

## DEPARTMENT OF ZOOLOGY

### BSC (Hons.) Zoology

#### *Category-I*

#### 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		
<b>Nonchordata – Protists to Pseudocoelomates</b>	<b>4</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>Class X II pass with Biology as one of the papers in Class XII</b>	<b>-</b>

#### **Learning Objectives**

The course would provide an insight to the learner about the existence of different life forms on the earth and appreciate the diversity of animal life. It will help the students to understand the features of non-chordates and their systematic organization based on evolutionary relationships, structural and functional affinities. The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals; the economic, ecological, and medical significance of various animals in human life; and will create interest among them to explore the animal diversity in nature.

#### **Learning outcomes**

Upon completion of the course, students should be able to:

- Learn about the importance of systematics, taxonomy, and structural organization of non-chordates.
- Appreciate the diversity of non-chordates living in varied habits and habitats
- Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.
- Critically analyse the organization, complexity and characteristic features of nonchordates.
- Recognize the life functions and the ecological roles of the animals belonging to different phyla.
- Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments, and projects.

#### **SYLLABUS OF DSC-1**

##### **Unit I: Introduction to Non-chordates (2 Hours)**

General characteristics of non-chordates and basis of classification.

**Unit II: Protista (07 Hours)**

General characteristics and classification; Life cycle of *Plasmodium vivax*; Locomotion and reproduction in Protista.

**Unit III: Porifera (05 Hours)**

Introduction to Parazoa; General characteristics and classification; Canal system in sponges.

**Unit IV: Cnidaria and Ctenophora (8 Hours)**

Introduction to Metazoa; General characteristics and classification; Polymorphism in Cnidaria; Corals and coral reefs.

**Unit V: Platyhelminthes and Nemathelminthes (8 Hours)**

General characteristics and classification; Parasitic adaptations of Helminthes; Life cycle of *Taenia solium* and *Ascaris lumbricoides*.

Note: Outline classification up to classes to be followed from “Ruppert, Fox and Barnes (2004). Invertebrate Zoology: A Functional Evolutionary Approach”. VII Edition, Cengage Learning, India

**Practical component**

1. Study of whole mount of Euglena, Amoeba, Noctiluca, Paramecium, Binary fission in Paramecium and Conjugation in Paramecium.
2. Examination of pond water collected from different places to observe diversity in Protista.
3. Study of Sycon, Hyalonema, Euplectella, Spongilla, T.S. of Sycon, L.S. of Sycon.
4. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium/Adamsia*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*.
5. Specimen/slide of any one Ctenophore.
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life stages (Slides/microphotographs).
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/microphotographs).
8. To submit a Project Report on the life cycle of any one parasite or pathogen/corals/coral reefs.
9. Examination of soil samples collected from different places to observe diversity in nematodes.

**Essential readings**

1. Ruppert, Fox and Barnes (2004). Invertebrate Zoology. VII Edition, Cengage Learning, India.
2. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education.
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis. III Edition, Blackwell Science.

## DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2) Biology of Cell: Structure

### 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		
<b>Biology of Cell: Structure and Function</b>	4	2	--	2	<b>Class X II pass with Biology as one of the papers in Class XII</b>	-

### Learning Objectives

The objective of the course is to help the students to learn and develop an understanding of a cell as a basic unit of life. This course is designed to enable them to understand the functions of cellular organelles and how a cell carries out and regulates cellular functions.

### Learning outcomes

Upon completion of the course, students should be able to:

- Understand the fundamental principles of cell biology.
- Explain the structure and functions of cell organelles involved in diverse cellular processes.
- Appreciate how cells grow, divide, survive, die, and regulate these important processes.
- Comprehend the process of cell signaling and its role in cellular functions.
- Have an insight into how defects in the functioning of cell organelles and regulation of cellular processes can develop into diseases. Learn the advances made in the field of cell biology and their applications

### SYLLABUS OF DSC- 2

#### **Unit I: Overview of Cells and Plasma membrane (05 Hours)**

Prokaryotic and Eukaryotic cells; Various models of plasma membrane structures, Transport across membranes: active and passive transport, facilitated transport; Cell-cell junctions, structures, and functions: Tight junctions, adherens junctions, gap junctions.

