

BY529 Mechanobiology of the Cell

Course number	: BY529
Course Name	: Mechanobiology of the Cell (MBoC)
Credit Distribution	: 3-0-0-3
Intended for	: B.Tech.-M.Tech. Integrated Dual Degree in Bio-Engineering, M. Tech Biotechnology and PhD candidates
Prerequisite	: BE201 Cell Biology or Consent of Faculty Member
Mutual Exclusion	: NA

1. Preamble:

This course is designed to introduce fundamental principles of mechanobiology namely the mechanosensing molecules in the cell and the mechanics of cell behaviour (adhesion, migration, gene expression, tissue development). Subsequently, the mechanobiology of organ systems, namely cardiovascular, bone, cartilage, liver, and nervous system as well as mechanobiology of diseases namely cancer, muscular dystrophy, and laminopathies will be introduced. This course will also discuss the techniques used for studying mechanobiology, such as nanofabrication, organoids, microfluidics, and various microscopy techniques. Finally, some applications of mechanobiology principles in disease diagnostics and therapeutics will also be discussed.

Course Modules with quantitative lecture hours (42 total hours):

Unit 1: *Introduction to Mechanobiology* (2 Hours)

Why study mechanobiology, pioneering experiments in mechanobiology

Unit 2: *Molecular Mechanisms of Mechanotransduction* (6 Hours)

Mechanosensory molecules in focal adhesions, cell-cell junctions, cytoskeleton, and nucleus

Unit 3: *Mechanobiology of cell behavior* (8 Hours)

Rigidity sensing and mechanotransduction in adhesion, migration, gene expression, and tissue development

Unit 4: *Mechanobiology of organ systems* (8 Hours)

Cardiovascular, Bone, Cartilage, Liver, Nervous system

Unit 5: *Mechanobiology of disease* (6 hours)

Muscular dystrophy, cancer, laminopathy

Unit 6: *Technology innovation for mechanobiology* (6 Hours)

Optical microscopy, nanofabrication, microfluidics, organoids, organ-on-chip

Unit 7: *Mechanobiology in medical diagnostics and therapeutics* (6 hours)

Cell therapy, Cancer diagnostics, Immune profiling

Laboratory/practical/tutorial Modules: NA

2. Text books:

1. Introduction to Cell Mechanics and Mechanobiology by Christopher R. Jacobs, Hayden Huang, and Ronal Y. Kwon. Garland Science, Taylor & Francis Group, 2012
2. The Cell as a Machine by Michael Sheetz and Hanry Yu. Cambridge Texts in Biomedical Engineering, Cambridge University Press, 2018

3. References:

1. Mechanobiology: Methods and Protocols by Ronen Zaidel-Bar. Humana Press, Springer Protocols. Methods in Molecular Biology 2023
2. Mechanobiology in Health and Disease by Stefaan W. Verbruggen. Academic Press, Elsevier, 2018
3. MBInfo (<https://www.mbi.nus.edu.sg/mbinfo/>) This is a wiki-style repository of mechanobiology with the aim to inform and educate the wider scientific community about mechanobiology and how physics and mechanics impact biological processes.