Essentials of Biophysics

Target audience: *Ph.D. students* Year: *1/2* Semester: *odd*
Course Type: Elective Credits: *4* Contact Hours: *60*

Course overview (100 words):

This course is designed mainly for Ph.D. students who are willing to think about living cells. It is very different from traditional biophysics courses. Various topics of the course are threaded with the underline physics perspective. The course aims to cover basic concepts of Biophysics to its applications. The course finally provides a flavor of how quantitative theoretical models are derived from statistical physics and can be used to understand complex biological processes.

Prerequisite Courses:

Elementary algebra and calculus, elementary physics, a distant memory of high school chemistry and biology will be advantageous.

Course outcomes:

1. Use physical techniques to get inside the nanoworld of cells, tweak them in physical ways, and measure the results quantitatively. Students will recognize and evaluate the role of free energy, heat, entropy, temperature, and random thermal motion in various biological processes.

2. Students will be familiar with various analytical and experimental techniques and aware about various biological systems and related complex phenomena.

3. Apply mathematical skills/concepts including algebra, differential and integral calculus, estimation, error analysis, differential equations and elementary concepts from probability theory to problems related to a wide variety of biological systems. Conclude and describe the underlying simplified physical model(s) that can express the richness and complexity of various biological systems and processes.

4. At the end of the course students should be in a position to understand present day scientific work in Biophysics and apply the knowledge in various related fields.

Course Topics:

Topics	Contact Hours
UNIT 1: Natural nanoworld: Physicist's perspective	22
1. Probabilistic facts of life	

2. Basic notions of thermodynamics	
3. Basic notions of statistical mechanics	
4. Reaction kinetics	
5. Brownian motion	
6. Biology by the numbers	
7. Molecular forces in biomolecules	
UNIT 2: Life at rest	20
1. Mechanical and Chemical equilibrium	
2. Enzyme kinetics	
3. Structure of Macromolecules	
4. Force spectroscopy techniques	
5. Polymer models	
6. Elastic properties of biomolecule	
UNIT 3: Life in motion and the related complexity	18
1. Random walks and its application	
2. Life in the slow lane: the low Reynolds-number world	
3. Master equation and its application	
4. Dynamics of natural Nano motors	
5. Life in crowded environments	
Total	60

References

Text Books:

1. *Biological Physics*, Philip Nelson, (WH Freeman New York, 2004)
2. *Biophysics: An introduction*, Rodney Cotterill (John Wiley & Sons, LTD, 2002);

Reference books:

3. Bruce Alberts at al., Molecular Biology of the Cell (Garland, 2002).
4. M. Schliwa, Molecular Motors (Wiley).
5. M. Rubinstein and R. H. Colby, Polymer Physics (Oxford University Press, 2004)
6. M. W. Zemansky and Richard Dittman, Heat and Thermodynamics (McGraw-Hill Book Company Inc. 1981).

7. Frederick Reif, ed. Fundamentals of Statistical and Thermal Physics (McGraw-Hill, 1965).
8. Atkins…
9. Lecture notes, various Journal papers and Web resources (communicated when necessary).

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.)

Probable Evaluation Methods:

Item	Weightage
Quizzes	20
Midterm	30
Final Examination	50

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