#### **Unit II: Endomembrane System (10 Hours)**

Structure and Functions: Endoplasmic Reticulum (ER), Golgi apparatus, Signal hypothesis, Vesicular transport from ER to Golgi apparatus, Protein sorting and transport from Golgi apparatus, Coated Vesicles, Lysosomes, Peroxisomes. Structure of Mitochondria, Semiautonomous nature, Endosymbiotic hypothesis; Respiratory chain, Chemiosmotic hypothesis, ATP Synthase.

#### **Unit III: Cytoskeleton (2 Hours)**

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments.

**Unit IV: Nucleus (4 Hours)**

Structure of Nucleus, Nuclear envelope, nuclear pore complex, Transport of molecules across nuclear membrane, nucleosome, nucleolus; Chromatin: euchromatin, heterochromatin.

**Unit V: Cell Division (4 Hours)**

Mitosis, Meiosis, Cell cycle and its regulation.

**Unit VI: Introduction to Cell Signaling (05 Hours)**

Cell Signaling through G-protein coupled receptor (GPCR) and role of secondary messenger: cAMP and protein kinase A.

**Practical component (60 Hours)**

1. Microscopy: Compound microscope: principle, components and handling; Phase contrast microscope; Electron microscope; Differential Interference Contrast (DIC) Microscope.
2. Principle and types of cell fixation and staining; Cell fractionation.
3. To study prokaryotic cells by Gram staining and eukaryotic cell (cheek cells) by hematoxylin/methylene blue.
4. To study the effect of hypotonic, isotonic, and hypertonic solutions on cell permeability.
5. Preparation of a temporary slide of squashed and stained onion root tip to study various stages of mitosis.
6. Study the effect of colchicine on mitosis at 24 hrs and 48 hrs.
7. Study of various stages of meiosis through permanent slides.
8. Preparation of stained mount to show the presence of Barr body in human female blood cells/cheek cells.
9. Cytochemical demonstration of:
  - a. DNA by Feulgen reaction
  - b. Mucopolysaccharides by PAS reaction
  - c. Proteins by Mercuric Bromophenol Blue/Acid Fast Green

**Essential readings**

1. Cooper, G.M., Hausman, R.E. (2019) The Cell: A Molecular Approach. VIII Edition, ASM Press and Sinauer Associates.
2. Becker, Kleinsmith, and Hardin (2018) The World of the Cell, IX Edition, Benjamin Cummings Publishing, San Francisco.
3. Karp, G. (2015). Cell and Molecular Biology: Concepts and Experiments, VIII Edition, John Wiley & Sons Inc.
4. Renu Gupta, Seema Makhija and Ravi Toteja (2018). Cell Biology Practical Manual, Prestige Publishers, New Delhi
5. VK Sharma (1991). Techniques in Microscopy and Cell Biology, Tata McGraw-Hill Publishing Company Limited, New Delhi

**DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3) Concepts of Ecology**

**Credit distribution, Eligibility and Pre-requisites of the Course**

Course	Credits	Credit distribution of the course	Eligibility	Pre-requisite
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title & Code		Lecture	Tutorial	Practical/ Practice	criteria	of the course(if any)
Concept of Ecology	4	2	0	2	Class X II pass with Biology as one of the papers in Class XII	NIL

### Learning Objectives

The primary aim of this course is to develop a scientific understanding of the diverse aspects of the field of ecology. The students will be familiarized with the interactions between the organisms and their physical environment. Additionally, various attributes of populations and communities with help of theoretical concepts and field examples will be discussed. It provides a platform to understand the varied forces that lead to variations among populations of a species.

### Learning outcomes

Upon completion of the course, the students should be able to:

- Demonstrate an understanding of the basic concepts of the subject
- Explain the characteristics, dynamics, and growth of populations
- Understand the characteristics of the community, ecosystem development and climax theories
- Gain knowledge about the relationship of the evolution of various species and the environment they live in.
- Design basic field studies, collect data and interpret it
- Carry out population and community studies

### SYLLABUS OF DSC-3

#### Unit I: Introduction to Ecology (03 Hours)

Autecology and Synecology, Laws of limiting factors, Study of physical factors: Temperature and Light.

#### Unit II: Population (07 Hours)

Unitary and Modular populations; Unique and group attributes of population: density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equations and patterns,  $r$  and  $k$  strategies; Intraspecific population regulation: density-dependent and independent factors.

