**UNIVERSITY OF DELHI**

**DEPARTMENT: Biomedical Science**

**COURSE NAME: B.Sc. (Hons)**

**(SEMESTER – 1)**

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

University of Delhi

**List of DSC Papers**

| Course Title | Nature of the Course | Total Credits | Components | | | Contents of the course |
|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | |
| Bioorganic Chemistry | DSC–01 | 4 | 3 | 0 | 1 | **Annexure-I** |
| Cell Biology | DSC- 02 | 4 | 3 | 0 | 1 | **Annexure-II** |
| Human Physiology and Anatomy I | DSC-03 | 4 | 3 | 0 | 1 | **Annexure-III** |

**List of GE Papers (Semester I/II)**

| Course Title | Nature of the Course | Total Credits | Components | | | Eligibility Criteria | Contents of the course |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| Concepts in Biotechnology | GE-01 | 4 | 3 | 0 | 1 | **student should have studied science (Biological science/ physical sciences)** | **Annexure-IV** |
| Landmark Discoveries in Science | GE-02 | 4 | 3 | 0 | 1 | **student should have studied science (Biological science/ physical sciences)** | **Annexure-V** |
| Toxic Substances and Human Health | GE-03 | 4 | 3 | 0 | 1 | **Open to Students from all subjects** | **Annexure-VI** |

# Semester I
# Bioorganic Chemistry
# Unique Paper Code:
# Discipline Specific Core (DSC)
# Credit: 4 (3T+1P)

**Theory** **Total Lectures: 45**

**LEARNING OBJECTIVES:**

Bioorganic Chemistry is a discipline that integrates organic chemistry and biochemistry. It aims at understanding the relevance of biological processes using the fundamental concepts of organic chemistry. This course includes basic principles of organic chemistry like concepts of stereochemistry and their importance in understanding various bio-molecular reactions along with introduction to biomolecules.

COURSE OUTCOMES:

- Identify, assess and analyze different types of stereoisomers and their properties in organic compounds and biomolecules.
- Explain the structures and function of biomolecules (carbohydrates, amino acids, lipids and nucleotide.
- To understand the mechanism of biologically significant name reaction and their role in biological systems.

**COURSE CONTENT:**

| **Unit I:Stereochemistry** | **(11 hrs)** |
|---|---|
| Optical isomerism: Optical activity, specific rotation, enantiomerism, D and L designation, racemic modification, R and S sequence rules, diastereoisomers.<br>Conformational isomers: conformation of ethane and butane, interconversion of projection formula, cyclohexane (mono- and di-substituted), resolution, optical purity.<br>Geometrical isomerism: Definition, nomenclature– E and Z. | |
| **Unit II: Introduction to Biomolecules I** | **(11)** |
| **Carbohydrates:**<br>Monosaccharides- cyclization of aldoses andketoses, conformations, concept of mutarotation, anomers, epimers.<br>Disaccharides- structure, reducing and non-reducing sugars. Polysaccharides- Starch, glycogen and cellulose.<br>**Lipids:**<br>Fatty acids, triacylglycerols, phospholipids, lipid bilayer formation, steroids (cholesterol) | |
| **Unit III: Introduction to Biomolecules II** | **(11)** |
| **Amino Acids:**<br>Structure and classification of amino acids, ionization, chemistry of peptide bond, non-ribosomal peptide bond formation, essential and non-essential amino acids, amino acids as precursors of other bioactive compounds, zwitterion, isoelectric point, optical properties of amino acids, Definition of a peptide, peptide unit, peptide group, bond length, cis and transconformation, primary, secondary (alpha helix, beta sheet, beta turn, collagen helix), tertiary and quaternary structures (with examples).<br>**Nucleotides:**<br>Sugars and Bases, conformation of sugar phosphate backbone, hydrogen bonding and tautomerism in nucleic acid bases<br>Effect of structure on reactivity of biomolecules. | |
| **Unit IV: Biologically Significant Name Reactions** | **(12)** |
| Aldol (Glucogenesis), retro-aldol (Glycolysis), benzoin condensation (umpolung-decarboxylation of pyruvate in the presence of TPP), Claisen condensation (synthesis of fatty acids), Michael addition (Dehydrases), Cannizzaro (Sugarmetabolism), Bayer Villiger reaction (FAD dependent ketone synthesis), Pinacol-pinacolone rearrangement (1,2-carboncarbonshift) | |

**PRACTICAL (12 Sessions x 2 hrs)**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution: Mohlisch, Barfoed, Fehling/ Tollen/ Benedict tests
2. Qualitative tests for carbohydrates toidentify the given unknown carbohydrate solution: Iodine test, Selvinoff, Osazone, Bial's tests
3. Qualitative tests for Amino acids and Proteins: Ninhydrin, Xanthoproteic, Million's, Lead Acetate, Biuret test
4. Qualitative test for Fats
5. Todetermine the Iodine number of the given oil/fat.
6. Tofind pKa value of acetic acid
7. To study the titration curve of glycine
8. Absorption spectrum of Protein
9. Absorption spectrum of DNA
10. Estimation of a Reducing sugar in a given sample.

