PHYS 4714 / 5714 G — (Introduction to) BIOPHYSICS
CRN 87502 / 87547 — Syllabus, fall semester 2018

Instructor: Uwe C. Täuber
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Prerequisites: PHYS 2206 or 2306.

Lectures: Tuesday, Thursday, 9.30 - 10.45 a.m., Robeson 103.
My lecture notes will be available on Canvas.
Questions and discussion in class are always welcome!

Discussion: Monday, 5.15 - 6.00 pm, New Classroom Building 110A;
Friday, 1.30 - 2.15 p.m., Pamplin 1008.

Office hours: Monday, 1.15 - 2.00 pm, Thursday, 11.00 - 11.45 am,
or by (email) appointment.

Homework: Weekly homework problems will be assigned (30 % of final grade),
due on Tuesdays in class. Teamwork is encouraged for solving the
homework assignments, but each student must turn in her/his individual solution. Copying or use of sample solutions is prohibited.
Should you encounter any difficulties, please feel free to ask me (or our GTA) for assistance (during office hours or via email).
Your papers will be graded, and sample solutions provided.

Graduate TA: Guangpu Luo, luogp12@vt.edu, Robeson 104B.

Exams: Midterms: Thursday, Sep. 13 & Oct. 18, 9.30 - 10.45 am.
Final exam: Monday, Dec. 7, 7.45 - 9.45 am (sorry!), comprehensive.
The Virginia Tech undergraduate / graduate honor codes apply to all homework assignments and exams.

Distribution: 30 % homework, 20 % each midterm test, 30 % final exam.

Course content: Selected topics from modern biological physics that range from cellular mechanics and hydrodynamics to biochemical kinetics and population dynamics will be discussed, with emphasis on physical aspects of biological phenomena. The necessary mathematical tools for their modeling and quantitative description will be developed.
Literature: The lectures will draw from the following recommended texts:


Course topics:

1. Introduction

2. Brownian motion, friction, and diffusion
   2.1. Discrete random walks
   2.2. Continuous random walks
   2.3. Stochastic processes, diffusion, and drift
   2.4. Langevin-Einstein theory of Brownian motion
   2.5. Random motion in an external potential, applications

3. Motion in a viscous environment
   3.1. Fluid hydrodynamics
   3.2. Motion at high Reynolds number: swimming and flight
   3.3. Motion at low Reynolds number, laminar flow
   3.4. Metabolic rates and allometric scaling

4. Thermal equilibrium, entropic forces
   4.1. Thermal equilibrium and entropy
   4.2. Temperature, laws of thermodynamics
   4.3. Canonical ensemble and variants
   4.4. Entropic forces

5. Macromolecules and membranes
   5.1. Polymers
   5.2. Biopolymers: DNA, actin, proteins
   5.3. Vesicles, micelles, membranes
6. Chemical kinetics
   6.1. Equilibrium, law of mass action
   6.2. Master equation and mean-field rate equations
   6.3. Polymerization kinetics
   6.4. Enzyme kinetics, Michaelis-Menten rule
   6.5. Correlation effects in diffusion-limited pair annihilation

7. Dynamics of populations and epidemics
   7.1. Birth-death processes
   7.2. Carrying capacity, logistic growth, simple epidemic processes
   7.3. Predator-prey competition and coexistence
   7.4. Dynamics of infectious diseases
   7.5. Pattern formation: Turing mechanism, chemotaxis, flocking

8. Molecular machines, nerve impulses
   8.1. Molecular motors
   8.2. Brownian ratchet engine
   8.3. Ion pumps
   8.4. Nerve impulses
   8.5. Neural networks

Notice: If you require any adaptations or accommodations because of a documented disability, if you need special arrangements in case the building must be evacuated, or if you have any emergency medical information to share with me, please contact me as soon as possible.

Honor code: The Undergraduate Honor Code pledge that each member of the university community agrees to abide by: As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do. Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code. For additional information, please visit www.honorsystem.vt.edu.