#### Unit III: Species Interactions (06 Hours)

Types of species interactions, Interspecific competition: Lotka-Volterra model of competition, Gause's Principle with laboratory and field examples, Niche concept; Predation: Lotka-Volterra equations, Functional and numerical responses, predator defence mechanisms, Resource partitioning.

#### Unit IV: Community (05 Hours)

Community characteristics: species richness, dominance, diversity, abundance, guilds, ecotone and edge effect; Ecological succession with examples and types.

### **Unit V: Ecosystem (6 Hours)**

Types of Ecosystems: Terrestrial ecosystem, vertical stratification in tropical forest; Food chain: detritus and grazing food chains, linear and Y-shaped food chains, food web; Energy flow through the ecosystem; Ecological pyramids and Ecological efficiencies; Biogeochemical cycle- nitrogen cycle.

### **Unit VI: Applied Ecology (03 Hours)**

Ecology in wildlife conservation and management, Protected areas: National Parks, Biosphere reserves and Sanctuaries; Restoration ecology, Principles of Environmental impact assessment.

### **Practical components (60 Hours)**

1. Study of life tables and plotting of survivorship curves of different types from hypothetical/ real data
2. Determination of population density in a natural or a hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index.
3. Study of an aquatic ecosystem:
  - a) Phytoplankton and zooplankton
  - b) Measurement of temperature, turbidity/penetration of light, determination of pH
  - c) Dissolved oxygen content (Winkler's method), chemical oxygen demand
  - d) Free carbon dioxide and alkalinity
4. Study of ten endemic animals of India with slides/pictures/videos.
5. Report on a visit to a National Park/Biodiversity Park/Wildlife Sanctuary.

### **Essential readings**

1. Odum, E.P. and Barrett G. W. (2008). Fundamentals of Ecology. Indian Edition (5th). Publisher: Brooks/Cole.
2. Smith T. M. and Smith R. L. (2015). Elements of Ecology. 9th International Edition. Publisher: Benjamin Cummings.
3. Saha G.K. and Mazumdar S. (2020) Wildlife Biology, An Indian Perspective. Publisher: PHI Learning Private Limited
4. Zimmer C. and Emlen D. J., (2013) 1st Edition. Evolution: Making Sense of Life, Roberts & Co.
5. Futuyma, Douglas and Mark, Kirkpatrick (2017) 3rd Edition. Evolutionary Biology, Oxford University Press

**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 Zoology**  
*Category-IV*

**GENERIC ELECTIVES (GE-1): 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	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
<b>Human Physiology</b>	4	2	-	2	12 <sup>th</sup> Pass	Nil	Zoology

**Learning Objectives**

This course offers an overview of the concepts of normal biological functions in the human body. The fundamentals of human physiology and histological structures will be correlated. The concept of homeostasis in response to changes in the external environment will be introduced. Further, students will be provided with knowledge that can be applied in everyday life. The students will be encouraged to pursue further studies in physiology and related fields as well as multidisciplinary subjects that require an understanding of the physiology of humans.

**Learning outcomes**

Upon completion of the course, students will be able to:

- Understand the principles of normal biological function in the human body.
- Outline basic human physiology and correlate it with histological structures.
- Understand the homeostasis in animals in response to changes in their external environment.

**SYLLABUS OF GE-1**

**Unit I: Tissues (05 Hours)**

Types of Tissues; Structure and Function of Epithelial, Connective, Muscular and Nervous tissues.

**Unit II: Functioning of Excitable Tissue (Nerve and Muscle) (05 Hours)**

Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Mechanism of muscle contraction (Sliding filament theory).

**Unit III: Digestion and Absorption of Food (05 Hours)**

Structure and function of digestive system; Digestion and absorption of carbohydrates, fats and proteins.

**Unit IV: Respiratory Physiology (04 Hours)**

Structure and function of respiratory tract and lungs; Ventilation, External and Internal respiration; Transport of oxygen and carbon dioxide in blood.

**Unit V: Cardiovascular System (04 Hours)**

Structure of heart, Cardiac cycle, Composition of blood

**Unit VI: Renal Physiology (03 Hours)**

Functional anatomy of kidney

**Unit VII: Reproductive Physiology (04 Hours)**

Structure of testis and ovary; Spermatogenesis and Oogenesis.