**SUGGESTED READINGS:**


- Nelson, D. L. and Michael M. Cox (2021) 8th Edition. Lehninger Principles of Biochemistry. New Jersey, USA: Prentice Hall Publishers.ISBN-13:978-1319228002.
- Nasipuri, D. (2020), Stereochemistry of Organic Compounds: Principles and Applications, 4 th Edition, New Age International. ISBN 10: 9389802474
- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2017), Organic Chemistry, 12th Edition, Wiley. ISBN: 978-1-119-24897-2
- Plummer, D. (2017) An Introduction to Practical Biochemistry, 3rd edition. McGraw-Hill College; ISBN-13: 978-0070841659.
- Hoffman, A. 8th Edition (2018). Wilson And Walker's Principles and Techniques of Biochemistry and Molecular Biology. Cambridge: Cambridge University Press. ISBN-13: 9781316677056


**BOOK FOR BASIC CONCEPTUAL READING**


- Berg, J. M., Tymoczko J. L. and Stryer L. (2019) 9th Edition, International edition Biochemistry. New York, USA: W. H. Freeman and Co. ISBN-9781319114671
- Campbell, M. K. and Farrel, S. O. (2012) 7th Edition. Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN: 13:978-1-111-42564-7
- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4
- Morrison, R.N., Boyd, R.N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). ISBN 10:8131704815 ISBN 13:9788131704813
- Eliel, L. (1975). 1st Edition. Stereochemistry of carbon compounds, New York, USA: Tata McGraw Hill. ISBN-13: 9780070992900
- Finar, I.L. (2002), Organic Chemistry (Volume 1), 6th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). ISBN-13: 978-0582305601
- Dugas, H. (1999) 3rd Edition. Bioorganic chemistry. New York, USA: Springer Verlag. ISBN-13: 978- 0387989105.

# Semester I
# Cell Biology
# Unique Paper Code:
# Discipline Specific Core (DSC)
# Credit: 4 (3T+1P)

**Theory** **Total**
**Lectures: 45**

**LEARNING OBJECTIVES:**

The objective is to offer detailed knowledge about the cells, its various components, processes and interactions with other cells:

- Structure and functions of various cellular compartments and organelles
- Fundamentals of transport of biomolecules inside the cell and its cytoskeleton
- Cell growth, cell-division and cell-cycle control mechanisms.
- Cell to cell communication and participation of signal transduction pathways, in driving cell response mechanics

**COURSE OUTCOMES:**

- Students will learn about how the cell has evolved and the basic types of cells present. Students will acquire insights into the composition and structure of cell membrane by navigating through various proposed cell models. Students will also learn the functions in detail about the processes of transport across cell membranes.
- Students will learn about the structure and function of various cellular compartments and organelles along with the concept of protein sorting and distribution in unique ways. Students will understand the association between cells through unique types of communication and developing junctions for attachment between neighbouring cells.
- Students will understand various cytoskeleton elements and their participation in maintaining cell shape and integrity. Students will gain knowledge about an overview of cell response to its environment, and involvement of cell- cell signalling mechanisms and to study signal transduction pathways.

**Detailed course content:**

| | |
|---|---|
| **Unit I:The Cell** | **(03)** |
| Historical background, significant landmarks, cell theory, structure of prokaryotic and eukaryotic cells | |
| **Unit II: Cell Membrane and Membrane Transport** | **(10)** |
| Functions, different models of membrane structure, types of membrane lipids, membrane proteins: types, methods to study membrane proteins (detergents, RBC ghosts), RBC membrane as a model, membrane carbohydrates, membrane asymmetry and fluidity, lipid rafts.<br>. Transport of small molecules: Passive transport (simple diffusion and facilitated diffusion) and active transport and their types (P, V, F and ABC transporter) with example of Na+/K+ pump.<br>. Transport of macromolecules: Endocytosis (pinocytosis, phagocytosis), exocytosis | |
| **Unit III: Cell Organelles** | **(15)** |
| tructure and functions of various organelles:<br>Nucleus: Different components, nuclear envelope- its structure, pore complex, nucleocytoplasmic, interaction (NLS and NES), nucleolus- structure and functions.<br>Endoplasmic reticulum: RER- Biosynthesis and processing of proteins, co-translational and post-translational transport of proteins, signal hypothesis, protein sorting. SER- detoxification, biosynthesis of membrane, carbohydrate metabolism, steroid synthesis.<br>Golgi apparatus: Golgi stack (cis, trans and medial cisternae), flow of proteins through Golgi body, glycosylation and protein sorting.<br>Lysosomes: Development of different forms of lysosomes, role in cellular digestion, lysosom storage diseases- Hurler syndrome, Hunter syndrome, Tay-Sachs disease and Inclusion cell disea (I-cell disease). | |
| Peroxisomes: Assembly, functions- H2O2 metabolism, oxidation of Fatty acids, glyoxysomes<br>Mitochondria: Detailed structure, endosymbiotic theory, its genome and functions in brief<br>Chloroplast: Detailed structure, its genome and functions in brief | |
| **Unit IV: Cell -Cell communication** | **(05)** |
| Structures and functions of different types of anchoring junctions (desmosomes and hemidesmosomes), tight junctions, communication junctions (gap junction and plasmodesmata). | |

