

Course Code	Course Name	Credits
26BY505	ADVANCED CELL BIOLOGY	04

### Course Objectives

- Analyze plasma membrane phase separation and intercellular communication networks.
- Evaluate cytoskeletal remodelling and optogenetic trafficking control systems.
- Interpret nuclear architecture, CRISPR-epigenome editing, and chromatin dynamics.
- Assess phase-separated signalling cascades and cell cycle checkpoint regulation.

### Learning Outcomes

Upon successful completion of this course, it is intended that a student will be able to:

- Explain plasma membrane dynamics, transport proteins, and intercellular junctions.
- Analyze cytoskeletal organization, motor proteins, and vesicular trafficking pathways.
- Describe nuclear transport, chromatin remodelling, and epigenetic regulation mechanisms.
- Evaluate GPCR/RTK signalling cascades, cell cycle checkpoints, and apoptotic pathways.

### Unit 1 - Plasma Membrane Dynamics (12 Hrs.)

Plasma membrane ultrastructure, fluid-mosaic model evolution. Phase separation in lipid rafts. Passive/active transport, aquaporins, and membrane protein complexes. Intercellular junctions: tight/gap junctions, plasmodesmata, desmosomes. Cryo-EM structures of transport proteins.

### Unit 2 – Cytoskeleton & Vesicular Systems (12 Hrs.)

Microfilaments: actin dynamics, myosins. Microtubules: MTOCs, catastrophe/frequency, kinesins/dyneins. Intermediate filaments: assembly/types. Vesicular trafficking, TGN sorting. Optogenetic cytoskeletal control, CRISPR screens for trafficking mutants.

### Unit 3 - Nuclear Architecture & Epigenetics (12 Hrs.)

Nuclear ultrastructure, NLS/NES/Ran GTPase transport. Chromatin: nucleosomes, euchromatin/heterochromatin, telomeres/centromeres. Histone modifications, DNA methylation. dCas9-epigenome editing, Hi-C chromatin conformation capture.

### Unit 4 – Signalling & Cell Cycle Control (12 Hrs.)

Signalling modules: GPCR, RTK, cytokine receptors. Second messengers, phase-separated signalosomes. Cell cycle phases/checkpoints (DNA damage/spindle). Cyclins/CDKs, Wee1 inhibitors, MAPK feedback loops.

### Unit 5 - Cell Death & Cancer Biology (12 Hrs.)

Apoptosis: intrinsic/extrinsic pathways, caspases, Bcl-2 family. Autophagy mechanisms. Cancer: oncogenes, p53, DNA repair defects. CRISPR-Cas9 tumour suppressors, ferroptosis. Viruses, epigenetic cancer drivers.

### Reference Books:

1. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2024). *Molecular Cell Biology, 9th Edition*. W. H. Freeman.
2. Alberts, B., Heald, R., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular Biology of the Cell, 7th Edition*. W. W. Norton & Company.
3. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. (2023). *Cell Biology, 4th Edition*. Elsevier.
4. Cooper, G. M., & Hausman, R. E. (2024). *The Cell: A Molecular Approach, 9th Edition*. Oxford University Press.
5. Karp, G., Iwasa, J. C., & Marshall, W. F. (2022). *Karp's Cell and Molecular Biology: Concepts and Experiments, 9th Edition*. Wiley.
6. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). *Molecular Biology of the Gene, 7th Edition*. Pearson.