



# INTRODUCTION TO CELL BIOLOGY

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**PRE-REQUISITES :** Any student who is starting a BSc course in Biology would find this useful.

**INTENDED AUDIENCE :** First year undergraduate Biology students.

**INDUSTRY SUPPORT :** Biotech companies may find this course useful for technicians and students who train with them.

### COURSE OUTLINE :

This course aims to introduce students to biomolecules and important fundamental concepts in cellular biochemistry, genetics and cellular organisation. It is aimed to give you an insight into how biomolecules work and help drive cellular architecture and function in a eukaryotic cell. In the first part, we focus on the information that makes the cell tick; from its storage in DNA to its conversion to executive molecules such as RNA and protein that perform essential routine processes in the cell. The central dogma is used as a guide to explore the structure of DNA, RNA and Protein and also explore the mechanisms of DNA replication, transcription and translation. Also touched upon are other important molecules such as water, carbohydrates and lipids. In the second part, we introduce basic mechanisms of heredity, as discovered by Gregor Mendel, in a modern context. In the third part, we will be discussing cell theory and the evolution of complexity in cells and the role compartmentalisation plays in mediating the same. The organisation of cells starting from the cell membrane as we move into the cell will be discussed. We will be looking at the role cytoskeleton have in cellular organisation and function. We will also be discussing organisation, role and regulation of cell organelles, everything from the endomembrane system to lysosomes to the nucleus. Eventually, we will be briefly discussing how all these cellular components come together to drive the process of cell division.

### ABOUT INSTRUCTOR :

Prof. Nagaraj Balasubramanian graduated from the University of Mumbai (Bombay) with a bachelors and masters degrees in Microbiology. He worked in the Cancer Research Institute (now ACTREC) at the Tata Memorial Center for his PhD in Biochemistry. He took a break from cancer biology to do a postdoc in mammalian phototransduction at the University of Miami, only to return to cell and cancer biology focusing on cell adhesion and trafficking at the University of Virginia. He moved to IISER Pune to start his lab in 2010. His lab is interested in understanding how cell adhesion regulates trafficking and its implications in cell migration and anchorage dependence in 2D and 3D microenvironments. They are further exploring the role cell adhesion has in regulating organelle function and its implications in anchorage-dependent signalling and function. Prof. Girish Ratnaparkhi obtained his PhD from the Molecular Biophysics Unit, Indian Institute of Science, Bangalore. He had postdoctoral stints at the National Centre for Biological Sciences, Bangalore and the Department of Chemistry and Biochemistry at the University of California, Los Angeles in the USA before joining IISER Pune. His lab uses the fruit fly *Drosophila melanogaster* to study animal development and disease. Broad research areas include cell signalling – especially in the immune response, maternal development, intra-organ signalling and neurodegeneration.

### COURSE PLAN :

**Week 1:** Overview of the Central Dogma of Molecular Biology. Storage and information flow within the cell. The Central Dogma: DNA replication

**Week 2:** The Central Dogma: Transcription & Translation

**Week 3:** Macromolecules in the cell: Proteins, Carbohydrates and Lipids. The rules governing heredity: A short introduction to Genetics

**Week 4:** Introduction to microscopy. Prokaryotes vs Eukaryotes, evolution of complexity and the endosymbiont theory

**Week 5:** Cell Membrane. Why lipids? Membrane organisation and function. Cytoskeleton components, how are they similar and different? How does this help their distinct function.

**Week 6:** Motor proteins, their evolution, specificity, directionality, and function in cells.

**Week 7:** The endomembrane system & Nucleus. ER, Golgi, lysosomes and vacuoles. Their assembly, crosstalk and function in cells.

**Week 8:** How does the endomembrane system connect to the nucleus. The organisation of the nucleus. The role of cell membrane, organelles and cytoskeleton in cell division. How does the cell manage to use these component to distribute its content evenly between daughter cells?