| | |
|---|---|
| **Unit V: Cytoskeletal Elements** | **(06)** |
| Structure, assembly and functions of:<br>Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies).<br>Microfilaments: Globular and filamentous actin, general idea about myosin.<br>Intermediate filaments: Different classes. | |
| **Unit VI: Cell Signaling and Cell Cycle** | **(06)** |
| Signaling molecules and their receptors (extracellular and intracellular), functions of extracellular receptors; Intracellular signal transduction pathways (cAMP, cGMP, steroid hormone response element). Different phases of cell cycle and their significance, mitosis and meiosis, checkpoints and regulation of cell cycle. | |

**PRACTICAL (12 Sessions x 2 hrs)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Light microscopy: Principle, construction and types. Study of positive and negative staining using photomicrographs.
2. Fluorescence microscopy: principle and applications. Concept of GFP
3. Electron microscopy: Principle, construction and types. Study of positive and negative staining, freeze fracture, freeze etching, shadow casting, endocytosis, exocytosis and phagocytosis using electron micrographs
4. To explain mitosis and meiosis using permanent slides.
5. To measure cell size using a stage micrometer.
6. To cytochemically demonstrate presence of total and basic proteins in cheek cells or onion peel using mercuric bromophenol blue or fast green.
7. To cytochemically demonstrate presence of carbohydrates in cheek cells or onion peel using periodic acid Schiff's reagent.
8. To cytochemically demonstrate presence of DNA in cheek cells or onion peel using Feulgen reagent.
9. To study the effect of isotonic, hypotonic and hypertonic solutions on cell.

**SUGGESTED READINGS:**


- Cooper, G. M. (2018). 8th Edition. *The cell: A molecular approach*. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605357072
- Hardin, J. Bertoni, G. P. Kleinsmith, L.J. and Becker, W.M. (2016). 9th Edition. *The world of the cell.* San Francisco, USA: Benjamin Cummings Publishers, ISBN-13: 978 - 0321934925.
- Karp, G. (2019). 9th Edition. *Cell and molecular biology:* New Jersey, USA: Wiley Publishers. ISBN-978—1-119-59816-9.


**BOOK FOR BASIC CONCEPTUAL READING**


- Cooper, G. M. and Hausman, R. E. (2013). 6th Edition. *The cell: A molecular approach*. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605351551
- Hardin, J. Bertoni, G. P. Kleinsmith, L.J. and Becker, W.M. (2008). 7th Edition. *The world of the cell.* San Francisco, USA: Benjamin Cummings Publishers, ISBN-13: 978 0805393934.
- Karp, G. (2013). 7th Edition. *Cell and molecular biology: Concepts and experiments.* New Jersey, USA: Wiley Publishers. ISBN-978-0470483374.
- Alberts, B et al. (2014). 6th edition. *Molecular Biology of the Cell*. W. W. Norton & Company. ISBN-13 : 978-0815345244
- Lodish H et al. (2003). 5th Revised edition. *Molecular Cell Biology*. W.H.Freeman& Co Ltd; ISBN-13 : 978-0716743668

# Semester I
# Human Physiology and Anatomy-I
# Unique Paper Code:
# Discipline Specific Core (DSC)
# Credit: 4 (3T+1P)

**Theory** **Total**

**Lectures: 45**

**LEARNING OBJECTIVES:**

- The course curriculum is a systematic presentation of physiological concepts to ensure appropriate depth and breadth of basic functioning of the human body and its interrelations with respect to heart, lung, kidney, gonads, endocrine glands and digestive system.
- It would give students exposure of physiological concepts needed as foundations for further studies in pharmacology, pathology and pathophysiology etc.
- It would provide a base to understand body defenses and the mechanisms of deranged function of human body
- The curricular objectives are focused primarily on normal body function. Accordingly, wherever possible clinical examples have been illustrated to the underlying physiological principles.