**Practical component (if any) (60 Hours)**

1. Preparation of temporary mount of neurons and blood cells (blood film preparation).
2. Preparation of haemin and haemochromogen crystals.
3. Haemoglobin estimation using Sahli's haemoglobinometer.
4. Determination of ABO Blood group.
5. Recording of blood pressure using a Sphygmomanometer.
6. Examination and detailed study of permanent histological sections of mammalian Stomach, Duodenum, Liver, Lung, Kidney, Pancreas, Testis and Ovary.

**Essential readings**

1. Tortora, G.J. and Derrickson, B.H. (2012). Principles of Anatomy and Physiology. XIIIth Edition, John Wiley and Sons, Inc.
2. Widmaier E, Raff H and Strang K. (2013). Vander's Human Physiology: The Mechanism of Body Functions. XIIIth Edition, McGraw-Hill Education.
3. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology. XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Kesar, S. and Vashisht, N. (2007) Experimental Physiology. Heritage Publishers.
5. Prakash, G. (2012) Lab Manual on Blood Analysis and Medical Diagnostics. S. Chand and Company Ltd.

**GENERIC ELECTIVES (GE-2): Nature and Wildlife Studies**

**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	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Nature and Wildlife Studies	4	2	-	2	12 <sup>th</sup> Pass	Nil	Zoology

**Learning Objectives**



The course is designed to acquaint students with varied aspects of wildlife conservation, including its importance, major threats, and management of habitats and populations. The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. Further, students will be motivated to pursue careers in the field of wildlife conservation and management..

### Learning outcomes

By studying the course the students will develop:

- Understanding about wild life
- Evaluation and Management of Wildlife
- Wild life resources and protection

### SYLLABUS OF GE-2

#### **Unit I: Conservation of Nature and Wildlife (06 Hours)**

Values of wildlife - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: Wildlife Conservation Society (WCS), Convention on Biological Diversity (CBD), Agenda 21 of United Nations.

#### **Unit II: Evaluation and Management of Wildlife (06 Hours)**

Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage; Census method

#### **Unit III: Management of Natural Habitats (04 Hours)**

Setting back succession: Grazing logging, Mechanical treatment, Advancing the successional process.

#### **Unit IV: Management Planning of Wildlife in Protected Areas (04 Hours)**

Human-wildlife conflict, Captive Breeding, Ecotourism.

#### **Unit V: Wildlife Health and Management (04 Hours)**

Care of injured and diseased animals, Quarantine; Zoonotic diseases: Ebola, Salmonellosis, Rabies, Foot and Mouth Disease, MonkeyPox, SARS, Bovine and Avian Flu.

#### **Unit VI: Protected Areas (06 Hours)**

National parks and sanctuaries, Biosphere reserves, Conservation and Community reserve, Important features of protected areas in India, Tiger conservation , management and challenges.

#### **Practical component (if any) (60 Hours)**

1. Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field: Identification of animals
4. through pug marks, hoof marks and scats.

5. To study the various animal tracking system: Global Positioning System, Remote Sensing and Biotelemetry.
6. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
7. A report based on a visit to National Park/ Wildlife Sanctuary/ Biodiversity Park or any other wildlife conservation site.

### **Essential readings**

1. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313
2. A.R.E. Sinclair, J.M. Fryxell and G. Caughley (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
3. S.K. Singh (2005). Textbook of Wildlife Management. IBDC, Lucknow.
4. K. Banerjee (2002). Biodiversity conservation in managed and protected areas. Agrobios, India.
5. B.D. Sharma (1999). Indian Wildlife Resources Ecology and Development. Daya Publishing House, Delhi.
6. R.B. Primack (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
7. B. B. Hossetti (1997). Concepts in Wildlife Management. Daya Publishing House, Delhi.

## ACBR

### **BSc (H) Biomedical Science** *Category-I*

#### **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		
<b>BIOORGANIC CHEMISTRY</b>	<b>4</b>	<b>3</b>	<b>-</b>	<b>1</b>	<b>Student should have studied science (Biological science/ physical sciences)</b>	<b>-</b>

#### **Learning Objectives**

The Learning Objectives of this course are as follows:

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.

#### **Learning outcomes**

The Learning Outcomes of this course are as follows:

The students will be able:

- 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.

