forensic medicine and toxicology: for classrooms and courtrooms*, *Seventh Edition*: CBS Publishers and Distributors. ISBN 9788123926469

3. **Keywords**

Forensic biology; blood spatter analysis; toxicology; narco-analysis; DNA fingerprinting; polygraph; odontology; forensic entomology.

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

DISCIPLINE SPECIFIC ELECTIVE (DSE-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 (if any)
		Lecture	Tutorial	Practical/ Practice		
Microbiology	04	02	00	02	Class XII with Science	NIL

Learning Objectives

The course aims to trace the history of development of the discipline of Microbiology and to emphasize the existence of the immense diversity in the microbial world and maintenance of microbes under laboratory conditions. Through this course students will be introduced to the concept of different modes of gene transfer in bacteria. Further, students will be made aware about the applications of microorganisms in food and industry.

Learning outcomes

On successful completion of the course students will be able to:

- Identify different types of microbes
- Perform routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, microbial growth etc.
- Carry out basic research using microbes
- Describe varied applications of microbes

2.2 Course Contents

Theory

Unit I: History and Diversity of Microbial world (8 Hours)

Spontaneous generation versus biogenesis, contributions of Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Richard Petri, Charles Chamberland, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei Winogradsky, Alexander Fleming, Elie Metchnikoff and Emil von Behring. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa. Cell-wall: Composition and detailed structure of Gram positive and Gram-negative cell walls, mechanism of Gram staining

Unit II: Microbial Nutrition, Growth and Control (6 Hours)

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH,

temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics.

Unit III: Microbial Genetics **(6 Hours)**

Conjugation, Transformation and Transduction. Gene mapping in Bacteria

Unit IV: Application of Microbes **(10 Hours)**

Basic design of fermenter, continuous and discontinuous culture. Preparation of fermented food products such as curd and cheese. Preparation of alcoholic beverages like wine and beer. Treatment of waste-water (Municipal treatment plant) and sewage. Bioremediation and biodegradation. Human microbiome: Role in health and disease**.** Soil Microbiome: Role in plant health

2.3 Practical: 60 Hours

1. To prepare and sterilize the culture media for the growth of microorganisms
2. To perform various culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml
3. To study growth curve of bacteria
4. To study the effect of pH/temperature on the growth of bacteria
5. To perform gram staining
6. To determine the effect of antibiotics using disc diffusion test
7. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs

2.4 Essential readings:

1. Willey, J., Sherwood, L., Woolverton, C. (2017). Prescott's Microbiology (10th ed.). McGraw Hill international. ISBN 13: 9781259657573.
2. Chan, M. J., Krieg E. C. S., Pelczar, N. R. (2004) Microbiology (5th ed.). McGraw Hill International. ISBN 13: 9780094623206.
3. Pierce, B.A. (2012) Genetics - A Conceptual Approach, (6thed.), W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1
4. Cappuccin, and Sherman N., Microbiology: A Laboratory manual (10th ed.). Benajamin/ Cummings. ISBN 1o J. G.3: 9780321840226. 86

Suggested readings:

1. Madigan, M. T., Martinko J. M., & Stahl D. A., (2010) Brock Biology of Microorganisms (13th ed.). Pearson Education International. ISBN 13: 9780321649638.
2. Snustad, D.P. and Simmons, M.J. (2012) Genetics (6th ed.), John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2

4. Keywords

Microbiological Techniques, Media, Sterilization, Growth curve

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

Common Pool of Generic Electives (GEs) offered by Department of Biochemistry

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 (if any)
		Lecture	Tutorial	Practical/ Practice		
Proteins and Enzymes	04	02	00	02	Class XII with Science	NIL

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 able to:

- 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 STRUCTURE)
BCH-GE-4: PROTEINS AND ENZYMES
Semester – III

2.2 Course Contents

THEORY – Total 30 Hours

UNIT I: Introduction to proteins (8 Hours)

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 (7 Hours)

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 (8 Hours)

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 (7 Hours)

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 – 60 Hours

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. 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 (if any)
		Lecture	Tutorial	Practical/ Practice		
Nutrition and Food Science	**04**	**02**	**00**	**02**	**Class XII with Science**	**Nil**

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

On successful completion of the course students will be able to:

- Describe the importance of food in our life
- Explain how food is spoiled and learn about some common food borne diseases/ food allergies
- Elaborate the functions of macro and micronutrients in our body
- Apply the knowledge gained to rationalize the diseases associated with malnutrition/ overnutrition and deficiency diseases

2.2 Course Contents

Theory – 30 Hours

Unit 1 –Basics of Food Science and Nutrition (5 Hours)

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 **(10 Hours)**

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 **(10 Hours)**

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 **(5 Hours)**

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 – 60 Hours

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. 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.

GENERIC ELECTIVES (GE-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		
Physiology of Sports and Exercise	**04**	**02**	**00**	**02**	**Class XII with Science**	**Nil**

Learning Objectives

To learn the changes in human body systems due to exercise and sporting activities in an integrated manner. To gain knowledge about sports training. Understanding the basic system physiology in sports. To understand the physiological adaptation and metabolic

changes during exercise at varying intensities. To gain skill in measurement of various physiological responses.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the effect of exercise in detail and in application perspective.
- Measure the changes and interpret them in the context of sports.
- Describe the system concepts behind sports performance.
- Explain human body functioning during exercise and thus provide appropriate nutrition/fuel.

2.2 Course Contents

Theory – 30 Hours

Unit I: Introduction to Exercise Physiology (Total Hours 4)

Structure, types and Function of Skeletal Muscle. Fuel for Exercise: Aerobic and anaerobic muscle metabolism, Muscle Fatigue.

Unit II: Cardiovascular and Pulmonary control in Sports Performance (Total Hours : 10)

Heart rate and Blood Pressure. Electrophysiology of Heart, Introduction and interpretation of EKG/ECG, Pacemakers and its Rhythms. Mechanics of ventilation during exercise. Cardiorespiratory Responses to physical activities. Training of cardiorespiratory responses in different types of physical activities for maximising output.

Unit III: Hormonal Effects on Physical Activities (Total Hours : 8)

Role of epinephrine, cortisol, sex hormones, growth hormones and growth factors on physical endurance. Effect of aging on Sport performance.

Unit IV: Drugs and Doping in Sports (Total Hours :8)

History and evolution of Doping and Anti-doping in Sports, Prevalence of Doping in Sports, Doping Control in Sports, Role of Athlete Support Personnel in Preventing Deliberate and Inadvertent Use of Prohibited Substances, WADA Rules and Regulations.

2.3 Practical: 60 Hours

1. BMI Estimation with and without software - Techniques of taking various anthropometric measurements; Skinfold measurement and Body Fat Percentage calculations.
2. Aerobic Power Field Assessments; Cooper 1.5-Mile Run/Walk Test and 12-Minute Run/Walk Test/Rockport Fitness Walking Test.

3. Tests for anaerobic power; Wingate Test/Anaerobic Cycling Power
4. High-Intensity Fitness Testing/ AAHPER health related physical fitness test Léger 20 m Shuttle Run Test/ Margaria - Kalamen Stair Climb Test,
5. Pulmonary Function Testing: Ratio of Forced expiratory volume (FEV1/FEV6) by spirometry, Lung Volumes and Capacities
6. Determination of age by Radiography (Dry lab)
7. Blood Pressure Measurements: Effects of Body Position, Dynamic Exercise and Isometric Contractions on BP.
8. Determination of Physiological adaptation with training through Submaximal Exercise Testing; Submaximal Bench Step Test/Submaximal Cycle Ergometer Test

2.4 Essential readings:

1. Physiology of Sport and Exercise 6th Edition with Web Study Guide-Loose-Leaf Edition by W. Larry Kenney, Jack Wilmore, David Costill.
2. Endocrinology of Physical Activity and Sport, Second Edition Constantini, Naama, Hackney, Anthony C, 2013.
3. David R. Mottram, Neil Chester (2018) Drugs in Sports, Routledge, ISBN:1351838989. Portefield, Jason (2008) Doping: athletes and drugs, Rosenn Publishing, New York, ISBN:1-4042-1917-5.
4. Laboratory Manual for Exercise Physiology 2nd Edition. With Web Study Guide, Human Kinetics by G. Gregory Haff, Charles Dumke, 2018.
5. Physiological Tests for Elite Athletes 2nd Edition by Australian Institute of Sport Rebecca Tanner, Christopher Gore, 2012.

Suggested readings:

1. A Textbook of Sports & Exercise Physiology by Dey Swapan Kumar, Jaypee Publishers
2. Exercise Physiology: Theory and Application to Fitness and Performance 10th Edition by Scott Powers and Edward Howley 2018.
3. Exercise Physiology: Nutrition, Energy, and Human Performance 8th Edition by William D. McArdle, Frank I. Katch, Victor L. Katch
4. Practical ECG for Exercise Science and Sports Medicine by Greg Whyte, Sanjay Sharma, Human Kinetics, 2010
5. ACSM's Guidelines for Exercise Testing and Prescription, 10th Edition by American College of Sports Medicine. Wolters Kluwer, 2017.

3. Keywords

Muscle metabolism, Muscle Fatigue, Cardiorespiratory Responses, Sport performance, Prohibited Substances

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

UNIVERSITY OF DELHI

CNC-II/093/1(26)/2023-24/179
Dated: 13.09.2023

N O T I F I C A T I O N

Sub: Amendment to Ordinance V

[E.C Resolution No. 14/ (14-1-4) dated 09.06.2023]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-IV, V and VI of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

DEPARTMENT OF BIOCHEMISTRY
BSc. (Hons.) Biochemistry
Semester IV

DISCIPLINE SPECIFIC CORE COURSE - (DSC-10)
METABOLISM OF AMINO ACIDS AND NUCLEOTIDES

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 Amino Acids and Nucleotides (BCH-DSC-401)	4	2L	00	2P	Class XII with Science and Biology	NIL

Learning Objectives

The main objective of the course is to offer detailed and comprehensive knowledge about the synthesis and degradation pathways of amino acids and nucleotides and their importance in the proper functioning of the cells. This course also interrelates the metabolism of these

molecules with respect to health diseases in addition to providing an overview of inhibitors of metabolism for treating the diseases of metabolic disorders.

Learning outcomes

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

1. Explain the importance of nitrogen cycle.
2. Explain the degradation and biosynthetic pathways of amino acids and nucleotides in humans.
3. Discuss the importance of amino acids as precursors to a variety of important biomolecules.
4. Examine the role of inhibitors of nucleotide metabolism as chemotherapeutic drugs
5. Discuss the integration of the amino acid, nucleotide, carbohydrate and lipid metabolism

SYLLABUS OF DSC-10

BCH-DSC-10 : METABOLISM OF AMINO ACID AND NUCLEOTIDES
Semester – IV

THEORY (Credits 2)

Total Hours: 30

Unit I: Overview of Nitrogen and Amino Acid Metabolism (6 Hours)

Nitrogen cycle, incorporation of ammonia into biomolecules, Role of essential and non-essential amino acids in growth and development, Metabolic fates of amino groups. Transamination, role of pyridoxal phosphate, Glucose-alanine cycle, Krebs bicycle, urea cycle, its regulation and inherited defects of urea cycle, Gamma Glutamyl cycle.

Unit II: Catabolism, Biosynthesis and precursor functions of amino acids (10 Hours)

Catabolic pathways of individual amino acids, Glucogenic and ketogenic amino acids. Metabolism of one carbon unit, Overview of amino acid synthesis: Biosynthesis of non-essential amino acids and its regulation, Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methyl malonic acidemia (MMA), homocystinuria, and Hartnup's disease, ***Precursor Functions of Amino Acids*****:** Biosynthesis of creatine and creatinine, polyamines (putrescine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA)

Unit III: Biosynthesis and Degradation of Nucleotides (10 Hours)

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways, Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides, Inhibitors of nucleotide metabolism. Lesch Nyhan Syndrome, Gout and SCID (Adenosine deaminase deficiency), Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides

Unit IV: Integration of Metabolism **(4 Hours)**

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

2.3 Practical (Credits 2)

Total Hours: 60

1. Assay of serum transaminase – SGOT and SGPT
2. Estimation of serum urea.
3. Estimation of serum uric acid.
4. Estimation of serum creatinine.
5. Glutamate Dehydrogenase Assay
6. Aspartate Transcarbomylase kinetics
7. Case studies on SCID, Gout and Lesch Nyhan Syndrome.

2.4 Essential 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.
- Devlin, T.M. (2011) Textbook of Biochemistry with Clinical Correlations (7th ed.), John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4 / BRV ISBN:978-0-470-60152-5.
- 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.
- Principles of Biochemistry (2013) 4th ed., Voet, Donald, Voet, Judith & Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.
- Victor Rodwell, David Bender, et al. (2018) ISE Harper's Illustrated Biochemistry Thirty-First Edition, McGraw Hill (A and L Lange series), ISBN-10. 1259837939; ISBN-13. 978-1259837937.

