BT653 Introduction to Mechanobiology (3 0 0 6)
Open elective

Pre-requisites: Nil

Preamble

Mechanobiology is an interdisciplinary field that merges biology, physics, and engineering to explore how mechanical forces drive cellular processes. This course, "Introduction to Mechanobiology," delves into how biological components—such as cells, tissues, and organs—sense and respond to mechanical cues to regulate crucial biological functions, including development, differentiation, physiology, and disease. Mechanical cues arise from the physical properties of cellular components, cells, and their environments, influencing cellular behaviour and, consequently, their surroundings. These bidirectional interactions between cells and tissues have profound implications for gene expression, cell fate, and function, leading to both transient and permanent tissue modifications. Understanding these processes is essential for grasping their roles in maintaining homeostasis and immunity, as well as in pathological conditions like fibrosis, inflammation, and cancer metastasis.

In this course, students will explore the fundamental principles of mechanobiology and gain insight into the technologies used to study living systems, including methods for mechanical manipulation and characterization. Students will learn how mechanical forces shape biological systems and how these insights can be applied to advance research and therapeutic strategies.

Course Description / Syllabus

Introduction to Mechanobiology: Cells as robust self-replicating machines, Life at low Reynolds number; Structural Components of Cells: Cytoskeletal filaments, Cell junctions, Extracellular matrix, Lipid bilayers; Mechanosensing and Mechanotransduction: Cell-matrix interactions and crosstalk, Biochemical mechanotransduction pathways, Cytoskeletal mechanotransduction, Mechanosensitive ion channels and ion-based mechanotransduction, Fluid boundaries and mechanical regulation, Nucleus as a master regulator in mechanotransduction; Techniques in Mechanobiology: Traction force microscopy, Pressure myograph, Atomic force microscopy, etc.; Mechanobiology in Development, Stem Cells, and Disease: Role of mechanobiology in development, Mechanobiology of stem cells, Mechanobiology of fibrosis, Mechanobiology of cancer vs. regeneration.

Texts

1. Sheetz, M., & Yu, H., *The Cell as a Machine*, 1st edition, Cambridge University Press, 2018
2. Phillips, R., Kondev, J., Theriot, J., & Garcia, H., *Physical Biology of the Cell*, 2nd edition, CRC Press, 2013

References

1. Verbruggen, S., *Mechanobiology in Health and Disease*, 1st edition, Academic Press Inc., 2018
2. Zaidel-Bar, R., *Mechanobiology: Methods and Protocols*, 1st edition, Humana, New York, NY, 2023