**COURSE OUTCOMES:**

Having successfully completed this course, students shall be able to learn and appreciate:

- The usefulness of dividing the human body in different anatomical planes and sections, cavities, along with the role of feedback system in maintaining homeostasis. Functional anatomy of the epithelial and connective tissues while focusing on integumentary and skeletal system. Overview of structure, types and function of cartilage, bone and joints.
- Structure, function and regulation of components/different formed elements of blood and the mechanism of clotting. Students would be able to understand different blood groups, basis of their classification, their importance in blood transfusions and tissue grafting and basic concepts of blood and bleeding disorders
- Student would be able to understand neurons their role and significance and how as apart of the brain they help in brain physiology. Appreciation of basic concepts of action potential/ graded potential in the conduction of nerve impulse. Action and significance of different neurotransmitters at the synapse along with the mechanism of

synaptic transmission using different ligand gated ion channels, G protein coupled receptors and their ligands as example.

- Students would learn organization of brain, with identification of structures and functionof different brain regions. Identify different neural pathways and explain their significance. They would understand the innate responses and conditioned response of day today life by studying autonomic nervous system and effect of its stimulation on different organs.

- The five senses which help an individual to perceive the world would be studied in detail. Stimulus modality, sensory adaptation and the role of generator potential in the sensory physiology of touch, gustation, olfaction, hearing and vision. They would recognize and explain the common disorders related to the senses.

- Students would be able to describe and distinguish between the structure, mechanism and regulation of contraction of skeletal, cardiac and smooth muscles. Enlist the energy requirements, characteristic features of different muscle fibers and their role in generating muscle tension. Demonstrate the concept of muscle fatigue, adaptation to physical training, and muscle degeneration and associated disorders.

**COURSE CONTENT:**

| | |
|---|---|
| **Unit I: Body organization and Integumentary system** | **(04hrs)** |
| General Anatomy of the body, Introduction to various kinds of body planes, cavities and their membranes, Tissues level of organization (Types, origin, function & repair). Structure and functions of human skin. | |
| **Unit II: Blood** | **(08)** |
| Composition and Function of Blood and its components (RBC, WBC, platelets and plasma). Hematopoiesis, Hemoglobin structure, function and abnormal hemoglobin. Basic concepts about Anemia and types. Blood Hemostasis (blood coagulation/ clotting, platelet function and role of endothelium ). | |
| **Unit III: Nerve physiology** | **(06)** |
| Structure, function and types of neuron, conduction of nerve impulse, Resting membrane potential, Action and graded potential. Synapse its types, Synaptic Transmission, Neurotransmitters and their receptors; types and function | |
| **Unit IV: Nervous System I: Organization of nervous system** | **(08)** |
| Structure, function and organization of Central nervous system, Peripheral nervous system and Autonomic nervous system. Motor physiology: Reflexes, types and reflex arch | |
| **Unit V: Nervous System II: Sensory Physiology** | **(10)** |
| Concept of receptors in the body and their types, structure, functional anatomy, regulation and common disorders of the following sensations: Vision, Hearing, Taste, Smell and other senses (Touch,Pain, Temp). | |
| **Unit VI: Muscular system** | **(04)** |
| Functional anatomy of muscular system, types of muscles, neuromuscular junction structure property and transmission, General characteristics, molecular mechanism and properties of skeletal muscle excitation and contraction, energetics and characteristics of whole muscle contraction. | |
| **Unit VII: Skeletal System** | **(05)** |
| Cartilage: structure, types and function. Bones: structure, function, location and types. Joints: structure, function and types | |

**PRACTICAL (12 Sessions x 2 hrs)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Estimation of haemoglobin (Sahli's method)
2. Determination of total erythrocyte count.
3. Determination of total leukocyte count.
4. Preparation of blood smears and identifying various WBC
5. To perform differential leukocyte count of blood.
6. To study a simple reflex arc
7. To study the sensation of taste, touch and smell.
8. To study different human organs and their sections through permanent histological slides T. S. of brain, spinal cord, skeletal fibres, cardiac muscles, skeletal muscles, cartilage joints and different tissues. (Minimum 8 slides covering the systems mentioned in theory.)

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**SUGGESTED READINGS:**


- Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6.(e book),ISBN: 978-1-119-70438-6 (for print book).
- Ganong'sReviewofMedicalphysiology,26thedition(2019),K.E.Barett,S.M.Barman,S. Boitano and H. Brooks; Tata McGraw Hill, ISBN 978-1-260-12240-4 (for print book) ISBN: 978-1-26-012241-1(for eBook)
- Textbook of Practical Physiology, 9th edition (2018), CL Ghai; Jaypee Publication, ISBN-13: 978-9352705320 ISBN-10: 9352705327


**BOOK FOR BASIC CONCEPTUAL READING**


- Guyton and Hall Textbook of Medical Physiology, 12th edition (2011), J. E. Hall; W B Saunders and Company, ISBN: 978-1-4160-4574-8 International Edition: 978-0-8089-2400-5
- Human Physiology, 12thedition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN 978–0–07–337811–4MHID 0–07–337811–9.