3. Keywords

Metabolism, essential and non-essential amino acids, Nucleotides, Biosynthesis, Salvage pathway, metabolic disorders, HGPRT, Adenosine deaminase

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

DISCIPLINE SPECIFIC CORE COURSE – (DSC-11)
Hormones: Biochemistry and Function

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		
Hormones: Biochemistry and Function (BCH-DSC-402)	**4**	**2L**	**0**	**2P**	**Class XII with Science and Biology**	**NIL**

Learning Objectives

The course is designed to enable the students to understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body. The course emphasizes on studying the different types of hormones along with their physiological action. The students will be taught the consequences of any hormonal imbalances (over and underproduction of hormones) with special emphasis on human diseases. It provides an understanding of the different endocrine factors that regulate metabolism, growth, electrolyte and mineral homeostasis, glucose homeostasis, stress physiology and reproductive function. It also prepares a student for postgraduate studies in any course related to molecular medicine.

Learning outcomes

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

1. Explain the molecular mechanism and signaling pathways mediating Hormone Action
2. Describe the physiological role of each hormone in regulating growth, appetite, metabolism and reproduction
3. Examine the regulatory mechanisms regulating Hormone secretion and release.
4. Discuss the basis of endocrine diseases taking case studies.

SYLLABUS OF DSC-11

BCH-DSC-11 : HORMONES : BIOCHEMISTRY AND FUNCTION
Semester – IV

2.2 Course Contents
Theory (2 credits)

Total Hours: 30

Unit 1: Introduction to hormones and Hypothalamic- hypophyseal system: (5 Hours)

Introduction to hormones; Hypothalamic - pituitary axis- anatomy, histology, vasculature, and secretions. Physiological and biochemical actions of hypothalamic hormones and Anterior

pituitary hormones; Hormone feed- back regulatory cascade. Posterior pituitary hormones – structure, physiology and biochemical actions of AVP and Oxytocin; Diabetes insipidus.

Unit 2: Hormones regulating growth, energy metabolism and calcium homeostasis
(10 Hours)

Regulation of Growth: growth hormone and somatomedin, Endocrine disorders - gigantism, acromegaly, dwarfism, pygmies.

Thyroid gland- Biosynthesis of thyroid hormone and its regulation: Role of TRH, TSH in T_4 synthesis and response. Physiological and biochemical action of Thyroxine. Pathophysiology of thyroxine secretion: Goiter, Graves' disease, cretinism, myxedema.

Regulation of calcium homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Unit 3: Hormones regulating glucose homeostasis, stress physiology and electrolyte balance: (10 Hours)

Hormones of the Pancreas: structure, synthesis, regulation of release, incretins, physiology and biochemical actions of insulin and glucagon. Role of these hormones in blood glucose homeostasis; Pathophysiology - diabetes type I and type II. GIT hormones: Secretin, gastrin and incretins.

Physiology and action of Aldosterone; the Renin Angiotensin System. Physiology and Biochemical actions of Cortisol; Role of POMC and CRH in cortisol synthesis; Adrenal medullary hormones: epinephrine and norepinephrine. The Fight or flight response; Dual receptor hypothesis. General adaptation syndrome: acute and chronic stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome.

Unit 4: Reproductive hormones: (5 Hours)

Male and female sex hormones. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based Contraceptives.

2.3 Practical (2 Credits)

Total Hours: 60

1. Glucose tolerance test.
2. Estimation of serum Ca^{2+}.
3. Determining the thyroid profile by estimating T_4 and TSH under normal and pathophysiological conditions. Or Estimation of estrogen during different days of the menstrual cycle.
4. Presentation Assignments on GI Tract hormones and Adipokines
5. HCG based pregnancy test.
6. Estimation of serum electrolytes.
7. Case studies: Diabetes Insipidus, Acromegaly and dwarfism, Diabetes Mellitus, Rickets, Osteoporosis, Cushing syndrome

2.4 Essential readings:

1. Vander's Human Physiology (2008) 11th ed.,Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
2. Sherwood, L. (2012) Introduction to Human Physiology 8th edition; Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.
3. Victor Rodwell, David Bender, et al. (2018) ISE Harper's Illustrated Biochemistry Thirty-First Edition, McGraw Hill (A and L Lange series), ISBN-10. 1259837939; ISBN-13. 978-1259837937

Suggested readings:

1. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
2. Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

3. Keywords

Hypothalamic-hypophyseal axis, hormones, calcium and glucose homeostasis, hormonal disorders.

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

DISCIPLINE SPECIFIC CORE COURSE – (DSC-12)
Gene Organization, Replication and Repair

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		
Gene Organization, Replication and Repair (BCH-DSC-403)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides an understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

Learning outcomes

After completion of this course, learners will be able to:

1. Analyse the structure of DNA and various forms of DNA and learn about organisation of genome in various life forms, supercoiling of DNA and its significance
2. Perform isolation of DNA and analyse the purity of isolated DNA sample
3. Evaluate the molecular basis of processes like DNA replication, recombination and transposition and demonstrate the significance of these processes
4. Perform various methods of DNA estimation
5. Discuss the various ways in which the DNA can be damaged leading to mutations, lesions and repair mechanisms

SYLLABUS OF DSC-12
BCH-DSC-12 : GENE ORGANIZATION, REPLICATION AND REPAIR
Semester – IV

2.2 Course Contents

Theory (2 Credits)

Total Hours: 30

Unit I: Structure of DNA and genomic organization **(8 Hours)**

Watson and Crick model of DNA, various forms of DNA, Supercoiling of DNA, linking number, Topoisomerases, Topoisomerase inhibitors and their clinical importance, Definition

of a gene, organization of genes in viruses, bacteria and eukaryotes, concept of split genes, introns, exons, satellite DNA, highly repetitive DNA.

Unit II: Replication of DNA **(10 Hours)**

The chemistry of DNA synthesis, DNA polymerase, the replication fork, enzymes and proteins in DNA replication, *E coli* DNA polymerases, stages of replication: initiation, elongation, origin of replication, relationship between replication and cell division, replication in eukaryotes, end replication problem, telomerases. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine.

Unit III: Recombination and transposition of DNA **(6 Hours)**

Homologous recombination, enzymes in homologous recombination, site-specific recombination, recombinases. Transposition, DNA transposition by cut and paste and replicative mechanism.

Unit IV: Mutations and DNA Repair **(6 Hours)**

Importance of mutations in evolution of species, Types of mutations, DNA damage by hydrolysis, alkylation, oxidation and radiation. Mutations caused by base analogs and intercalating agents. Ames test. Replication errors and their repair, mismatch repair system. Repair of DNA damage-direct reversal of DNA damage, base excision repair, nucleotide excision repair, translesion DNA synthesis. DNA repair diseases.

2.3 Practical (2 Credits)

Total Hours: 60

1. DNA estimation by DPA
2. Separation of nitrogenous bases by paper chromatography
3. To plot the ultraviolet absorption spectrum of DNA
4. Isolation of chromosomal DNA from *E coli* cells
5. Determination of DNA concentration and purity by UV absorption.
6. Determination of the melting temperature of DNA
7. Demonstration of the mechanism of Transposition and Recombination (Dry Lab)
8. Ames test
9. Exercise with *in silico* tools (NCBI, GenBank, EMBL, DDBJ, NBD, BLAST and Clustal omega)

2.4 Essential readings:

- Lehninger: Principles of Biochemistry (7th ed.) (2017) Nelson, D.L. and Cox, M.M W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
- Molecular biology of the gene: (7th ed), (2014) Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. International). Pearson.

Suggested readings:

- Genetics - A Conceptual Approach,) (6^{th} ed). (2012), Pierce, B.A. W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-

- Lewin's Gene X (10th edition) (2018). Lewin, B., Krebs, J.E., Kilpatrick, S.T., Goldstein, E.S., Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.
- The Cell: A Molecular Approach (7th ed.) (2009). Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland (Washington DC), Sinauer Associates, MA. ISBN:978-0- 87893-3030.
- *Biochemistry* (6th ed.) (2016). Garrett, R. H., & Grisham, C. M. Brooks Cole. ISBN: 9781305882409

3. Keywords

DNA, Double helix, Supercoiling, Recombination, Transposition, DNA Repair

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

POOL OF DSEs

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-4)
BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS

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		
Biochemical Mechanisms and Responses in Plants (BCH-DSE-4)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological science

Learning Objectives

The course aims to provide thorough understanding of metabolic processes in plants and the role of different biosynthetic pathways in growth and development of plants. The course will also impart basic concepts and applications of plant secondary metabolites.

Learning outcomes

On successful completion of the course students will be able to:

1. Describe the structure and function of plant cell organelles in plant metabolism.
2. Explain the various plant biochemical processes and metabolic pathways including photosynthesis, photorespiration, nitrogen fixation and assimilation and plant secondary metabolism and their biological significance.
3. Discuss the role of plant hormones in plant growth and development.
4. Evaluate the various plant responses to different abiotic and biotic stress conditions.
5. Plan and execute plant tissue culture.

SYLLABUS OF DSE-4

BCH-DSE-4 : BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS
Semester – IV

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit I: Photosynthesis and Respiration **(8 Hours)**

Introduction to Plant cells, Cell wall, Vacuole and Tonoplast membrane, Plastids and Peroxisomes. Overview to photosynthesis and Carbon assimilation, Light reaction and photosystems, Cyclic and non-cyclic photophosphorylation, Calvin cycle and its regulation, C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration. Photoinhibition. Glycolytic pathway and its alternative reactions in plants, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain in plants, alternative NAD(P)H oxidative pathways.

Unit II: Nitrogen metabolism (7 Hours)

Nitrogen cycle; Biological nitrogen fixation; Structure and function of Nitrogenase complex. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate aminotransferase (GS-GOGAT) pathway.

Unit III: Plant physiology and Secondary metabolites (10 Hours)

Plant vascular system; Plant hormones and their role in plant growth and development; Regulation of plant morphogenetic processes by light. Plant stress responses to abiotic and biotic stresses: Water deficit, temperature, salinity, insect manifestation. Secondary metabolites: types, structure and functions of Alkaloids, Phenolics and terpenoids.

Unit IV: Plant tissue culture (5 Hours)

Cell and tissue culture techniques, types of cultures: organ and explant culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somaclonal variation. Germplasm storage and cryo-preservation. Brief introduction to transgenic plants.

2.3 Practical:

Credits: 2 Total Hours : 60

1. Induction of hydrolytic enzymes (proteases /amylases/lipase) in germinating wheat seeds.
2. Effect of plant hormones on plant growth (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds).
3. Extraction and assay of Urease from Jack bean.
4. Estimation of carotene/phenols/tannins in fruits and vegetables.
5. Estimation of ascorbic acid in fruits and vegetables.
6. Effect of light on chlorophyll production.
7. Separation and analysis of chloroplast proteins (Rubisco) using SDS-PAGE.
8. Plant tissue culture

2.4 Essential readings:

1. Buchann (2015). Biochemistry and Molecular Biology of plant. (2nd ed.). I K International. ISBN-10: 8188237116, ISBN- 978047 07 14218
2. Caroline Bowsher, Martin steer, Alyson Tobin (2008). Plant Biochemistry. Garland Science. ISBN 978-0-8153-4121-5.

3. Dey, P. M. and J.B. Harborne, J.B., (Editors) (1997). Plant Biochemistry. Academic Press. ISBN-10:0122146743, ISBN-13:978-0122146749. 94
4. Taiz, L. and Zeiger, E. (2010). Plant Physiology (5th ed.). Sinauer Associates Inc. ISBN-13: 978-0878938667, ISBN-10: 0878938664

4. Keywords

Plant cell, photosynthesis, respiration, nitrogen fixation and assimilation, secondary metabolism, stress biology.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-5)
NUTRITIONAL BIOCHEMISTRY

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		
Nutritional Biochemistry (BCH-DSE-5)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological science

Learning Objectives

This course provides students with knowledge and understanding of the characteristics, function, metabolism and deficiency of macro and micronutrients in the human body. It involves integrated learning between the areas of Biochemistry and Nutrition.

Learning outcomes

On successful completion of the course students will be able to:

1. Critically analyse and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition.
2. Demonstrate the relationship between nutrition and health.
3. Discuss the macro and micronutrients and their nutritional deficiencies.
4. Describe techniques used in the assessment of nutritional status and nutritional disorders.
5. Explain drug nutrient interactions.

SYLLABUS OF DSE-5

BCH-DSE-5 : NUTRITIONAL BIOCHEMISTRY
Semester – IV

2.2 Course Contents

Theory (Credits – 2)

Total Hours: 30

Unit I: Introduction to Nutrition and Energy Metabolism (4 Hours)

Defining nutrition, role of nutrients. Unit of energy, Food energy, SDA. Energy expenditure and its components, Energy Balance, Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit II: Macronutrients (10 Hours)

Food sources of carbohydrates, functions of carbohydrates, RDA, Factors affecting bioavailability, Glycemic index and glycemic load. Dietary fiber and the role of fibre in health. Role of Gut microbiome in maintaining health. Role of prebiotics and probiotics in nutritive health.

Essential Fatty Acids; Functions of EFA, AI, excess and deficiency of EFA, factors affecting bioavailability. Dietary implications of ratios of n6 and n3, MUFA, PUFA and SFA, Cholesterol in the body.

Functions of proteins in the body. RDA for different age groups. Essential and Nonessential amino acids. Complete and incomplete protein, Amino Acid Interactions: Antagonism, Toxicity, Imbalance, Amino acid complementation and Supplementation in foods. Protein quality determinants NPU, Biological Value, PDCAAS, Nitrogen balance. PEM: Marasmus and Kwashiorkor.

