

<b>5<sup>th</sup> Semester</b>	<b>RBM5D004</b>	<b>Mechanobiology</b>	<b>L-T-P 3-0-0</b>	<b>3 Credits</b>
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**Module-I**

Brief introduction to mechanical force: Basics of classical mechanics, mechanics of solids and fluids, with examples from biology. Introduction to viscoelasticity and surface tension and how do they operate at cellular and tissue level. Concept of scaling in biology. Biology by the numbers.

**Module-II**

How do the cells generate force? Cell as a chemical machine. Thermodynamics, rate-kinetics, and mechanics. Effect of intercellular and intra-cellular forces at molecular- and meso-scale. Concept of forced induced unfolding of proteins and DNA. Force-dependent reaction kinetics of slip and catch bonds. Forces during cell division.

**Module-III**

Biology, Chemistry, and Physics of cellular force-bearing structures: Molecular and meso-scale perspective. Acto-myosin network, Microtubules, Intermediate filaments, Different cell-cell junctions, Extracellular matrix (ECM), Cell-ECM adhesions. Molecular motors.

**Module-IV**

How can we measure forces at molecular and cellular level? Traction force microscopy, micropillar assays, monolayer stress microscopy, atomic force microscopy, optical traps, molecular tension sensors.

**Module-V**

Forces in tissue and organism development: Forces that shape a developing embryo. Forces in the epithelium. How the cells build the tissue stiffness: molecular assembly and collective effect. Epithelial constriction, invagination, bending, folding, and hydraulic fracture. Density-dependent and independent jamming and unjamming of the epithelium. Force measuring techniques at tissue level: current approaches and limitations.

Effect of fluidic forces: Development of heart and blood vessel. Different flow types and their biochemical effect. Rheology of blood. Introduction to microfluidics as the blood-vessel mimic.

Mechanobiology of human diseases: Cardio-vascular diseases, aging

**Books:**

- 1) Introduction to the Physics of Fluids and Solids by James S. Trefil, Dover Books on Physics.
- 2) Physical Biology of the Cell by Rob Phillips et al., Garland Science
- 3) Biological Physics: Energy, Information, Life by Philip Nelson, W.H. Freeman & Co Ltd
- 4) Biological Physics of the Developing Embryo by Gabor Forgacs and Stuart A. Newman, Cambridge University Press