# Semester I/II
# Concepts in Biotechnology
# Unique Paper Code:
# Generic Elective (GE)
# Credit: 4 (3T+1P)

**Theory** **Total**

**Lectures: 45hrs**

**Eligibility: The student should have studied science (Biological science/physical sciences)**

**LEARNING OBJECTIVES:**

The purpose of this course is to introduce students to importance of Biotechnology in allied fields. It will enable students from diverse backgrounds to understand basic concepts in Gene Cloning and DNA Analysis, and appreciate applications of Biotechnology in everyday life. The course will provide students with an insight into the various molecular biology techniques commonly used in Biotechnology, and some of the relevant bio-safety issues and ethical concerns.

**COURSE OUTCOMES:**

- Learn about basic biotechnology techniques and key concepts that are used in isolation and characterization of biomolecules (DNA and proteins).
- Develop basic understanding of the robust techniques with wide applications (such as PCR, DNA sequencing) and appreciate their contribution in development of biotechnology.
- Comprehend the importance of gene cloning in biotechnology and learn the intricacies of gene cloning using plasmids and bacteriophages as cloning vectors.
- Understand the importance of construction of genomic libraries and their specialized screening methods to identify gene of interest.
- Learn the concept and application of DNA fingerprinting, recombinant protein expression, biopharmaceutical protein production, and gene therapy.

- Gain an insight of safe handling of GMO’s, their environmental release and ethical practices.

**COURSE CONTENT:**

| **Unit I: Techniques Used in Biotechnology** | **(13 hrs)** |
|---|---|
| Brief history of biotechnology and its importance. Isolation and purification of plasmid DNA. Agarose and Polyacrylamide gel electrophoresis (Native and SDS). Southern and Western hybridization. Polymerase Chain Reaction (PCR): Principle, DNA polymerases in PCR, Primer Designing, Types of PCR - Hot Start, Multiplex and Reverse Transcription and their Applications. Sequencing: Enzymatic (Sanger's dideoxy) method, Introduction to Automated Sequencing. | |
| **Unit II: Process of Gene Cloning, Expression and Protein Purification** | **(13)** |
| Restriction endonucleases: Restriction and Modification Systems, Nomenclature and Types of Restriction Enzymes (Type I-IV), Recognition of Restriction Sites. Joining of DNA Molecules: Sticky End and Blunt End Ligations, Role of DNA Ligase, Adaptors, Linkers, Homopolymer Tailing. Vectors: Plasmids (pUC Vectors), Bacteriophage (Lambda Phage Derived Replacement And Insertion Vectors), Cosmids, *In Vitro* Packaging, Expression Vectors (One example each of prokaryotic and eukaryotic expression vectors). Bacterial Transformation, Antibiotic Selection and Blue/White Screening of Transformants. Challenges in Expression of Eukaryotic Proteins in Prokaryotic Hosts. | |
| **Unit III: Genomic and cDNA Libraries** | **(06)** |
| Construction of Genomic and cDNA Libraries, their Screening by Nucleic Acid Hybridization (Colony and Plaque Hybridization). | |
| **Unit IV: Applications of Biotechnology** | **(07)** |
| DNA Fingerprinting. Using the Example of Human Insulin learn the Importance of Various Applications of Biotechnology: Recombinant Protein Expression, Biopharmaceutical Protein Production and Gene Therapy. | |
| **Unit V: Biosafety and Ethical Issues** | **(06)** |

| | |
|---|---|
| Safe Handling and Disposal of GMOs and Relevant Ethical Issues. Impact of GMOs on the Environment (Bt. Toxin). | |

**PRACTICALS (12 Sessions x 2 = 24 hrs)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To prepare laboratory reagents.
2. To perform plasmid DNA isolation.
3. To perform agarose gel electrophoresis of isolated plasmid DNA.
4. To perform restriction digestion of plasmid DNA.
5. To perform agarose gel electrophoresis of digested DNA.
6. To study restriction mapping.
7. To amplify DNA using PCR.
8. To perform agarose gel electrophoresis of amplified DNA.

**SUGGESTED READINGS:**


- Glick, B. R. and Patten, C. L. (2022). 6thEdition. *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. USA: ASM press, ISBN-13: 978-1683673668.
- Brown, T. A. (2020). 8thEdition. *Gene cloning and DNA analysis: An introduction*. New York, USA: John Wiley and Sons, ISBN-13: 978-1119640783.
- Karp, G. (2016). 8th Edition. *Cell and Molecular Biology: Concepts and Experiments*. United states: Wiley. ISBN-13: 9781538832462.
- Primrose, S. B. and Twyman, R. B. (2014). 7th Edition. *Principles of Gene Manipulation and Genomics*. New York, USA: John Wiley and Sons. ISBN-13: 978-1118653883.
- Green, M. R. and Sambrook, J. (2012). 4th Edition. *Molecular Cloning: A Laboratory Manual* (three-volume set). New York, USA: Cold Spring Harbor Laboratory Press ISBN-13: 978- 1936113422.