Unit III: Fat and water soluble Vitamins (9 Hours)

Vitamin A, D, E, K and dietary sources, RDA, Role of Vitamin A in Visual cycle and overview of other functions. Role of Vitamin K in Gamma carboxylation (blood clotting). Role of Vitamin E as an antioxidant. Role of Vitamin D in maintenance of bone physiology and overview of other functions. Vitamin C- Dietary sources, RDA, role in collagen synthesis. The B Complex vitamins- Dietary sources, RDA. Functions and role in metabolism, Role of Vitamin B12 and Folate in Haematopoiesis and Neurology. Biochemical basis for deficiency symptoms, Hypervitaminosis.

Unit IV: Minerals (7 Hours)

Minerals: Dietary Sources, RDA. Sodium, Potassium, Calcium, Iron, Chloride, Copper and Phosphorus- Function, metabolism, Excretion, Deficiency, Toxicity, Trace Elements Iodine, Fluoride, Mg, Zn, Se, Chromium, Molybdenum: Function, Metabolism, deficiency, Toxicity and Sources.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. Anthropometric identifications for nutrition related diseases, BMR calculation
2. Determination of oxidative stress: TBARS in serum, antioxidant enzymes in hemolysate/plant sources.
3. Estimation of A/E vitamin in serum.
4. Estimation of minerals in drugs/food/serum.
5. Determination of nutritive value of foods.
6. Understanding fortification and supplementation
7. Presentation and discussion on Food as medicine.
8. Group discussion on Nutrient-nutrient and drug-nutrient interactions
9. Case studies on nutritional disorders.

2.4 Essential readings:

1. Coombs Jr. G. F., (2008). *The vitamins, Fundamental aspects in Nutrition and Health.* Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
2. 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.
3. Rosalind Gibson (2005). *Principles of Nutritional Assessment.* Oxford University Press. ISBN: 9780195171693
4. Tom Brody (1999). *Nutritional Biochemistry* (2nd Ed). Harcourt Braces. ISBN:9814033251, 978981403325.
5. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

Suggested reading:

1. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

3. Keywords

Nutrition, macronutrients, micronutrients, energy balance, nutrient deficiency

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

POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE COURSE - (GE-7)
CELLULAR COMMUNICATIONS

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		
Cellular Communications (BCH-GE-7)	04	02	0	02	Class XII with Science and Biology	Basic course in cell biology

Learning Objectives

- Explain the concept of Cell-cell communication.
- Describe the various types of receptors, signal transduction pathways, second messengers and effector molecules.
- To understand how signalling pathways, regulate cell motility, metabolism, growth, organogenesis, and cell death.
- Discuss the crosstalk between signal transduction pathways crosstalk and are auto-regulated.
- To know about various diseases associated with cellular communication pathway defects.

Learning outcomes

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

1. Describe various types of cell - cell communication.
2. Discuss the various types of receptors and signal transduction pathways in bacteria, plants and animal system.
3. Explain the importance of various signalling pathways in the regulation of metabolism, growth, organogenesis and cell death.
4. Discuss the cellular communication defects that lead to various types of diseases including cancers.

SYLLABUS OF GE-7

BCH-GE-7 : CELLULAR COMMUNICATIONS
SEMESTER - IV

2.2 Course Contents

Theory (Credit 2)

Total Hours : 30

Unit: 1 Introduction to cell- cell communication. (2 Hours)

Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Cognate signalling.

Unit: 2 Receptors and Signal transduction pathways (16 Hours)

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G-Protein-coupled Receptors: Heterotrimeric G proteins, Second messengers: cAMP, cGMP, Lipid-derived Second Messengers (IP3, DAG) NO, Calcium Signalling. Effector systems - adenylyl cyclase, guanylyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG).

Enzyme linked receptors: Receptor Tyrosine Kinases: EGF, insulin and erythropoietin. Ras - MAP kinase cascade, and JAK - STAT pathway.
Ion-channel linked receptors; Neurotransmitter receptors (Acetylcholine receptor). Nerve transmission.

Intracellular receptors: Cytoplasmic and nuclear receptors. Steroid hormone, thyroid hormone receptors. Gene regulation.

Integrin receptors. Integrin signalling. Cell matrix communication Receptor Regulation. Cross talk.

Unit 3: Photoreceptors and signal transduction in plants (4 Hours)

Phytochromes, cryptochromes and phototropins signalling.

Unit 4: Cell death signalling (4 Hours)

Apoptosis, Autophagy

Unit 5: Bacterial signalling (4 Hours)

Quorum sensing, autoinducers, chemotaxis.

2.3 Practical

Credit: 2 **Total Hours : 60**

1. Yeast response to mating pherohormones .
2. Study of Chemotaxis response in Tetrahymena/ paramecium/ dictostylium
3. Study change in heart rate (sympathetic response) on exposure to caffeine (cAMP mediated) in zebrafish larvae.
4. Chemotaxis/ motility assay in microbes.
5. Effect of plant hormones on plant growth or photomorphogenesis in response to light. (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds)

Essential readings:

1. Lodish, U. H. (2016) Molecular Cell Biology. W.H. Freeman, 2016.
2. Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). W.H. Freeman. ISBN:9781319230906
3. Lim, W., Mayer, B., & Pawson, T. (2015). Cell signaling: principles and mechanisms. New York: Garland Science, Taylor & Francis Group.
4. Kocher, S. L., and Gujral, S. K. (2020). Plant Physiology Theory and Application. Cambridge University Press DOI: https://doi.org/10.1017/9781108486392.018
5. Demuth, D., & Lamont, R. (Eds.). (2006). Bacterial Cell-to-Cell Communication: Role in Virulence and Pathogenesis (Advances in Molecular and Cellular Microbiology). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511541506

Suggested readings:

1. ZFIN protocols
2. Harris UM. A., McGee, S. A., and Batzi J. M. (2018). Uncooking Yeast: Cells Signalling a Rise to Inquiry. Tested Studies for Laboratory Teaching. Proceedings of the Association for Biology Laboratory Education. 38 (9) 1-48
3. Plant physiology and biotechnology laboratory manual. Compiled by: David Law, Lada Malek and JoAnne Henderson. 2006. https://old.amu.ac.in/emp/studym/99997510.pdf

3. Keywords

Chemical signaling, Receptors, signal transduction, GPCRs, RTKs, Photoreceptors, cell death signaling, bacterial signalling

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

GENERIC ELECTIVES COURSE - (GE-8)
BIOCHEMICAL CORRELATION OF DISEASES

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		
BIOCHEMICAL CORRELATION OF DISEASES (BCH-GE-8)	**04**	**02**	**0**	**02**	**Class XII with Science and Biology**	**XIIth pass in biology**

Learning Objectives

The course aims to provide students with knowledge and understanding of the spectrum of human diseases. It will introduce the concept of a well-balanced diet, healthy lifestyle, the biochemical mechanism 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 could be employed for prevention of infectious and non-infectious diseases.

Learning outcomes

On successful completion of the course students will be able to:

1. Discuss the importance of a balanced diet, regular exercises and healthy lifestyle in leading a disease-free life.
2. Explain the functioning of the immune system and endocrine system and the basis of various autoimmune and hormonal disorders.
3. Correlate the genetic mutation and metabolic disorders.
4. Discuss the molecular mechanism of microbial pathogenicity, drug resistance and implications in public health management.

SYLLABUS OF GE-8

BCH-GE-8 : BIOCHEMICAL CORRELATION OF DISEASES
SEMESTER - IV

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

Unit I: Inherited Metabolic diseases and Hormonal disorders (9 Hours)

Introduction to inherited Metabolic diseases. Alkaptonuria, Phenylketonuria; Glycogen storage diseases (Von Gierke disease, Cori disease); Lipid storage diseases: Gaucher's disease; SCID. Overview of the endocrine disorders: Cushing's disease, Diabetes insipidus.

Unit II: Nutritional deficiency and lifestyle-based diseases (7 Hours)

Concept of nutrition and balanced diet; Protein-energy malnutrition: Kwashiorkor and Marasmus; Vitamin deficiency diseases: Beri-Beri, Scurvy, Pellagra, Nutritional deficiency Anemia, Night blindness, Rickets. Lifestyle-based diseases: Atherosclerosis, Diabetes Mellitus-II.

Unit III: Autoimmune diseases (6 Hours)

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 IV: Infectious diseases (8 Hours)

Classification of infectious diseases; Role of sanitation, drugs and vaccines in prevention, transmission and treatment of infectious diseases. Diseases caused by viruses: Polio, Influenza, HIV and COVID. Diseases caused by bacteria: Tetanus, Tuberculosis. Protozoan infections: Malaria; Parasitic infections: Kala Azar.

2.3 Practical:

Credits: 2 **Total Hours : 60**

1. Anthropometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA).
2. Measurement of Blood pressure
3. Determination of blood Lipid Profile: Triglyceride, Cholesterol
4. Glucose tolerance test
5. Widal test
6. Permanent slides of malarial parasites/Leishmania
7. Case studies related to autoimmune diseases, life-style disorders and hormonal imbalance

2.4 Essential readings:

1. Berg, J.M., Tymoczko, J.L., Gatto, G.J., Stryer, L. (2019). Biochemistry (9th ed.). W.H Freeman and Company (New York). ISBN-13:9781319114671
2. Coico, R. (2021). Immunology: A Short Course (8th ed.). John Wiley & Sons, Inc (New Jersey). ISBN: 9781119551577.
3. Devlin, T. M., (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
4. Willey, J., Sandman, K., Wood, D. (2019). Prescott's Microbiology (11th ed.). McGraw Hill International Edition (New York) ISBN: 9781260211887.

Suggested readings:

1. Sherwood, L. (2012). Introduction to Human Physiology (8th ed.). Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541.
2. Hadley, M.E., Levine, J.E. (2007). Endocrinology (6th ed.). New Delhi, Pearson Education, Inc. ISBN: 978-81-317-2610-5.
3. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

3. Keywords

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

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

GENERIC ELECTIVES COURSE – (GE-9)
FUNDAMENTALS OF MOLECULAR BIOLOGY

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		
Fundamentals of Molecular Biology (BCH-GE-9)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological science

Learning Objectives

This course is designed to introduce the concepts of how the genetic material is organized within genomes and the difference in the architecture of the genome in various organisms. It deals with the replication of the genetic material in prokaryotes and eukaryotes as well as the expression of genes into RNA as well as proteins; all being crucial life processes required for the perpetuity and successful functioning of living organisms. It also introduces the concept of regulation of gene expression in prokaryotes.

Learning outcomes

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

1. Perform the isolation of bacterial genomic DNA and assess its purity
2. Evaluate the characteristic properties of DNA and RNA using biochemical assays like Dische test and Bial's test.
3. Identify the different nitrogenous bases present in Nucleic acids
4. Compare the DNA replication in prokaryotes and eukaryotes.
5. Discern the processes of conversion of the information stored in the genetic code into mRNA as well as proteins.

SYLLABUS OF GE-9

BCH-GE-9 : FUNDAMENTALS OF MOLECULAR BIOLOGY
SEMESTER - IV

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

Unit 1 Genome organization in organisms (3 Hours)

Definition of a gene, organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA, linking number, topoisomerases.

Unit 2 Replication of genomes (9 Hours)

General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Three stages of DNA replication, end replication problem, telomerase, Inhibitors of DNA replication and applications in medicine.

Unit 3 Transcription (10 Hours)

Transcription in prokaryotes, RNA polymerase, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, various stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Concept of operons (Lac operon). Eukaryotic RNA polymerases. Inhibitors of transcription and applications in medicine.

Unit 4 Translation (8 Hours)

Features of the genetic code, structure of ribosomes, charging of tRNAs, amino acyl tRNA synthetases; three stages of protein synthesis - initiation, elongation and termination. Inhibitors of protein synthesis.

2.3 Practicals

CREDITS: 2 **Total Hours: 60**

1. Quantitative determination of DNA and RNA by absorbance at 260 nm.
2. Estimation of DNA by Dische's reagent.
3. Estimation of RNA by Bial's reagent.
4. Separation of nitrogenous bases by paper chromatography.
5. Isolation of chromosomal DNA from *E. coli* and estimation of its purity by 260nm/280nm absorbance.

2.4 Suggested Readings

1. Nelson, D.L. and Cox, M.M. (2013). *Lehninger: Principles of Biochemistry* (6^{th} ed.,) W.H. Freeman & Company (New York), ISBN-13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.

2. Berg, J.M., Tymoczko, J.L. and Stryer, L., (2012). *Biochemistry* (7th ed.,) W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
3. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008) *Watson: Molecular Biology of the Gene* (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN-13: 9780321762436.

3. Keywords

Genes, Replication, Transcription, Translation, Genetic code, Protein synthesis.

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

SEMESTER V
BSC (HONS.) BIOCHEMISTRY

DISCIPLINE SPECIFIC CORE COURSE – (DSC-13)
MOLECULAR CELL BIOLOGY

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		
Molecular Cell Biology (BCH-DSC-501)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The course aims to provide advanced knowledge about the function of cellular organelles and the mechanism of protein sorting in the cell. It will also provide details of cellular communications in the cell and understanding of molecular regulation of cell growth and cell death. The course will outline the molecular details of cancer development and treatment.

Learning outcomes

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

1. Explain the process of protein trafficking in the cell and role of various regulatory proteins involved in the process.
2. Discuss the different modes of cellular communication in a multicellular organism
3. Explain the regulatory mechanisms involved in controlling the process of mitosis, meiosis, apoptosis, necrosis and autophagy.
4. Examine the molecular and genetic basis of cancer development and various molecular approaches used for cancer treatment.

