Physical Biology

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Course Details and Syllabus

- **Elective**
- **Credits: 3+1**

1. **Introduction to physical biology of the cell**
    a. **Brief introduction to thermal and statistical physics**
    b. **Overview of multivariate calculus and stochastic processes**
    c. **Static and dynamic properties in cells**
    d. **Scaling, dimensionless ratios and non – dimensionalization**
    e. **Magnitude estimates**
    f. **Buckingham Pi Theorem**

2. **Biological Data**
    a. **Probability distributions**
    b. **Time – scale analysis**
    c. **Time – frequency analysis**
    d. **Modeling**

3. **Equilibrium**
    a. **Mechanical equilibrium**
    b. **Chemical equilibrium**
    c. **Two state systems and cooperativity**
    d. **Biopolymers and membranes**
    e. **Electrostatics in solution**

4. **Dynamics**
    a. **Brownian motion**
    b. **Rate equations**
    c. **Diffusion**
    d. **Kinetics of association and dissociation**

5. **Cytoskeleton and molecular motors. Polymerization kinetics. Transport and force generation.**
6. **Biological electricity. Pumps and channels. The Hodgkin – Huxley model.**

7. **Biological networks. Cell signaling. Biological pattern formation.**

8. **Theory of living matter**
    a. **Field theory in biology**
    b. **Continuum theory protocol**
    c. **Theory of linear elasticity: gut folding (case study)**
    d. **Theory of hydrodynamics: cytoplasmic streaming (case study)**
    e. **Theory of viscoelasticity: cell junction dynamics (case study)**
    f. **Active matter**

9. **Physical biology in whole organisms**

References

1. Robert Phillips, Jane Kondev, and Jule Theriot, *Physical Biology of the Cell*, Garland Science, New York, 2012.