DISCIPLINE SPECIFIC CORE COURSE -2 (DSC-2) CELL BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Cell Biology	4	**3**	**0**	**1**	**Class XII Biology/Biotech**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

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 communications 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 (01 Week)

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

Unit II: Cell Membrane and Membrane Transport (03 Weeks)

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

Unit III: Cell Organelles (03 weeks)

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- H2O2 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 (01 Weeks)

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

Unit V: Cytoskeletal Elements (01 Weeks)

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.

Intermediate filaments: Different classes.

Unit VI: Cell Signaling and Cell Cycle (02 Weeks)

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

(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 cells

Essential/recommended 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.

Suggestive 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; ISBN-13 : 978 0716743668