SYLLABUS OF DSC-13

BCH-DSC-501 : MOLECULAR CELL BIOLOGY
SEMESTER - V

Theory (2 Credits)

Total Hours: 30

Unit I: Protein Sorting and Secretory Pathway **(7 Hours)**

Overview of the endomembrane system; Co-translational and post-translational targeting of proteins into Endoplasmic Reticulum; Protein Modifications, Folding and Quality Control in ER; Protein targeting to Golgi complex and Lysosomes; Exocytosis; Sorting of Proteins to Mitochondria, Chloroplasts and Peroxisomes.

Unit II: Cellular Signaling (10 Hours)

Chemical signaling- endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Hormone receptors- extracellular and intracellular. G protein coupled receptors, G proteins, second messengers- cAMP, cGMP, IP3, DAG, Ca^{2+}, Effector systems- adenylyl cyclase, guanylyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases-EGF, Insulin and Ras-MAP kinase cascade. Non-receptor tyrosine kinase-erythropoietin receptor JAK-STAT pathway. Intracellular receptor family: Steroid hormone receptor and NO receptors.

Unit III: Cell cycle and Apoptosis (8 Hours)

Overview of the cell cycle; Stages of eukaryotic cell cycle; Events of Mitotic Phase and Cytokinesis; Role of cyclins and cyclin-dependent kinases; Molecular mechanisms of cell cycle regulation and Cell Growth; Meiosis and its regulation; Cell death: Apoptosis, Necrosis and Autophagy; Intrinsic and extrinsic apoptotic pathways; Regulation of apoptotic pathways.

Unit IV: Molecular Basis of Cancer Biology (5 Hours)

Types of cancer; Stages of cancer development; Properties of Cancerous Cells; Genetic basis of cancer; Cancer causing agents: radiations, chemical carcinogens and introduction to viral oncogenes; Role of cancer critical genes: oncogenes and tumor suppressor genes; Molecular approaches for cancer treatment.

2.3 Practical (2 Credits)

Total Hours: 60

1. Isolation of organelles by subcellular fractionation and validation of separated organelles by marker enzymes.
2. Study the changes in heart rate (sympathetic response) on exposure to caffeine (cAMP mediated) in model organisms.
3. Preparation of hepatocyte primary culture and cell enumeration.
4. Study of cell viability/death assay by use of trypan blue and MTT assay.
5. Polyploidy in onion root tip by colchicine treatment.
6. Study of apoptosis through analysis of DNA fragmentation patterns.
7. Identification and study of cancerous cells using permanent slides and photomicrograph.

2.4 Essential readings:

1. Cooper, G.M. (2018). The Cell: A Molecular Approach. (8th ed.). Sinauer Associates Inc: Oxford University Press. ISBN: 9781605357072
2. Karp, G., (2010). Cell and Molecular Biology: Concepts and Experiments (8th ed.). John Wiley & Sons. Inc. ISBN: 978-1-118-65322-7.
3. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of the Cell. (6th ed.). Garland Science. ISBN: 978-0815345244

4. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh. A., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). W.H. Freeman & Company (New York). ISBN-13: 978-1319208523/ ISBN-10: 1319208525

Suggested readings:

1. Kleinsmith, L. J., Hardin, H., Wayne G., Becker, M. (2009). The World of the cell (7th ed.). ISBN-13: 978-0805393934 / ISBN-10: 0805393935.

3. Keywords

Protein Sorting, Protein Modification, exocytosis, Cellular communication, autophagy, mitosis, meiosis, Apoptosis, Necrosis, Cancer, Oncogenes, Chemotherapeutics.

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

DISCIPLINE SPECIFIC CORE COURSE – (DSC-14)
CONCEPTS IN GENETICS AND EVOLUTION

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		
Concepts in Genetics and Evolution (BCH-DSC-502)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The aim of the course is to provide an understanding of both classical and modern concepts in the areas of mapping techniques, transmission, molecular, quantitative, population and evolutionary Genetics. Practicals are well correlated with the theory topics and designed to support skill-oriented learning outcomes. The course also works as preparation for further studies in a Master's programme in molecular biology or related topics.

Learning outcomes

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

1. Explain the principles of Mendelian genetics, extensions and applications.
2. Examine the various factors that confer genotypic and phenotypic variability.
3. Correlate human and viral genetics to create linkage and genetic maps.
4. Perform experiments using genetic model system *Drosophila melanogaster*.
5. Analyse biological data using statistical tools
6. Discuss the principles of transmission and inheritance in real life situations.

SYLLABUS OF DSC-14

BCH-DSC-502 : CONCEPTS IN GENETICS AND EVOLUTION
SEMESTER - V

2.2 Course Contents

Theory (2 Credits)

Total Hours: 30

Unit I: Mendelian and Non-Mendelian genetics (8 Hours)

Revision of Mendelian Genetics; Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Complementation test using examples from

Drosophila eye colour mutants to differentiate allelic variants from gene interaction. Pleiotropic gene interaction - epistatic and non- epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.

Unit II: Linkage, crossing over and mapping techniques (9 Hours)

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications, detection of linked loci by pedigree analysis in humans, LOD score, somatic cell hybridization for positioning genes on chromosomes and physical maps using molecular markers.

Unit III: Molecular genetics (8 Hours)

Sex determination: Genetic basis of sex determination in Humans, *Drosophila melanogaster* and *C. elegans. Non-nuclear inheritance and Epigenetics:* Extra nuclear inheritance, tests for organelle heredity and maternal effect; Mechanism of dosage compensation; X chromosomal inactivation in humans and *Drosophila melanogaster.* Epigenetic mechanisms of transcriptional regulation. Monoallelic expressions and Genomic imprinting.

Unit IV: Quantitative and Evolutionary Genetics (5 Hours)

Inheritance of complex traits, analysis of quantitative traits, quantitative trait loci (QTL), narrow and broad sense heritability, and their identification. Hybrid vigor and transgressive inheritance.

Molecular evolution - analysis of nucleotide and amino acid sequences, homologous sequences, molecular phylogenies, phenotypic evolution and speciation, Understanding the concept of fitness with respect to evolutionary genetics.

2.3 Practical (2 Credits)

Total Hours :60

1. Understanding Mendelian genetics (dry lab).
2. Monohybrid crosses in *Drosophila* for studying autosomal/sex-linked inheritance.
3. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
4. Smear technique to demonstrate sex chromatin in buccal epithelial cells/neutrophils.
5. Understanding Hardy-Weinberg principle. PTC testing in a population and calculation of allelic and genotype frequencies.
6. Understanding chromosomal structure.
   - The study of normal and abnormal human karyotype (dry lab).
   - understanding polyploidy by studying karyotypes in plants
7. Study of human pedigrees (dry lab).

2.4 Essential readings:

1. Principles of Genetics (2015) 7th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 9781119142287
2. Genetics - A Conceptual Approach (2020), 7th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN: 978-01346047

Suggested readings:

1. An Introduction to Genetic Analysis (2017), 11th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN: 1464109486

2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2019). Concepts of Genetics. Edition 12. Benjamin Cummings.

3. Keywords

Complementation, Allelic and gene interaction, Gene mapping, Non-nuclear inheritance and Epigenetics, Sex determination, Quantitative and Evolutionary Genetics

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

DISCIPLINE SPECIFIC CORE COURSE – (DSC-15)
GENE EXPRESSION AND REGULATION

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		
Gene Expression and Regulation (BCH-DSC-503)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The objective of the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem-solving skills.

Learning outcomes

After completion of this course, learners will be able to:

1. Analyse the processes of transcription and translation in prokaryotes and eukaryotes
2. Discuss the features of the genetic code and various experimental approaches used to crack the code
3. Perform estimation of RNA by orcinol method
4. Discuss the molecular basis of RNA processing and RNA splicing
5. Perform isolation of RNA from bacteria and plant cells
6. Evaluate the various ways in which transcription and translation are regulated

SYLLABUS OF DSC-15

BCH-DSC-503 : GENE EXPRESSION AND REGULATION
SEMESTER - V

2.2 Course Contents
Theory (2 credits)

Total Hours: 30

Unit I: Transcription in Prokaryotes and Eukaryotes (10 Hours)

Transcription cycle in bacteria, Sigma factor, bacterial promoters and RNA Polymerases, various stages of RNA synthesis- initiation, elongation and termination, rho-dependent and rho-independent termination. Introduction of basal eukaryotic transcription machinery: three classes of eukaryotic RNA polymerases – I, II and III, and their respective promoters. Details of transcription by RNA polymerase II, features of RNA polymerase II core promoters. Inhibitors of eukaryotic and prokaryotic transcription and their applications.

Unit II: RNA Processing **(4 Hours)**

Various types of mRNA processing- polyadenylation and capping, brief overview of rRNA and tRNA processing. Chemistry of RNA splicing, the spliceosome machinery, group I and group II introns, alternative splicing.

Unit III: Translation **(7 Hours)**

Salient features of the genetic code, triplet nature, degenerate, wobble hypothesis, codon usage bias. Experimental approaches used to decipher the genetic code. Messenger RNA, transfer RNA, charging of tRNA. Structure of the ribosome. Three stages of translation-initiation, elongation and termination in prokaryotes and eukaryotes.

Unit IV: Regulation of gene expression **(9 Hours)**

Concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of *lac* and *trp* operon, riboswitches. Eukaryotic gene regulation by chromatin remodelling, regulation of galactose metabolism in yeast, action of enhancers and insulators, working of activators and repressors, synthesis and mechanism of action - siRNA and miRNA.

2.3 Practical (2 Credits)

Total Hours: 60

1. Quantitative estimation of RNA by Orcinol Method
2. Extraction of total RNA from bacteria /yeast
3. To study growth curve and diauxic growth curve in *E. coli*
4. To study inducible promoter activity by reporter assay
5. To study the effect of inhibitors on protein synthesis
6. DNA Footprinting (Dry Lab)

2.4 Essential readings:

1. 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.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008) *Watson: Molecular Biology of the Gene* (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN-13: 9780321762436

Suggested readings:

1. Lewin, B., Krebs, J.E., Kilpatrick, S.T., Goldstein, E.S., (2018) *Lewin's Gene X* (10th edition). Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.

3. Keywords

RNA, Transcription, Translation, Genetic code, Gene expression, Operon

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

POOL OF DISCIPLINE SPECIFIC ELECTIVES

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-2)
BIOCHEMICAL APPLICATIONS IN FORENSIC SCIENCES

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		
Biochemical Applications in Forensic Sciences (BCH-DSE-2)	04	02	0	02	Class XII with Science and Biology	NIL

Learning Objectives

The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidence, which will help students develop analytical and problem-solving skills for real life situations. With a background of the DSC of Biochemistry, the students get an insight into a major area of application of Modern Biology. The course will keep abreast with all recent developments and emerging trends in forensic science like DNA fingerprinting, brain mapping and facial reconstruction; thus, helping interested students take up forensic science as a future course of study.

Learning outcomes

On successful completion of the course students will be able to:

1. Explain the fundamental concepts and principles of forensic science and their significance.
2. Demonstrate forensic investigation, preservation of evidences, as well as chemical, physical and biological analysis of biological samples
3. Establish the age, sex and identity of an individual of an individual by document evaluation, fingerprints, footprints and DNA analysis.
4. Analyze samples for drug testing, ink and stain testing and document and handwriting verification.
5. Perform Narco Analysis, polygraphy, lie detection and facial reconstruction.

SYLLABUS OF DSE-2

BCH-DSE-2 : BIOCHEMICAL APPLICATIONS IN FORENSIC SCIENCES
Semester – V

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit I: Introduction to forensic science and application of biological sciences to forensic investigation (10 Hours)

History and Development of Forensic Science, Biochemical analysis of various biological evidences: blood, semen, viscera, bite marks, and hair. Establishment of identity of individuals: fingerprints, footprints, blood and DNA. Anthropology – skeletal remains, Odontology. Time of death - rigor mortis, liver mortis, algor mortis, forensic entomology. Biochemical basis for determination of cause of death. case studies

Unit II: Application of chemical sciences to forensic investigation (6 Hours)

Detection of drugs of abuse and narcotics in biological samples, Toxicological examination of viscera, detection of petroleum products and food adulteration. Analysis of inks and their use in questioned document identification. Blood spatter analysis, Case studies

Unit III: DNA Fingerprinting (6 Hours)

Introduction to DNA-and source of DNA in Forensic case work, Techniques of DNA fingerprinting-RFLP, STR, PCR, DNA fingerprinting in paternity disputes, mass disaster and other forensic case work, studying kinship by DNA profiling: Related individuals have similar DNA profiles, DNA profiling and the remains of the Romanovs. Sex identification by DNA analysis: PCRs directed at Y chromosome-specific sequences, Amelogenin gene typing. Case studies

Unit IV: Recent advances in forensics (8 Hours)

Narco analysis: theory, forensic significance, future prospect, *Brain mapping:* introduction, EEG, P-3000 wave, forensic applications, limitation of technique, *Polygraph*: Principle and technique, polygraph as forensic investigative tool, use of psychoactive drugs in forensic analysis. NHRC guidelines for polygraph test. *Facial reconstruction*: Method and technique, facial reconstruction in forensic identification, Case studies.