**BOOK FOR BASIC CONCEPTUAL READING**


- Cantor, C. R. and Smith, C. L. (2004). 1st Edition. *Genomics: The science and technology behind the human genome project*. New York, USA: John Wiley and Sons. ISBN-13: 978-0471461869.
- Old, R. W. and Primrose, S. B. (1994). 7th Edition. *Principles of Gene Manipulation: an Introduction to Genetic Engineering.* Boston: Wiley. ISBN-13: 978-0632037124.
- Joseph Sambrook, E.F. Fritsch, T. Maniatis. (1989). 2nd Edition. *Molecular Cloning: A Laboratory Manual. New York, USA: Cold Spring Harbor Laboratory*. Press ISBN- 978-0879693732.

# Semester I/II
# Landmark Discoveries in Science
# (Unique Paper Code:
# General Elective (GE)
# Credit: 4 (3 T + 1 P)

**Theory**

**Eligibility: The student should have studied science (Biological science/physical sciences)**

**LEARNING OBJECTIVES:**

The objective of the course is to ensure students appreciate the convenience and comfort that they have is all because of discoveries and inventions of the past. Meticulous execution of historical experiments in very little resources would also motivate them towards doing valuable research with enormous facilities that they have. The historical accounts of science provide grounds for interpretation and may be useful in arousing appreciation of science. The course would provide: Detailed analysis of classically designed and executed experiments in Life Sciences over the years. It will provide a foundation of biology by uncovering various players in the machinery of biological processes. I will also be helpful in technical, scientific analysis with historical background for a robust understanding of various discoveries. Critical analysis of the history of biology would surely help students comprehend futuristic scientific discoveries.

**COURSE OUTCOMES**

- Students will be able to learn how was light manipulated during the past to peer into previously invisible world—those too small or too far away to be seen by the naked eye.
- Students will learn about experiments that had fundamental contribution to our present understanding of key molecular elements of life. They will understand how to examine microbial cells and colonies, using various techniques to

manipulate color, size, and contrast in ways that helped Scientists to identify species and diagnose disease.

- Studying this unit, students would come to know that there were three group of Naturalists working simultaneously to find answers to inheritance, evolution and basic composition of life. Students will be divulged with hereditary aspects of life. They will get familiar with genes and their roles in living organisms.
- Having understood the relationship of genes and inheritance, students would find interesting to learn the mystical molecule that make up these genes. Sequential study of these experiments would step by step unravel the mystery of genetic material.
- Students at this point of course would be curious to know the structure of molecule that forms the genetic material. They would learn how the information present on DNA manifests itself as specific characteristic features and help in diversity among organisms.
- Students will be explained how the in depth knowledge about DNA became the most important tool for *in vitro* research, modification and applications thereof.
- Students will be briefed about some landmark discoveries which helped the field of medicine to grow tremendously and played a significant role in improving the overall health of the human population.
- Students can be given small projects to write discoveries done in conventional way.
- They will be required to provide a descriptive view of the topics assigned to them. Students should highlight the research topic with reference to current understanding.

**COURSE CONTENT:**

| | |
|---|---|
| **Unit I: View of the invisible Biology** | **(04 hrs)** |
| Rudimentary microscopes to magnify objects; Use of eye glasses as simplest microscopes - Flea or fly glasses; Observing nature in the new world under lens; Book of Optics; Scientific use of Microscopes; Importance of Malphigi microscope that used field lens; Compound Microscope; Robert Hooke's observations in Micrographia; Foldscope by Manu Prakash | |
| **Unit-II: Origin of Life – A question** | **(03)** |
| Spontaneous generation versus biogenesis; Problem of spores; Microbiology and Medicine - Germ theory of Disease; Recognition of agents of infection – Koch's Postulates. | |
| **Unit-III: Understanding Biology by observations** | **(04)** |
| A) Study of evolution of life: Darwins Theory (B) Study of Inheritance of Life: classical era with contributions of Aristotle, Epicurus, and others; Modern genetics: Gregor Johann Mendel, his work on pea plants, theory of Mendelian inheritance (C) Study of composition of Life : Levels of cellular and molecular organization; Cells, tissues and organs in our body; Pioneers of chromosome studies; Discovery of nucleic acids; Nuclein verified as a distinct chemical entity; Early identification of purines and pyrimidines; building blocks of Nucleic acids and proteins; Chemistry of Nucleic acids; Levene's tetranucleotide hypothesis. | |
| **Unit-IV: DNA as the hereditary material – An experimental view** | **(06)** |
| Transformation: Classic work of Frederick Griffith; DNA as the Pneumococcal Transforming Factor; *In vitro* Transformation system; Announcement that the transforming Principle was DNA; Mirsky's Criticism; The Avery, MacLeod and McCarty proclamation; Additional experiments that supported DNA as the transforming principle; Hershey and Chase clinched the role of DNA as the Genetic Material | |