#### **SYLLABUS OF DSC-1**

##### **UNIT – I Stereochemistry**

**(9**

##### **Hours)**

Optical isomerism: Optical activity, specific rotation, enantiomerism, D and L designation, racemic modification, R and S sequence rules, diastereoisomers.

Conformational isomers: conformation of ethane and butane, interconversion of projection formula, cyclohexane (mono- and di-substituted), resolution, optical purity.

Geometrical isomerism: Definition, nomenclature– E and Z.

**UNIT – II Introduction to Biomolecules I (12 Hours)**

**Carbohydrates:**

Monosaccharides- cyclization of aldoses and ketoses, conformations, concept of mutarotation, anomers, epimers.

Disaccharides- structure, reducing and non-reducing sugars. Polysaccharides- Starch, glycogen and cellulose.

**Lipids:**

Fatty acids, triacylglycerols, phospholipids, lipid bilayer formation, steroids (cholesterol)

**UNIT – III Introduction to Biomolecules II (12 Hours)**

**Amino Acids:**

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).

**Nucleotides:**

Sugars and Bases, conformation of sugar phosphate backbone, hydrogen bonding and tautomerism in nucleic acid bases Effect of structure on reactivity of biomolecules.

**UNIT – IV Biologically Significant Name Reactions (12 Hours)**

Aldol (Glucogenesis), retro-aldol (Glycolysis), benzoin condensation (umpolungdecarboxylation 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 component (12 Sessions x 2 hrs) – 30 Hours**

(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 to identify 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. To determine the Iodine number of the given oil/fat.
6. To find 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.

### Essential readings

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

### Suggestive 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. ISBN13: 9781316677056

## DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): CELL BIOLOGY

### 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		
CELL BIOLOGY	4	3	-	1	Student should have studied science (Biological science/ physical sciences)	-

### Learning Objectives

The Learning Objectives of this course are as follows:

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

### Learning outcomes

The Learning Outcomes of this course are as follows:

- 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.

## SYLLABUS OF DSC- 2

### UNIT – I The Cell

( 3 Hours)

Historical background, significant landmarks, cell theory, structure of prokaryotic and eukaryotic cells

### UNIT – II Cell Membrane and Membrane Transport

( 6 Hours)

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.

A. 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<sup>+</sup>/K<sup>+</sup> pump.

B. Transport of macromolecules: Endocytosis (pinocytosis, phagocytosis), exocytosis

### UNIT – III Cell Organelles

(15

Hours)

Structure and functions of various organelles:

- Nucleus: Different components, nuclear envelope- its structure, pore complex, nucleocytoplasmic, interaction (NLS and NES), nucleolus- structure and functions.
- 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.
- Golgi apparatus: Golgi stack (cis, trans and medial cisternae), flow of proteins through Golgi body, glycosylation and protein sorting.

- Lysosomes: Development of different forms of lysosomes, role in cellular digestion, lysosomal storage diseases- Hurler syndrome, Hunter syndrome, Tay-Sachs disease and Inclusion cell disease (I-cell disease).
- Peroxisomes: Assembly, functions- H<sub>2</sub>O<sub>2</sub> metabolism, oxidation of Fatty acids, glyoxysomes
- Mitochondria: Detailed structure, endosymbiotic theory, its genome and functions in brief
- Chloroplast: Detailed structure, its genome and functions in brief

#### **UNIT – IV Cell -Cell communication (9 Hours)**

Structures and functions of different types of anchoring junctions (desmosomes and hemidesmosomes), tight junctions, and communication junctions (gap junction and plasmodesmata).

#### **UNIT – V Cytoskeletal Elements (6 Hours)**

Structure, assembly and functions of:

- A. Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies).
- B. Microfilaments: Globular and filamentous actin, general idea about myosin.
- C. Intermediate filaments: Different classes.

#### **Unit VI: Cell Signaling and Cell Cycle (6 Hours)**

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 component (30 Hours)**

(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.

#### **Essential readings**

- 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; ISBN13 : 978-0716743668

#### Suggestive 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.

### DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): 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		
<b>HUMAN PHYSIOLOGY AND ANATOMY-I</b>	<b>4</b>	<b>3</b>	<b>-</b>	<b>1</b>	<b>Student should have studied science (Biological science/ physical sciences)</b>	

#### Learning Objectives

The Learning Objectives of this course are as follows:

- 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.

### **Learning outcomes**

The Learning Outcomes of this course are as follows:

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 a part 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 function of 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.