2.3 Practicals

Credit: **2** **Total Hours : 60**

1. Definition, Identification and Mapping of Crime scene
2. Collection, Preservation, Packaging, and Labeling of biological evidence for their forensic investigation.
3. Preliminary and Confirmatory test for blood/semen/saliva

4. Examination of Micro Evidences: fiber, hair, pollen and soil
5. Fingerprint development from various surfaces and their microscopic and chemical examination
6. Handwriting identification based on class characteristic and individual characteristics
7. Identification of dyes, drugs and ink by TLC
8. Blood spatter analysis
9. DNA Fingerprinting: Sex determination through Y specific STRs and Maternal lineage identification through mitochondrial DNA comparisons.
10. Field trip to a forensic laboratory

2.4 Essential readings:

- James, S.H., Nordby, J.J. & Bell, S. (2014). *Forensic Science: An Introduction to Scientific and Investigative Techniques, Fourth Edition*: Taylor & Francis. ISBN 9781439853832
- Jones, P., & Williams, R.E. (2009). *Crime Scene Processing and Laboratory Workbook First Edition*: CRC Press. ISBN 9780429249976
- Saferstein, R. (2018). *Criminalistics: An Introduction to Forensic Science, Twelveth edition*: Pearson Education. ISBN 10:0134477596, ISBN 13: 9780134477596
- Veeraraghavan, V. (2009). *Handbook of Forensic Psychology, First Edition*: Selective & Scientific Books, ISBN 13: 9788189128166.

Suggested readings:

- Lee, H., Palmbach, T. & Miller, M. (2001). *Henry Lee's crime scene handbook, First Edition*: Academic Press ISBN 9780080507989
- Parikh, C.K. (2016). *Parikh's textbook of medical jurisprudence, forensic medicine and toxicology: for classrooms and courtrooms*, *Seventh Edition*: CBS Publishers and Distributors. ISBN 9788123926469

3. Keywords

Forensic biology; blood spatter analysis; toxicology; narco-analysis; DNA fingerprinting; polygraph; odontology; forensic entomology.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-3)
MICROBIOLOGY

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		
Microbiology (BCH-DSE-3)	04	02	0	02	Class XII with Science and Biology	XIIth pass with biology

Learning Objectives

The course aims to trace the history of development of the discipline of Microbiology and to emphasize the existence of the immense diversity in the microbial world and maintenance of microbes under laboratory conditions. Through this course students will be introduced to the concept of different modes of gene transfer in bacteria. Further, students will be made aware about the applications of microorganisms in food and industry.

Learning outcomes

On successful completion of the course students will be able to:

1. Identify different types of microbes
2. Perform routine microbiological practices including sterilisation, media preparation, maintenance of microbial culture, microbial growth etc.
3. Plan basic research using microbes
4. Discuss the varied applications of microbes.

SYLLABUS OF DSE-3

BCH-DSE-3 : MICROBIOLOGY
Semester – V

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit I: History and Diversity of Microbial world **(8 Hours)**

Spontaneous generation versus biogenesis, contributions of Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Richard Petri, Charles Chamberland, Edward Jenner, Louis Pasteur,

Robert Koch, Martinus W. Beijerinck, Sergei Winogradsky, Alexander Fleming, Elie Metchnikoff and Emil von Behring. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa. Cell-wall: Composition and detailed structure of Gram positive and Gram-negative cell walls, mechanism of Gram staining

Unit II: Microbial Nutrition, Growth and Control (6 Hours)

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics.

Unit III: Microbial Genetics (6 Hours)

Conjugation, Transformation and Transduction. Gene mapping in Bacteria

Unit IV: Application of Microbes (10 Hours)

Basic design of fermenter, continuous and discontinuous culture. Preparation of fermented food products such as curd and cheese. Preparation of alcoholic beverages like wine and beer. Treatment of waste-water (Municipal treatment plant) and sewage. Bioremediation and biodegradation. Human microbiome: Role in health and disease**.** Soil Microbiome: Role in plant health

2.3 Practical:

Credits: 2 Total Hours : 60

1. To prepare and sterilise the culture media for the growth of microorganisms
2. To perform various culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml
3. To study growth curve of bacteria
4. To study the effect of pH/temperature on the growth of bacteria
5. To perform gram staining
6. To determine the effect of antibiotics using disc diffusion test
7. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs

2.4 Essential readings:

1. Willey, J., Sherwood, L., Woolverton, C. (2017). Prescott's Microbiology (10th ed.). McGraw Hill international. ISBN 13: 9781259657573.
2. Chan, M. J., Krieg E. C. S., Pelczar, N. R. (2004) Microbiology (5th ed.). McGraw Hill International. ISBN 13: 9780094623206.
3. Pierce, B.A. (2012) Genetics - A Conceptual Approach, (6th ed.), W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1
4. Cappuccin, and Sherman N., Microbiology: A Laboratory manual (10th ed.). Benajamin/ Cummings. ISBN 1o J. G.3: 9780321840226. 86

Suggested readings:

1. Madigan, M. T., Martinko J. M., & Stahl D. A., (2010) Brock Biology of Microorganisms (13th ed.). Pearson Education International. ISBN 13: 9780321649638.
2. Snustad, D.P. and Simmons, M.J. (2012) Genetics (6th ed.), John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2

3. Keywords

Microbiological Techniques, Media, Sterilization, Growth curve

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-6)
IN-SILICO TOOLS IN PROTEOMICS AND GENOMICS

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		
In-silico Tools in Proteomics and Genomics (BCH-DSE-6)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to Biological sciences

Learning Objectives

The objective of this course is to impart basic understanding of computational biology with a broader knowledge of genomics and proteomics. In silico tools used in the study of genomes and proteins will be emphasized. The course presents an overview of theoretical knowledge, and practical methods for characterization of functional elements in DNA and Protein data. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, genome analysis, prediction of protein structures and protein-protein interactions.

Learning outcomes

On successful completion of the course students will be able to:

1. Discuss the basics of bioinformatics and computational biology
2. Describe the use of several softwares/tools in omics biology.
3. Discuss, access and use biological databases in the public domain.
4. Explain protein structure using visualization softwares.
5. Perform sequence alignments
6. Discuss the fundamental aspects of *in-silico* protein structure prediction.
7. Explain the applications of bioinformatics from genomes to personalized medicine.
8. Describe the concept of drug designing using a bioinformatic approach.

SYLLABUS OF DSE-6

BCH-DSE-6 : In-silico Tools in Proteomics and Genomics
Semester – V

2.2 Course Contents

Theory
Credits: 2 **(30 Hours)**

Unit I: Introduction to omics biology **No. of hours: 4**

History of omics biology, introduction to central dogma, Scope of bioinformatics, Tools and databases (sequence alignment, BLAST, NCBI and PDB databases)

Unit II: Genomics **No. of hours: 9**

Introduction to Genomics, Structure and Organization of Prokaryotic and Eukaryotic Gene. Genome Sequencing, Human Genome Project, Genome Browsers, Gene annotation, Gene Identification and Sequence analysis

Unit III: Protein structure prediction and proteomics **No. of hours: 9**

Introduction to proteomics, 2D gel Electrophoresis, Mass spectroscopy, computational prediction of protein 2D and 3D structure - Homology Modeling, Fold Recognition and *ab-intio* methods, protein - protein interactions (yeast two hybrid system, pull down assay), Protein Disordered Regions

Unit IV: Applications of genomics and proteomics **No. of hours: 8**

Functional Genomics, Comparative genomics, Proteomics in Drug discovery, Protein-Drug interaction studies, Computer Aided Drug Discovery (CADD). Role of genomics and proteomics in Diagnostics and Therapeutics. Role of AI in genomics and proteomics.

2.3 Practical:

Credits: 2 **(60 Hours)**

1. Sequence retrieval (protein and gene) from NCBI.
2. Sequence Analysis - BLAST suite of tools for pairwise alignment.
3. Gene Prediction Tools (Genscan/Glimmer)
4. Structure download (protein and DNA) from PDB & Molecular view by visualization Software (Pymol/Rasmol)
5. Protein Secondary Structure Prediction Tools (GORR)
6. Protein Tertiary Structure Prediction (Homology Modelling/SWISS Model)
7. Protein -Protein Interaction Databases (STRING)
8. Protein-Ligand Docking and Interaction studies (CADD)

2.4 Essential readings:

1. David M. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press; ISBN 978-087969712-9.
2. Pevsner, J. (2003). Bioinformatics and Functional Genomics (1st ed.), John Wiley & Sons, Inc. (New Jersey); ISBN: 0-47121004-8.
3. Baxevanis A.D. and Ouellette Francis B.F. (2005), Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd ed.), John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-4.
4. Ghosh, Z. and Mallick, B., (2008) Bioinformatics – Principles and Applications, (1st ed.) Oxford University Press (India), ISBN: 9780195692303.
5. Introduction to Proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., Humana Press Inc., New Jersey, USA. 2002.

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

POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE COURSE - (GE-5)
NUTRITION AND FOOD SCIENCE

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		
Nutrition and Food Science (BCH-GE-5)	04	02	0	02	Class XII with Science	NIL

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

On successful completion of the course students will be able to:

- Describe the importance of food in our life
- Explain how food is spoiled and learn about some common food borne diseases/ food allergies
- Elaborate the functions of macro and micronutrients in our body
- Apply the knowledge gained to rationalize the diseases associated with malnutrition/ overnutrition and deficiency diseases

BCH-GE-5 : NUTRITION AND FOOD SCIENCE
SEMESTER – V

2.2 Course Contents
Theory
Credits: 2 **Total Hours: 30**

Unit 1 –Basics of Food Science and Nutrition **(10 Hours)**

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 (10 Hours)

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 (10 Hours)

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 (5 Hours)

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 Hours:60

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. 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.

GENERIC ELECTIVE COURSE - (GE-6)
PHYSIOLOGY AND SPORTS AND EXERCISE

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		
Physiology of Sports and Exercise (BCH-GE-6)	**04**	**02**	**0**	**02**	**Class XII with Science**	**Basic course on human physiology**

Learning Objectives

To learn the changes in human body systems due to exercise and sporting activities in an integrated manner. To gain knowledge about sports training. Understanding the basic system physiology in sports. To understand the physiological adaptation and metabolic changes during exercise at varying intensities. To gain skill in measurement of various physiological responses.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the effect of exercise in detail and in application perspective.
- Measure the changes and interpret them in the context of sports.
- Describe the system concepts behind sports performance.
- Explain human body functioning during exercise and thus provide appropriate nutrition/fuel.

BCH-GE-6 : PHYSIOLOGY OF SPORTS AND EXERCISE
SEMESTER - V

2.2 Course Contents

Theory

Credits: 2 **Total Hours : 30**

Unit I: Introduction to Exercise Physiology (Total Hours: 4)

Structure, types and Function of Skeletal Muscle. Fuel for Exercise: Aerobic and anaerobic muscle metabolism, Muscle Fatigue.

Unit II: Cardiovascular and Pulmonary control in Sports Performance (Total Hours : 10)

Heart rate and Blood Pressure. Electrophysiology of Heart, Introduction and interpretation of EKG/ECG, Pacemakers and its Rhythms. Mechanics of ventilation during exercise. Cardiorespiratory Responses to physical activities. Training of cardiorespiratory responses in different types of physical activities for maximising output.

Unit III: Hormonal Effects on Physical Activities (Total Hours: 8)

Role of epinephrine, cortisol, sex hormones, growth hormones and growth factors on physical endurance. Effect of aging on Sport performance.

Unit IV: Drugs and Doping in Sports (Total Hours : 8)

History and evolution of Doping and Anti-doping in Sports, Prevalence of Doping in Sports, Doping Control in Sports, Role of Athlete Support Personnel in Preventing Deliberate and Inadvertent Use of Prohibited Substances, WADA Rules and Regulations.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. BMI Estimation with and without software - Techniques of taking various anthropometric measurements; Skinfold measurement and Body Fat Percentage calculations.
2. Aerobic Power Field Assessments; Cooper 1.5-Mile Run/Walk Test and 12-Minute Run/Walk Test/Rockport Fitness Walking Test.
3. Tests for anaerobic power; Wingate Test/Anaerobic Cycling Power
4. High-Intensity Fitness Testing/ AAHPER health related physical fitness test Léger 20 m Shuttle Run Test/ Margaria - Kalamen Stair Climb Test,
5. Pulmonary Function Testing: Ratio of Forced expiratory volume (FEV1/FEV6) by spirometry, Lung Volumes and Capacities
6. Determination of age by Radiography (Dry lab)
7. Blood Pressure Measurements: Effects of Body Position, Dynamic Exercise and Isometric Contractions on BP.

8. Determination of Physiological adaptation with training through Submaximal Exercise Testing; Submaximal Bench Step Test/Submaximal Cycle Ergometer Test

2.4 Essential readings:

1. Physiology of Sport and Exercise 6th Edition with Web Study Guide-Loose-Leaf Edition by W. Larry Kenney, Jack Wilmore, David Costill.
2. Endocrinology of Physical Activity and Sport, Second Edition Constantini, Naama, Hackney, Anthony C, 2013.
3. David R. Mottram, Neil Chester (2018) Drugs in Sports, Routledge, ISBN:1351838989. Portefield, Jason (2008) Doping: athletes and drugs, Rosenn Publishing, New York, ISBN:1-4042-1917-5.
4. Laboratory Manual for Exercise Physiology 2nd Edition. With Web Study Guide, Human Kinetics by G. Gregory Haff, Charles Dumke, 2018.
5. Physiological Tests for Elite Athletes 2nd Edition by Australian Institute of Sport Rebecca Tanner, Christopher Gore, 2012.