| | |
|---|---|
| **Unit-V: Solving the puzzle of DNA structure** | **(07)** |
| Early studies of diffraction of X Rays by DNA fibers – contributions of Rosalind Franklin; Use of X – rays in medicines and research; Erwin Chargaff's discovery of base complementarity in DNA; Watson and Crick model of DNA; Contribution of Linus Pauling; DNA is replicated in Semi-conservative Fashion; Deciphering the Genetic Code; One Gene One Enzyme Edict. | |
| **Unit-VI: Technical advancements in biology** | **(07)** |
| Polymerase Chain Reaction – a revolution in modern biology; DNA Manipulations using Restriction enzymes; Discovery of reverse transcriptase leading to development of RT-PCR for RNA amplification; Work of Stanley Cohen and Herbert Boyer; Advent of gene cloning - History and current applications | |
| **Unit-VII: Research as a backbone of modern medicine** | **(07)** |
| (A) Discovery of antimicrobial agents; Contribution of Joseph Lister and later by Alexander Flemming leading to Discovery of Magic bullets; (B) Control of Infectious Diseases – Variolation, mithridatism and vaccination from the view of Edward Jenner; Vaccine production strategies – with examples of BCG and SARS-CoV2 vaccines; Historical timeline of vaccination strategies;(C) Marie Curie – Use of radiation in medicine. | |
| **Unit VIII: Project Work [On any one topic]** | **07** |
| Study historical research papers and provide a descriptive view of research that was carried out by Scientists as Minor Project.<br>(A) Ancient system of medicine<br>(B) Contribution of any one Indian Scientists in Biology<br>(C) Contribution of any Physicists or Chemists in Biology (for topics listed above) | |

**PRACTICAL (12 Sessions x 2 = 24 hrs)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Comparison of invisible life under the view of microscopes versus foldscope.
2. Cells as a unit of life and observation under the microscopes.
3. How do the cells divide – a view under the microscope: (mount of an onion root tip, onion bud cells or grasshopper testis).
4. Mendel's laws of inheritance – clues from nature.
5. Extraction of genomic DNA
6. Use of electric field to analyse DNA and other biomolecules.
7. Sneak Peek through the discovery of Polymerase chain reaction (PCR): Demonstration of original method and comparison with today's sophistication.
8. To test Flemming's hypothesis that the mold killed the bacteria.
9. Group Discussion on Research Topics assigned to students.

**SUGGESTED READINGS:**


- Watson, J. D. (2011) *The Double Helix – A personal account of the discovery of the structure of DNA*. Scribner. ISBN 9780743219174.
- Cooper, G. M. and Hausman, R. E. (2013). 6th Edition. *The cell: A molecular approach*. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605351551
- Karp, G. (2013). 7th Edition. *Cell and molecular biology: Concepts and experiments.* New Jersey, USA: Wiley Publishers. ISBN-978-0470483374.
- Cox, M. M. Doudna J. A. and Donnell, M. O. (2012). 1st Edition. *Molecular Biology: Principles and Practice.* London, United Kingdom: W H Freeman & Co Publishers, ISBN-13: 978-0-716-7998-8.
- Watson, J. D. Baker T. A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2013). 7th Edition. *Molecular Biology of the Gene.* New York, United States: Cold Spring Harbor Laboratory Press, ISBN-13: 978-0-321-76243-6.


**BOOK FOR BASIC CONCEPTUAL READING**


- Alberts, B et al. (2014). 6th edition. *Molecular Biology of the Cell*. W. W. Norton & Company. ISBN-13 : 978-0815345244
- Bryson, B. (2003) *A short history of nearly everything.* Transworld Publishers. London W5 5SA. A Random House Group Company. ISBN: 9780552997041.
- Lodish H et al. (2003). 5th Revised edition. *Molecular Cell Biology*. W.H.Freeman& Co Ltd; ISBN-13 : 978-0716743668
- Green, M. R. and Sambrook, J. (2012). 4th Edition. *Molecular Cloning: A Laboratory Manual*, New York, United States: Cold Spring Harbor Laboratory Press, ISBN-13:978-1936113422.
- Kornberg, A. (2005). 2nd Edition. *DNA Replication.* California, United States: University Science Books, ISBN-13: 978-1891389443.

# Semester I/II
# Toxic Substances and Human Health
# Unique Paper Code:
# Generic Elective (GE)
# Credit: 4(3T+1P)

**Theory**

**Eligibility: Open to Students from all subjects**

LEARNING OBJECTIVE:

In daily life, humans are exposed to several toxic substances. Many household products, medicines, cosmetic products, paints, and even food and water may contain toxic substances.; Frequent or improper use of many consumer products or exposure to higher amounts than prescribed, may cause serious health problems. This paper introduces the common toxic substances to which humans are routinely exposed; and health related issues in case of toxicity.