### **SYLLABUS OF DSC-3**

#### **UNIT – I Body organization and Integumentary system (6 Hours)**

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 (6 Hours)**

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 (6 Hours)**

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 (6 Hours)**

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 (6 Hours)**

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 (9 Hours)**

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 (6 Hours)**

Cartilage: structure, types and function. Bones: structure, function, location and types. Joints: structure, function and types

**Practical components ( 30 Hours)**

(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.)

**Essential readings**

- 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: 978-08089-2400-5
- Human Physiology, 12th edition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN 978007-337811-4MHID 0-07-337811-9.

**Suggestive 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's Review of Medical Physiology, 26th edition (2019), K.E. Barrett, 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, ISBN13: 978-9352705320 ISBN-10: 9352705327

**Common Pool of Generic Electives (GE) Courses  
Offered by ACBR  
Category-IV**

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

**GENERIC ELECTIVES (GE-1): CONCEPTS IN BIOTECHNOLOGY**

**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		
<b>CONCEPTS IN BIOTECHNOLOGY</b>	<b>4</b>	<b>3</b>	<b>-</b>	<b>1</b>	<b>The student should have studied science (Biological science/physical sciences)</b>	<b>NA</b>

**Learning Objectives**

The Learning Objectives of this course are as follows:

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.

**Learning outcomes**

The Learning Outcomes of this course are as follows:

- 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.

## **SYLLABUS OF GE-1**

### **UNIT – I Techniques Used in Biotechnology (12 Hours)**

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 (15 Hours)**

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 (18 Hours)**

Construction of Genomic and cDNA Libraries, their Screening by Nucleic Acid Hybridization (Colony and Plaque Hybridization).

### **UNIT – IV Applications of Biotechnology (6 Hours)**

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 (6 Hours)**

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

### **Practical component- (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

### Essential readings

- 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.

### Suggestive readings

- Glick, B. R. and Patten, C. L. (2022). 6th Edition. Molecular Biotechnology: Principles and Applications of Recombinant DNA. USA: ASM press, ISBN-13: 978-1683673668.
- Brown, T. A. (2020). 8th Edition. 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

## GENERIC ELECTIVES (GE-2): LANDMARK DISCOVERIES IN 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
		Lecture	Tutorial	Practical/ Practice		
<b>LANDMARK DISCOVERIES IN SCIENCE</b>	4	3	-	1	<b>The student should have studied science (Biological science/physical sciences)</b>	NA

### Learning Objectives

The Learning Objectives of this course are as follows:

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. It 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.

### Learning outcomes

The Learning Outcomes of this course are as follows:

The students will be able:

- 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 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.

## SYLLABUS OF GE-2

### UNIT – I View of the invisible Biology

(6 Hours)

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

(6 Hours)

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

(6 Hours)

A) Study of evolution of life: Darwin's 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 (4.5 Hours)**

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 (4.5 Hours)**

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 (6 Hours)**

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 (6 Hours)**

(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] (6 Hours)**

Study historical research papers and provide a descriptive view of research that was carried out by Scientists as Minor Project.

- (A) Ancient system of medicine
- (B) Contribution of any one Indian Scientists in Biology
- (C) Contribution of any Physicists or Chemists in Biology (for topics listed above)

**Practical component (if any) - (30 Hours)**

(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.

### Essential readings

- 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.

### Suggestive 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.

## GENERIC ELECTIVES (GE-3): TOXIC SUBSTANCES AND HUMAN HEALTH

### 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		
TOXIC SUBSTANCES AND HUMAN HEALTH	4	3	-	1	Open to Students from all subjects	NA

### Learning Objectives

The Learning Objectives of this course are as follows:

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.



## Learning outcomes

The Learning Outcomes of this course are as follows:

After studying, students will be able to:

- 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.

## SYLLABUS OF GE-3

### **UNIT – I Introduction to toxic substances and assessment of toxicity (9 Hours)**

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 (6 Hours)**

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

### **UNIT – III Household toxicants (9 Hours)**

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 (6 Hours)**

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 (6 Hours)**

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

**UNIT – VI Environmental toxicants (9 Hours)**

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 component - (30 Hours)**

(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.

**Essential readings**

- 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. ISBN13: 978-0415247634.

**Suggestive readings**

- <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.