Suggested readings:

1. A Textbook of Sports & Exercise Physiology by Dey Swapan Kumar, Jaypee Publishers
2. Exercise Physiology: Theory and Application to Fitness and Performance 10th Edition by Scott Powers and Edward Howley 2018.
3. Exercise Physiology: Nutrition, Energy, and Human Performance 8th Edition by William D. McArdle, Frank I. Katch, Victor L. Katch
4. Practical ECG for Exercise Science and Sports Medicine by Greg Whyte, Sanjay Sharma, Human Kinetics, 2010
5. ACSM's Guidelines for Exercise Testing and Prescription, 10th Edition by American College of Sports Medicine. Wolters Kluwer, 2017.

3. Keywords

Muscle metabolism, Muscle Fatigue, Cardiorespiratory Responses, Sport performance, Prohibited Substances

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

GENERIC ELECTIVES COURSE - (GE-10)
INTERMEDIARY METABOLISM

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		
INTERMEDIARY METABOLISM (BCH-GE-10)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological sciences

Learning Objectives

The course aims to familiarise the learner with the pathways of fuel and energy metabolism with an emphasis on their interrelationship and integrated regulation.

Learning outcomes

On successful completion of the course learners will be able to:

1. Discuss the underpinnings of fuel metabolism
2. Describe the mechanism of ATP synthesis.
3. Discuss the biosynthesis and degradation pathways.
4. Evaluate the interrelationships of carbohydrate and lipid metabolism
5. Discuss the biosynthesis and degradation of amino acids and nucleotides
6. Correlate the integration of metabolism

SYLLABUS OF GE-10

BCH-GE-10 : INTERMEDIARY METABOLISM
SEMESTER - V

2.2 Course Contents
Theory (Credit 2)

Total Hours : 30

Unit I: Carbohydrate metabolism **(14 Hours)**

Glycolysis as a universal pathway, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis, Pentose phosphate pathway, Pyruvate dehydrogenase complex, oxidation of acetyl CoA. TCA cycle, amphibolic role, ATP calculation, Glycerol-3-phosphate and malate-aspartate shuttle.

Unit II: Fatty acid catabolism **(6 Hours)**

TAG as energy source, β oxidation of saturated fatty acids in mitochondria, Fatty acid activation and overview of regulation, formation of ketone bodies and metabolism

Unit III: Amino acid and nucleotide metabolism (6 Hours)

Transamination, Deamination, urea cycle and its regulation, Glucose-alanine cycle, Krebs bicycle, Nucleotide Biosynthesis - salvage pathways, Degradation.

Unit IV Integration of metabolism (4 Hours)

Metabolic shifts in absorptive, post absorptive, fasting and starvation states.

2.3 Practical:

Credits: 2 **Total Hours : 60**

1. Estimation of blood glucose by GOD-POD method
2. Demonstration of alcohol fermentation by yeast.
3. Estimation of serum cholesterol.
4. Estimation of serum TAGs.
5. Estimation of urea in serum
6. Estimation of uric acid in serum

2.4 Essential readings:

1. 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.
2. 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.
3. 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.
4. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10:0-07-099487-0.

Suggested Readings:

1. Principles of Biochemistry (2013) 4th ed., Voet, Donald, Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.

3. Keywords

Catabolism, anabolism, Glycolysis, TCA, Glycogen metabolism, Gluconeogenesis, nucleotide metabolism, beta oxidation, salvage pathway and integration

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

SEMESTER VI
BSc. (Hons.) Biochemistry

DISCIPLINE SPECIFIC CORE COURSE – (DSC-16)
HUMAN PHYSIOLOGY

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		
Human Physiology (BCH-DSC-601)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The objective of the course is to provide a comprehensive study of the molecular and cellular mechanisms that govern the integrative working and regulation of the various organ systems in the human body. The course will provide a foundation of the physiological principles and the application of the same in real-life situations. It will prepare students for higher education in any field related to medical physiology.

Learning outcomes

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

1. Explain the homeostatic control and functioning of the human body systems
2. Discuss the regulatory mechanism regulating different organ system.
3. Describe the functioning of the different organ systems.
4. Explain the basis of various physiological diseases.
5. Perform and analyse various physiological tests that examine the function of various systems of the human body.

SYLLABUS OF DSC-16

BCH-DSC-16 : HUMAN PHYSIOLOGY
SEMESTER - VI

2.2 Course Contents
Theory (2 Credits)

Total Hours: 30

Unit I: Circulatory system **(7 Hours)**

Homeostasis: definition and control mechanisms (negative and positive feedback mechanisms). Blood Composition and Blood coagulation. Anatomy of Heart. Heartbeat Coordination: Cardiac action potential and Pacemaker potential. Cardiac cycle. Cardiac output and its regulation. The role of blood vessels in circulation: Arteries, Veins and Blood capillaries.

Unit II: Life Processes (15 Hours)

Respiratory physiology: Ventilation and lung mechanics. Inspiration, Expiration, Lung compliance and its determinants. Transport of oxygen and carbon dioxide in blood. Regulation of respiration.

Renal physiology: Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Urine concentration: The counter current multiplier system. Blood buffer systems.

Gastrointestinal physiology: Propulsion, motility, digestion and assimilation of food. Secretory functions of the gastrointestinal tract. Enteric nervous system. Regulation of GI tract functions. Hepatic physiology and Enterohepatic circulation.

Unit III: Introduction to muscular and neural physiology (4 Hours)

Molecular mechanisms of skeletal and smooth muscle contraction: role of troponin, tropomyosin, and calcium in contraction, excitation-contraction coupling. Overview of Central and Peripheral Nervous System and neural conduction.

Unit IV: Reproductive Physiology (4 Hours)

Sex determination and differentiation. Oogenesis, Spermatogenesis, capacitation and transport of sperm, blood-testis barrier. Fertilization, Implantation and Placentation.

2.3 Practical (2 Credits)

Total Hours: 60

1. Hematology:
    a. Determination of Packed Cell Volume, Bleeding Time and Clotting Time.
    b. Preparation of blood smear and estimation of differential leucocyte count.
    c. Enumeration of Blood cells: RBC and WBC
    d. Estimation of hemoglobin and calculation of blood indices
2. Serum Proteins Electrophoresis
3. Understanding the anatomy/structure of following: Heart, GI Tract, Kidney and Nephron, Neuron, Lung and alveoli, skeletal, smooth and cardiac muscle
4. Pulmonary function tests: Understanding Lung capacities and Lung volumes using Spirometry
5. Determination of the Blood Pressure.
6. Case studies: Renal clearance, Gastrointestinal disorder, Anemia, Jaundice (any two)
7. Virtual Lab on ECG

2.4 Essential Readings:

- Widmaier, E.P., Raff, H. and Strang, K.T. (2019) Vander's Human Physiology 15th ed., McGraw Hill International Publications (New York), ISBN: 978-1259903885
- Fox, S.I. (2018) Human Physiology 15th ed., McGraw Hill International Publications, (New York) ISBN 978-1259864629

Suggested Readings:

- Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052
- Sherwood, L. (2012) Introduction to Human Physiology 8th edition; Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.
- Gerard G Totora. (2017). Principles of Physiology and Anatomy 15th Edition, Wiley. ISBN: 978-1-119-40006-6

3. Key word:

Physiology, Homeostasis, life processes, heart, neurophysiology, reproduction

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

DISCIPLINE SPECIFIC CORE COURSE – (DSC-17)
BASICS OF IMMUNOLOGY

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		
Basics of Immunology (BCH-DSC-602)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The course is designed to understand the basic concepts in Immunology. It is important to understand the structure of the cells and organs associated with the immune system to appreciate their function in fighting infections. So, the students will study their structure and the various receptors associated with them. They will be exposed to the concept of antigen antibody and the types of immune responses generated in the body. The recognition of the antigen by B and T cells and the role of Major histocompatibility complex in generation of immune response will be elaborated.

Learning outcomes

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

1. Explain the concept of innate and adaptive immunity.
2. Describe the structure and function of cells and organs of the immune system
3. Discuss the Attributes of an immunogen, structure and the functions associated with different isotypes of antibodies
4. Explain the humoral immune response and antibody diversity.
5. Explain the Antigen presentation mechanisms and generation of cell mediated immunity

SYLLABUS OF DSC-17

BCH-DSC-17 : BASICS OF IMMUNOLOGY
SEMESTER - VI

2.2 Theory (2 Credits)

Total Hours: 30

Unit 1 : Introduction to the Immune System: (8 Hours)

Historical Perspective, Innate and Adaptive immunity and their role in generation of immune response, Primary and Secondary Immune Response, Cells and Organs of the Immune System, Hematopoiesis, Antigens, Properties of Immunogen, Haptens, Adjuvants, B Cell and T Cell Epitopes, Structure and Effector Functions of Different Types of Antibodies, Biological Activities of Subclasses of Antibodies, Antigenic Determinants on Immunoglobulins, Immunoglobulin Superfamily, B cell receptor,

Unit 2 : **Innate Immunity:** **(6 Hours)**

Anatomical Barriers, Soluble and Membrane Bound Molecular Sensors (PRRs), Inflammation, Phagocytic cells and Innate Immunity, Toll like receptors, Activation Pathways of Complement System, Regulation and Biological Consequences of Complement Activation.

Unit 3 : **Humoral Immune Response** **(8 Hours)**

B Cell Development, Maturation & Differentiation, Clonal Selection theory, Genetic basis of Antibody Diversity, Class switching.

Unit 4 : **Cell mediated Immune Response** **(8 Hours)**

Major Histocompatibility, General Organization and Inheritance of the MHC, Antigen Presenting Cells, Processing and Presentation of Antigen by the endocytic and cytosolic pathways, Development, Maturation & Differentiation of T cells, Role of Cytotoxic T lymphocytes, T cell and B cell interactions

2.3 Practical (2 Credits)

Total Hours: 60

1. Immunodiffusion –Double immunodiffusion and Single radial immunodiffusion
2. Differential Leucocyte Count
3. Visualization of lymphoid Organs and lymphatic system (Videos)
4. Isolation of lymphocytes from blood/spleen
5. Complement mediated lysis.
6. Active and Passive agglutination reactions
7. Dot blot and ELISA

2.4 Essential readings:

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H. Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3/ISBN: 10:0-7617-8590-0.
2. Immunology: A Short Course (2009) 6th ed., Coico, R. and Sunshine, G., John Wiley & sons, Inc. (New Jersey), ISBN: 978-0-470-08158-7.

Suggested Readings:

1. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowar, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4
2. Cellular and Molecular Immunology (2021), 10th edition, Abbas, A.K., Lichtman, A.H., Shiv Pillai, Elsevier, ISBN: 9780323757485

3. Keywords:

Immunity, innate, adaptive, antibody, MHC, Humoral and Cell mediated immune response, Processing of antigens

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

DISCIPLINE SPECIFIC CORE COURSE – (DSC-18)
FUNDAMENTALS OF RECOMBINANT DNA TECHNOLOGY

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		
Fundamentals of Recombinant DNA Technology (BCH-DSC-603)	4	2L	0	2P	Class XII with Science and Biology	Basic course in Molecular Biology

Learning Objectives

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes and eukaryotes.

Learning outcomes

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

1. Perform restriction digestion of DNA samples.
2. Prepare genomic and cDNA libraries,
3. Perform basic cloning techniques to design a recombinant protein in a bacterial system.
4. Design primers for PCR, perform DNA amplification by PCR, and understand the principles of DNA sequencing.

SYLLABUS OF DSC-18

BCH-DSC-18 : FUNDAMENTALS OF RECOMBINANT DNA TECHNOLOGY
SEMESTER - VI

2.2 Course Contents

Theory (2 Credits)

Total 30 hours

Unit 1: Principles of gene cloning **(14 hours)**

Restriction and modification systems, restriction endonucleases and other enzymes used in gene cloning. Cloning vectors used in *E. coli*: plasmids pBR322, pUC, pGEM3Z. Ti-plasmid, and viral vectors (λ bacteriophage, CMV and SV40), high-capacity vectors BAC and YAC. Ligation of DNA molecules. Linkers, adapters and homopolymer tailing.

Unit 2: Selection for recombinants and clone identification (5 hours)

Uptake of DNA by cells and selection of recombinants. Making cDNA and Genomic DNA libraries. Clone identification by colony hybridization.

Unit 3: Expression of cloned genes (6 hours)

Vectors for expression of foreign genes in *E. coli,* expression cassettes: Hybrid promoters trc, tac. Challenges in producing recombinant protein in *E. coli.* Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit 4: Polymerase chain reaction, DNA sequencing and Site Directed Mutagenesis

(5 hours)

Fundamentals of polymerase chain reaction, Types of PCR; reverse transcriptase PCR, Primer designing. DNA sequencing by Sanger's method including automated DNA sequencing, pyrosequencing. Site–directed mutagenesis (overlap extension method).

