Physics 222 – Biological Physics – Spring 2021

Instructor:

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Office: Innovation Hall E205
Office hours: TBA

Schedule:

TBA

Prerequisites:

Phys 012 or Phys 152 (or equivalent), and Math 121 (Vector Calculus)

Course textbook:

Physical Biology of the Cell, 2nd edition (2012, Garland Science).
Authors: Rob Phillips, Jane Kondev, Julie Theriot and Hernan Garcia.
ISBN: 978-0-8153-4450-6

Optional references:

Biological Physics: Energy, Information, Life (2014, W.H. Freeman).
Author: Philip C. Nelson
ISBN: 978-0-7167-9897-2

Mechanics of the Cell, 2nd edition (2012, Cambridge University Press).
Author: David H. Boal
ISBN: 978-0-521-11376-2

The Machinery of Life (2009, Copernicus Books)
Author: David S. Goodsell
ISBN: 978-0-387-84924-9

Biochemistry (any recent edition, W.H. Freeman/Macmillan).
Authors: Jeremy M Berg, John L Tymoczko, and Lubert Stryer.
Available online for reference at the NCBI bookshelf:
http://www.ncbi.nlm.nih.gov/books/NBK21154/

Grading:

The grade for the class will be assigned based on homework (30 %), a midterm exam (30 %), a final exam (30 %), and in-class attendance/participation (10 %). This course will be offered at the advanced undergraduate/graduate level. Students taking the course for graduate credit may have additional requirements.

Course plan (specific topics and order may change):

1. Basic cellular components, length and time scales in biology.

2. Molecular solvation and the hydrophobic effect.
3. Biochemical building blocks – proteins, sugars, nucleic acids and lipids.
4. Macromolecular structure.
5. Proteins.
6. Lipid membranes.
7. Heat, energy and entropy – how cells get work done.
8. Thermodynamics and statistical mechanics of biological systems.
9. Two-state models and cooperativity.
10. Random walks and polymers.
11. Elasticity and mechanics of filaments and membranes.
12. Physics of water – fluid dynamics and Navier-Stokes equation.
13. Motion at low Reynold's number.
14. Brownian motion and diffusion in 2 and 3 dimensions.
15. Chemical equilibria and reaction kinetics.
16. Enzyme kinetics and the Michaelis-Menten equation.
17. Crowding effects.
18. In addition to the above topics, we may also take brief "interludes" to learn about computational and experimental techniques in biophysics including
    a. Molecular dynamics simulations
    b. Fluorescence microscopy and super-resolution techniques
    c. Electron microscopy and 3D reconstruction
    d. X-ray crystallography
    e. Single molecule force spectroscopy