**COURSE OUTCOMES:**

- Introduction to the various toxic substances and how humans come in contact with toxic hazards. Definitions of various terminologies used in toxicology, and methods of assessment of toxicity of a substance are also covered.
- Upon contact with humans, toxic compounds may be absorbed in the body, and distributed to various organs to show toxic effects. Toxic compounds, once inside the body, are also metabolized or chemically altered. In most cases, after metabolism, the physicochemical properties of toxicants are altered, which helps in their speedy removal from the body.
- Many household products contain substances/ingredients which, if properly not used or applied on the body in excess, can cause serious health effects. These substances include cleaners, household pesticides, cosmetics, disposable utensils, paints, polish, etc. Students will be introduced to few such ingredients and their harmful effects.
- In addition to nutrients, our food also contains several substances which are unavoidable or added unintentionally. These substances and food adulterants, if taken for long time can cause adverse effects.
- Drugs are used to treat diseases. However, if taken at high dose (such as overdosing), drugs act as potential toxic substances. Moreover, several drugs have side effects even at prescribed dose or if used for prolonged duration.
- Anthropogenic activity and natural causes in some cases leads to contamination of soil, water and air with several potential toxicants. These toxicants enter human body via air that we breathe, drinking water and food. With examples of a few toxic substances, students will be introduced how toxicants enter the body from the environment and the adverse health effects caused by them.

**COURSE CONTENT:**

**Unit I: Introduction to toxic substances and assessment of toxicity (08hrs)**

Types of toxic substances, human contact/exposure with toxic substances (occupational, intentional, accidental etc.); various definitions (toxin, toxicants, xenobiotics, exposure, acute toxicity, chronic toxicity etc); Dose Response Relationship, efficacy, potency, LD50, TD50, NOAEL, ADI; selective toxicity.

**Unit II: Movement of toxic substances inside the body (05hrs)**

Brief introduction to absorption of toxicants via various routes, concept of bioavailability, first pass metabolism, distribution and excretion.

**Unit III: Household toxicants (10hrs)**

Route of exposure, mechanism of toxicity and health effects of common household toxicants:

i. Cleaners, disinfectants, air fresheners (sodium hypochlorite, ammonia, phenol, naphthalene, 1, 4-Dichlorobenzene, methanol).
ii. Garden products, and home mosquito repellents and rat kills (pesticides: organophosphates, pyrethroids, aluminium and zinc phosphide).
iii. Cosmetic products (metals: lead, cadmium; solvents: toluene, acetone).
iv. Other products: disposable utensils (styrene), antifreezing agents (ethylene glycol), Volatile Organic Compounds (VOCs).

**Unit IV: Toxicants and toxins in food**
**(06hrs)**

Mechanism of toxicity and health effects of:

i. Pesticide residues (DDT, lindane)
ii. Toxins (amatoxin, muscarine, bacterial toxins)

Brief discuss on food preservatives, colouring agents and flavouring agents etc, and food adulterants.

**Unit V: Drugs as toxicants (02hrs)**

Brief introduction of drugs as toxicants with examples; adverse effects of drugs at therapeutic doses, and overdosing.

**Unit VI: Environmental toxicants (05hrs)**

Route of exposure, mechanism of toxicity and health effects of:

i. Industrial chemicals (mercury, Polycyclic Aromatic Hydrocarbons, dioxins).
ii. Gaseous air pollutants (nitrogen oxides, sulfur dioxide, carbon monoxide).
iii. Particulate matter (PM).

**PRACTICAL (12 Sessions x 2 hrs):**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Calculation of LD50 value of an insecticide from the data provided.
2. To estimate formaldehyde content in the given sample.
3. To detect presence of paracetamol in the given sample.
4. Analysis of sodium hypochlorite content in various household products.
5. To detect primary alcohol in sample/ household products.
6. To detect aromatic amines in the sample/ household products.
7. To study various toxic substances in terms of exposure, health effects, from various online resources (such as https://www.atsdr.cdc.gov/ , TOXNET or other sources)
8. To separate a mixture of naphthol and naphthalene by solvent extraction method.

SUGGESTED READING:

- https://www.atsdr.cdc.gov/
- https://www.cdc.gov/

- Klaassen, C.D and Watkins, J.B. (2015). 3rd Edition. *Casarett and Doull's Essentials of Toxicology*. McGraw Hill Education. ISBN-13:978-0071847087.
- Klaassen, C.D and Watkins, J.B. (2021). 4th Edition. *Casarett and Doull's Essentials of Toxicology*. McGraw Hill, ISBN-13: 978-1260452297.


**BOOKS FOR BASIC CONCEPTUAL READING:**


- Klaassen, C.D. (2018). 9th Edition. *Casarett and Doull's Toxicology, The Basic Science of the Poisons.* McGraw Hill. ISBN-13: 978-1259863745.
- Stine, K.E. and Brown T.M (2015). 3rd Edition. *Principles of Toxicology.* Florida, USA: CRC Press. ISBN-13: 9781466503434.
- Timbrell. J. (2001). 3rd Edition. *Introduction to Toxicology.* CRC Press. ISBN-13: 978-0415247634.