2.3 Practical (2 Credits)

Total: 60 hours

1. Isolation of plasmid DNA from *E. coli* cells.
2. Digestion of plasmid DNA with restriction enzymes.
3. Preparation of competent cells and transformation with plasmid DNA.
4. Amplification of a DNA fragment by PCR.
5. Alpha-Complementation of β−galactosidase for Blue and White selection.
6. Hyper expression of a recombinant protein (SDS PAGE).
7. Poly histidine-tagged recombinant protein and purification using Ni– affinity resin

2.4 Essential readings:

- Brown, T.A. (2016) Gene Cloning and DNA Analysis (7th ed.), Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
- Primrose, S.B., and Twyman, (2006) Principles of Gene Manipulation and Genomics (7th ed.), R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
- Glick B.R., Pasternak, J.J. and Patten, C.L., (2010) *Molecular Biotechnology:* Principles and Applications of Recombinant DNA (4th ed.), ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).
- Michael R Green and J. Sambrook (2014) Molecular Cloning: A laboratory manual, (4th ed.), Cold spring Harbor laboratory press (3vol.), ISBN: 978-1-936113-42-2.

Suggested readings:

- Brown, T.A. (2007) Genomes (3rd ed.), Garland Science publishing, ISBN: ISBN 0 8153 4138 5.

3. Keywords

Genetic Engineering, cloning, Recombinant Protein expression and purification, Biotechnology.

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

POOL OF DISCIPLINE SPECIFIC ELECTIVES

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-4)
BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS

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		
Biochemical Mechanisms and Responses in Plants (BCH-DSE-4)	04	02	00	02	Class XII with Science and Biology	Basic courses allied to biological sciences

Learning Objectives

The course aims to provide thorough understanding of metabolic processes in plants and the role of different biosynthetic pathways in growth and development of plants. The course will also impart basic concepts and applications of plant secondary metabolites.

Learning outcomes

On successful completion of the course students will be able to:

1. Describe the structure and function of plant cell organelles in plant metabolism.
2. Explain the various plant biochemical processes and metabolic pathways including photosynthesis, photorespiration, nitrogen fixation and assimilation and plant secondary metabolism and their biological significance.
3. Discuss the role of plant hormones in plant growth and development.
4. Evaluate the various plant responses to different abiotic and biotic stress conditions.
5. Plan and execute plant tissue culture.

SYLLABUS OF DSE-4

BCH-DSE-4 : BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS
Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit I: Photosynthesis and Respiration **(8 Hours)**

Introduction to Plant cells, Cell wall, Vacuole and Tonoplast membrane, Plastids and Peroxisomes. Overview to photosynthesis and Carbon assimilation, Light reaction and photosystems, Cyclic and non-cyclic photophosphorylation, Calvin cycle and its regulation, C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration. Photoinhibition. Glycolytic pathway and its alternative reactions in plants, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain in plants, alternative NAD(P)H oxidative pathways.

Unit II: Nitrogen metabolism (7 Hours)

Nitrogen cycle; Biological nitrogen fixation; Structure and function of Nitrogenase complex. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate aminotransferase (GS-GOGAT) pathway.

Unit III: Plant physiology and Secondary metabolites (10 Hours)

Plant vascular system; Plant hormones and their role in plant growth and development; Regulation of plant morphogenetic processes by light. Plant stress responses to abiotic and biotic stresses: Water deficit, temperature, salinity, insect manifestation. Secondary metabolites: types, structure and functions of Alkaloids, Phenolics and terpenoids.

Unit IV: Plant tissue culture (5 Hours)

Cell and tissue culture techniques, types of cultures: organ and explant culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somaclonal variation. Germplasm storage and cryo-preservation. Brief introduction to transgenic plants.

2.3 Practical:

Credits: 2 Total Hours : 60

1. Induction of hydrolytic enzymes (proteases /amylases/lipase) in germinating wheat seeds.
2. Effect of plant hormones on plant growth (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds).
3. Extraction and assay of Urease from Jack bean.
4. Estimation of carotene/phenols/tannins in fruits and vegetables.
5. Estimation of ascorbic acid in fruits and vegetables.
6. Effect of light on chlorophyll production.
7. Separation and analysis of chloroplast proteins (Rubisco) using SDS-PAGE.
8. Plant tissue culture

2.4 Essential readings:

1. Buchann (2015). Biochemistry and Molecular Biology of plant. (2nd ed.). I K International. ISBN-10: 8188237116, ISBN- 978047 07 14218
2. Caroline Bowsher, Martin steer, Alyson Tobin (2008). Plant Biochemistry. Garland Science. ISBN 978-0-8153-4121-5.

3. Dey, P. M. and J.B. Harborne, J.B., (Editors) (1997). Plant Biochemistry. Academic Press. ISBN-10:0122146743, ISBN-13:978-0122146749. 94
4. Taiz, L. and Zeiger, E. (2010). Plant Physiology (5th ed.). Sinauer Associates Inc. ISBN-13: 978-0878938667, ISBN-10: 0878938664

3. Keywords

Plant cell, photosynthesis, respiration, nitrogen fixation and assimilation, secondary metabolism, stress biology.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-5)
NUTRITIONAL BIOCHEMISTRY

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		
Nutritional Biochemistry (BCH-DSE-5)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological sciences

Learning Objectives

This course provides students with knowledge and understanding of the characteristics, function, metabolism and deficiency of macro and micronutrients in the human body. It involves integrated learning between the areas of Biochemistry and Nutrition.

Learning outcomes

On successful completion of the course students will be able to:

1. Critically analyse and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition.
2. Demonstrate the relationship between nutrition and health.
3. Discuss the macro and micronutrients and their nutritional deficiencies.
4. Describe techniques used in the assessment of nutritional status and nutritional disorders.
5. Explain drug nutrient interactions.

SYLLABUS OF DSE-5

BCH-DSE-5 : NUTRITIONAL BIOCHEMISTRY
Semester – VI

2.2 Course Contents
Theory (Credits – 2)

Total Hours: 30

Unit I: Introduction to Nutrition and Energy Metabolism (4 Hours)

Defining nutrition, role of nutrients. Unit of energy, Food energy, SDA. Energy expenditure and its components, Energy Balance, Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit II: Macronutrients **(10 Hours)**

Food sources of carbohydrates, functions of carbohydrates, RDA, Factors affecting bioavailability, Glycemic index and glycemic load. Dietary fiber and the role of fibre in health. Role of Gut microbiome in maintaining health. Role of prebiotics and probiotics in nutritive health.

Essential Fatty Acids; Functions of EFA, AI, excess and deficiency of EFA, factors affecting bioavailability. Dietary implications of ratios of n6 and n3, MUFA, PUFA and SFA, Cholesterol in the body.

Functions of proteins in the body. RDA for different age groups. Essential and Nonessential amino acids. Complete and incomplete protein, Amino Acid Interactions: Antagonism, Toxicity, Imbalance, Amino acid complementation and Supplementation in foods. Protein quality determinants NPU, Biological Value, PDCAAS, Nitrogen balance. PEM: Marasmus and Kwashiorkor.

Unit III: Fat and water soluble Vitamins **(9 Hours)**

Vitamin A, D, E, K and dietary sources, RDA, Role of Vitamin A in Visual cycle and overview of other functions. Role of Vitamin K in Gamma carboxylation (blood clotting). Role of Vitamin E as an antioxidant. Role of Vitamin D in maintenance of bone physiology and overview of other functions. Vitamin C- Dietary sources, RDA, role in collagen synthesis. The B Complex vitamins- Dietary sources, RDA. Functions and role in metabolism, Role of Vitamin B12 and Folate in Haematopoiesis and Neurology. Biochemical basis for deficiency symptoms, Hypervitaminosis.

Unit IV: Minerals **(7 Hours)**

Minerals: Dietary Sources, RDA. Sodium, Potassium, Calcium, Iron, Chloride, Copper and Phosphorus- Function, metabolism, Excretion, Deficiency, Toxicity, Trace Elements Iodine, Fluoride, Mg, Zn, Se, Chromium, Molybdenum: Function, Metabolism, deficiency, Toxicity and Sources.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. Anthropometric identifications for nutrition related diseases, BMR calculation
2. Determination of oxidative stress: TBARS in serum, antioxidant enzymes in hemolysate/plant sources.
3. Estimation of A/E vitamin in serum.
4. Estimation of minerals in drugs/food/serum.
5. Determination of nutritive value of foods.
6. Understanding fortification and supplementation
7. Presentation and discussion on Food as medicine.
8. Group discussion on Nutrient-nutrient and drug-nutrient interactions
9. Case studies on nutritional disorders.

2.4 Essential Readings:

1. Coombs Jr. G. F., (2008). *The vitamins, Fundamental aspects in Nutrition and Health.* Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
2. 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.
3. Rosalind Gibson (2005). *Principles of Nutritional Assessment.* Oxford University Press. ISBN: 9780195171693
4. Tom Brody (1999). *Nutritional Biochemistry* (2nd Ed). Harcourt Braces. ISBN:9814033251, 978981403325.
5. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

Suggested reading:

1. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

3. Keywords

Nutrition, macronutrients, micronutrients, energy balance, nutrient deficiency

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-7)
MOLECULAR BASIS OF NON-COMMUNICABLE HUMAN DISEASES

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		
Molecular Basis of Non-communicable Human Diseases (BCH-DSE-7)	04	02	00	02	Class XII with Science and Biology	Course in human physiology

Learning Objectives

Non-communicable diseases are a diverse group of chronic diseases that are not transferred between individuals. NCDs have long-term health consequences and often create a need for long-term treatment and care. This course is aimed at providing the learner with an understanding of the multiple aetiological factors that lead to NCDs. It will also discuss the molecular and biochemical basis of the symptoms of major NCDs like Cardiovascular disease, Cancer, lifestyle disorders, chronic renal and lung disease. Apart from the major NCDs some other NCDs will also be taught. The practicals will address the diagnostics of some of these NCDs. The course will not only help students get an insight into some aspects of molecular medicine but will also give them some background if they wish to pursue a post-graduation in molecular medicine or any other relevant field.

Learning outcomes

On successful completion of the course students will be able to:

1. Discuss the relationship between lifestyle and noncommunicable diseases.
2. Analyze the various molecular and biochemical interactions that contribute to the cause of NCDs.
3. Explain the networking between different endogenous and exogenous factors that contribute to NCDs burden.
4. Describe specific biomarkers that can be used to diagnose a disease or Disorder.
5. Perform tests of various diagnostic parameters that are used to identify NCDs.
6. Discuss the disease burden in today's urban society and also understand the wide spectrum of symptom diversity that occurs in such diseases through case studies.

SYLLABUS OF DSC-7

BCH-DSC-7 : MOLECULAR BASIS OF NON-COMMUNICABLE HUMAN DISEASES
Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit 1: Multifactorial complex disorders (10 Hours)

Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases: Polycystic ovarian syndrome, COPD, ARDS, Emphysema, Chronic and acute renal failure, Glomerulonephritis; Cancer: Molecular basis for neoplastic growth, metastasis, and cancer pathology; Cancer immunity; Molecular approaches to cancer treatment: Cervical cancer and preventive vaccine, Biomarkers for early detection of cancer- breast, prostrate, hepatic.

Unit 2: Metabolic and Lifestyle disorders (10 Hours)

Obesity and eating disorders like Anorexia nervosa and Bulimia. Diabetes mellitus, Metabolic syndrome and the relationship with hypertension, hypothyroidism and stress. Cardiovascular disorders and Atherosclerosis-defining the broad spectrum of ailments that fall in this category, understanding the factors that contribute to the syndrome, stages of disorder and the management of the condition. Irritable bowel syndrome- biochemistry behind the disorder and the influence of diet, stress and environment on the condition.

Unit 3: Diseases due to misfolded proteins (5 Hours)

Introduction to protein folding and proteasome removal of misfolded proteins; Etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, Sickle cell Anemia, Thalassemia.

Unit 4: Monogenic diseases (5 Hours)

Inborn errors in metabolism: PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, and clotting disorders (Hemophilia and Deep vein Thrombosis).

2.3 Practicals

Credits: 2 **Total Hours: 60**

1. Assessment of Obesity and metabolic syndrome
2. Estimation of glycosylated haemoglobin
3. Permanent slides for different types of cancer
4. Diagnosis of Thalassemia / Sickle cell Anemia
5. D dimer test / CRP tests
6. Serum LDH isozymes as a diagnostic tool

7. TropT as a cardiac marker
8. Biomarkers used in cancer diagnosis (virtual)
9. Case Studies on NCDs
10. Role of vaccination in adults to prevent NCDs with age: Group discussion.

2.4 Essential readings:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Introduction to Human Physiology (2012) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541
3. The World of the cell, 7th edition (2009). Lewis J. Kleinsmith, Jeff Hardin, Gr Wayne M. Becker. ISBN-13: 978-0805393934 ISBN-10: 0805393935.
4. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6

Suggested readings:

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

3. Key words:

Non-communicable disease, Lifestyle disorders, cancer, Monogenic disease, Multifactoral disease, Misfolded proteins.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-8)
RESEARCH METHODOLOGY

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		
Research Methodology (BCH-DSE-8)	04	02	00	02	Class XII with Science and Biology	NIL

Learning Objectives

The main objective of this paper is to provide students with a general introduction to the methodological foundations and tools used in research for an understanding of the ways to identify problems, develop hypotheses and research questions and design research projects. The course will expose students to the range of designs used in research in laboratory, field experiments, surveys and content analysis. It will also provide an introduction to the concept of controls, statistical tools and computer applications used in research. In addition, the course will impart knowledge of scientific writing, oral presentation and the various associated ethical issues.

Learning outcomes

On successful completion of the course students will be able to:

1. Describe the importance of research in knowledge generation.
2. Explain the research process
3. Evaluate the importance of the major quantitative and qualitative research methods
4. Construct an effective research proposal
5. Examine the importance of research ethics
6. Record and analyse data using computer software
7. Prepare a Scientific presentation and article.

SYLLABUS OF DSE-8

BCH-DSE-8 : RESEARCH METHODOLOGY
Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours: 30

Unit I: Introduction to Research (4 Hours)

Objectives and characteristics of research; significance of research, types of research methods-qualitative and quantitative; basic and applied; descriptive and analytical; various phases of research-problem identification, generation of hypothesis, experimental design, results and discussion. Writing a research proposal-schematic presentation.

Unit II: Basic principles of research design (8 Hours)

Review of literature using appropriate sources – reviews, patents, research papers, books and e-resources; Significance of controls in research, Types of research designs – exploratory, descriptive, experimental, survey and case study.

Unit III: Statistical tools and Report writing (12 Hours)

Data collection, analysis and graphical presentation; Sample – types and characteristics; Basic Statistical Tools - Measures of central tendency, Arithmetic mean, Median, Mode, Standard deviation, Co-efficient of variation (Discrete serious and continuous serious), Correlation, Regression, Multiple Regression, hypothesis testing, P-value, data analysis and interpretation; Report writing, format of publications and presentations-oral and poster.

Unit IV: Scientific conduct and ethics in Research (6 Hours)

Biosafety and Ethics - compliance and concerns; Plagiarism-Software tools and Creative Commons; Introduction to Intellectual Property Rights; Citation and acknowledgement, Impact factor, h-index, Indian and international funding agencies.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. Citation formats and citation generator
2. Plagiarism tools
3. Design of a research survey on a specific problem
4. Writing a concept note / research proposal
5. Writing of a mini-review paper
6. Systematic review, meta data analysis and presentation
7. Poster/oral presentations

2.4 Essential readings:

1. Cresswell, J. (2009) *Research Design: Qualitative and quantitative Approaches* Thousand Oaks CA, (3rd ed.), Sage Publications
2. Kothari, C.R. (2004) *Research Methodology: Methods and Techniques* (2nd ed.), New Age International Publishers.
3. Kumar, R. (2011) *Research Methodology: A Step-by-Step Guide for Beginners* (5th ed.), SAGE publisher
4. Walliman, N. (2017*) Research Methods: The Basics,* **(**2nd ed.), London; New York: Routledge
5. *WHO (2001) Health Research Methodology – A Guide for Training in Research Methods.*

3. Keywords

Research methodology; Patents; Plagiarism; Ethics; Biosafety; Report writing

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

POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE COURSE - (GE-7)
CELLULAR COMMUNICATIONS

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		
Cellular Communications (BCH-GE-7)	04	02	00	02	Class XII with Science and Biology	Basic course in Cell Biology

Learning Objectives

- Explain the concept of Cell-cell communication.
- Describe the various types of receptors, signal transduction pathways, second messengers and effector molecules.
- To understand how signalling pathways, regulate cell motility, metabolism, growth, organogenesis, and cell death.
- Discuss the crosstalk between signal transduction pathways crosstalk and are auto-regulated.
- To know about various diseases associated with cellular communication pathway defects.

Learning outcomes

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

1. Describe various types of cell - cell communication.
2. Discuss the various types of receptors and signal transduction pathways in bacteria, plants and animal system.
3. Explain the importance of various signalling pathways in the regulation of metabolism, growth, organogenesis and cell death.
4. Discuss the cellular communication defects that lead to various types of diseases including cancers.

SYLLABUS OF GE-7

BCH-GE-7 : CELLULAR COMMUNICATIONS
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours : 30

Unit: 1 Introduction to cell- cell communication. (2 Hours)

Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Cognate signalling.

Unit: 2 Receptors and Signal transduction pathways (16 Hours)

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G-Protein-coupled Receptors: Heterotrimeric G proteins, Second messengers: cAMP, cGMP, Lipid-derived Second Messengers (IP3, DAG) NO, Calcium Signalling. Effector systems - adenylyl cyclase, guanylyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG).

Enzyme linked receptors: Receptor Tyrosine Kinases: EGF, insulin and erythropoietin. Ras - MAP kinase cascade, and JAK - STAT pathway.
Ion-channel linked receptors; Neurotransmitter receptors (Acetylcholine receptor). Nerve transmission.

Intracellular receptors: Cytoplasmic and nuclear receptors. Steroid hormone, thyroid hormone receptors. Gene regulation.

Integrin receptors. Integrin signalling. Cell matrix communication Receptor Regulation. Cross talk.

Unit 3: Photoreceptors and signal transduction in plants (4 Hours)

Phytochromes, cryptochromes and phototropins signalling.

Unit 4: Cell death signalling (4 Hours)

Apoptosis, Autophagy

Unit 5: Bacterial signalling (4 Hours)

Quorum sensing, autoinducers, chemotaxis.

2.3 Practical

Credit: 2 **Total Hours : 60**

6. Yeast response to mating pherohormones .
7. Study of Chemotaxis response in Tetrahymena/ paramecium/ dictostylium
8. Study change in heart rate (sympathetic response) on exposure to caffeine (cAMP mediated) in zebrafish larvae.
9. Chemotaxis/ motility assay in microbes.
10. Effect of plant hormones on plant growth or photomorphogenesis in response to light. (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds)

Essential readings:

1. Lodish, U. H. (2016) Molecular Cell Biology. W.H. Freeman, 2016.
2. Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). W.H. Freeman. ISBN:9781319230906
3. Lim, W., Mayer, B., & Pawson, T. (2015). Cell signaling: principles and mechanisms. New York: Garland Science, Taylor & Francis Group.
4. Kocher, S. L., and Gujral, S. K. (2020). Plant Physiology Theory and Application. Cambridge University Press DOI: https://doi.org/10.1017/9781108486392.018
5. Demuth, D., & Lamont, R. (Eds.). (2006). Bacterial Cell-to-Cell Communication: Role in Virulence and Pathogenesis (Advances in Molecular and Cellular Microbiology). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511541506

Suggested readings:

1. ZFIN protocols
2. Harris UM. A., McGee, S. A., and Batzi J. M. (2018). Uncooking Yeast: Cells Signalling a Rise to Inquiry. Tested Studies for Laboratory Teaching. Proceedings of the Association for Biology Laboratory Education. 38 (9) 1-48
4. Plant physiology and biotechnology laboratory manual. Compiled by: David Law, Lada Malek and JoAnne Henderson. 2006. https://old.amu.ac.in/emp/studym/99997510.pdf

3. Keywords

Chemical signaling, Receptors, signal transduction, GPCRs, RTKs, Photoreceptors, cell death signaling, bacterial signalling

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

GENERIC ELECTIVES COURSE - (GE-8)
BIOCHEMICAL CORRELATION OF DISEASES

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		
BIOCHEMICAL CORRELATION OF DISEASES (BCH-GE-8)	04	02	00	02	Class XII with Science and Biology	XIIth pass with biology

Learning Objectives

The course aims to provide students with knowledge and understanding of the spectrum of human diseases. It will introduce the concept of a well-balanced diet, healthy lifestyle, the biochemical mechanism 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 could be employed for prevention of infectious and non-infectious diseases.

Learning outcomes

On successful completion of the course students will be able to:

1. Discuss the importance of a balanced diet, regular exercises and healthy lifestyle in leading a disease-free life.
2. Explain the functioning of the immune system and endocrine system and the basis of various autoimmune and hormonal disorders.
3. Correlate the genetic mutation and metabolic disorders.
4. Discuss the molecular mechanism of microbial pathogenicity, drug resistance and implications in public health management.

SYLLABUS OF GE-8

BCH-GE-8 : BIOCHEMICAL CORRELATION OF DISEASES
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

Unit I: Inherited Metabolic diseases and Hormonal disorders (9 Hours)

Introduction to inherited Metabolic diseases. Alkaptonuria, Phenylketonuria; Glycogen storage diseases (Von Gierke disease, Cori disease); Lipid storage diseases: Gaucher's disease; SCID. Overview of the endocrine disorders: Cushing's disease, Diabetes insipidus.

Unit II: Nutritional deficiency and lifestyle-based diseases (7 Hours)

Concept of nutrition and balanced diet; Protein-energy malnutrition: Kwashiorkor and Marasmus; Vitamin deficiency diseases: Beri-Beri, Scurvy, Pellagra, Nutritional deficiency Anemia, Night blindness, Rickets. Lifestyle-based diseases: Atherosclerosis, Diabetes Mellitus-II.

Unit III: Autoimmune diseases (6 Hours)

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 IV: Infectious diseases (8 Hours)

Classification of infectious diseases; Role of sanitation, drugs and vaccines in prevention, transmission and treatment of infectious diseases. Diseases caused by viruses: Polio, Influenza, HIV and COVID. Diseases caused by bacteria: Tetanus, Tuberculosis. Protozoan infections: Malaria; Parasitic infections: Kala Azar.

2.3 Practical:

Credits: 2 **Total Hours : 60**

8. Anthropometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA).
9. Measurement of Blood pressure
10. Determination of blood Lipid Profile: Triglyceride, Cholesterol
11. Glucose tolerance test
12. Widal test
13. Permanent slides of malarial parasites/Leishmania
14. Case studies related to autoimmune diseases, life-style disorders and hormonal imbalance

2.4 Essential readings:

5. Berg, J.M., Tymoczko, J.L., Gatto, G.J., Stryer, L. (2019). Biochemistry (9th ed.). W.H Freeman and Company (New York). ISBN-13:9781319114671
6. Coico, R. (2021). Immunology: A Short Course (8th ed.). John Wiley & Sons, Inc (New Jersey). ISBN: 9781119551577.
7. Devlin, T. M., (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
8. Willey, J., Sandman, K., Wood, D. (2019). Prescott's Microbiology (11th ed.). McGraw Hill International Edition (New York) ISBN: 9781260211887.

Suggested readings:

4. Sherwood, L. (2012). Introduction to Human Physiology (8th ed.). Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541.
5. Hadley, M.E., Levine, J.E. (2007). Endocrinology (6th ed.). New Delhi, Pearson Education, Inc. ISBN: 978-81-317-2610-5.
6. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

3. Keywords

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

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

GENERIC ELECTIVES COURSE - (GE-11)
TOOLS OF GENETIC ENGINEERING

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		
Tools for Genetic Engineering (BCH-GE-11)	04	02	00	02	Class XII with Science and Biology	Basic course in Molecular Biology

Learning Objectives

The objective of the course is to teach:

- Basics of theoretical and practical aspects of recombinant DNA technology.
- Various techniques for DNA manipulation in prokaryotes and eukaryotes.

Learning outcomes

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

1. Grow bacterial culture and obtain single isolated colonies
2. Estimate the concentration of DNA by UV spectroscopy
3. Extract plasmid DNA from recombinant *E. coli*
4. Perform restriction digestion and evaluate the end products by agarose gel electrophoresis
5. Perform Polymerase chain reaction and amplify a DNA fragment
6. Explain the various methods for expression of recombinant genes in *E.coli*
7. Perform gene cloning

SYLLABUS OF GE-11

BCH-GE-11 : TOOLS FOR GENETIC ENGINEERING
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

UNIT I: Introduction to recombinant DNA technology **(5 Hours)**

Overview of gene cloning. Restriction and Modification systems, Restriction endonucleases, DNA modifying enzymes (DNA polymerase I, Taq polymerase, DNAse I, DNA Ligase).

UNIT II: Cloning vectors for prokaryotes and eukaryotes **(6 Hours)**

Salient features of vectors (pBR322, pUC8, Lambda bacteriophage, Ti plasmid) used in cloning.

UNIT III: **Introduction of DNA into cells and selection of recombinants (9 Hours)**

Ligation of DNA molecules: linker, adapters, homopolymer tailing. Introduction of DNA into bacterial cells, selection of transformed cells, insertional inactivation. Identification of recombinant phages. cDNA and Genomic DNA libraries. Clone identification by colony and plaque hybridization.

UNIT IV: Basics of Polymerase Chain Reaction and DNA sequencing (5 Hours)

Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by chain-termination method, pyrosequencing.

UNIT V: Expression of cloned genes (5 Hours)

Vectors for expression of foreign genes in *E. coli,* expression cassettes. Hybrid promoters trc, tac, λpL and T7 promoter-based expression–vectors. Challenges in producing recombinant protein in *E. coli.* Fusion tags (poly-histidine, GST) and their role in purification of recombinant proteins.

2.3 Practicals

Credits : 2 **Total Hours: 60**

1. Growing a culture of *E.coli* and obtaining isolated colonies by streak-plate method.
2. DNA estimation by UV spectrophotometry.
3. Isolation of plasmid DNA from *E. coli.*
4. Restriction digestion of plasmid DNA and agarose gel electrophoresis.
5. Amplification of a DNA fragment by PCR (demonstration)

2.4 Essential Readings

1. Gene Cloning and DNA Analysis (2016) 7th ed., Brown, T.A., Wiley Blackwell Publishing (Oxford, UK), ISBN: 978-1-119-07256-0.
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

3. Key Words

Genetic Engineering, Recombinant Proteins, PCR, DNA Sequencing

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