

**Tentative topics to be addressed
in PHY615, Biological and Medical Physics, Fall 2007**

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1. Biological thermodynamics

How do transition state rates relate to kinetic models?
What is the difference between equilibrium and nonequilibrium thermodynamics?
What is the relationship between kinetics and thermodynamics?

2. Membrane biophysics, neurophysiology, ion channels, and ion pumps

How do lipid rafts organize and behave in a cell membrane?
How does a membrane protein fold in a hydrophobic environment?
How does a cell membrane function?
How do the biopolymers (DNA, proteins) translocate through protein channels?
How do the thermoreceptors (cold and warm) function?

3. Single-molecule biophysics and biopolymers (molecular biophysics)

Why do we have to study biological processes at the single-molecule level?
How does entropically-driven folding of biopolymers appear in nature?
What are the energetic barriers that must be overcome to unfold a protein, or an RNA molecule?
Why does DNA like to bend, but not to fold?
How do molecular motors function?

4. Cell signaling

How do sensory receptors make electrical signals?
Why is mechanotransduction rapid and direct?
Why is visual transduction slow?
Why and how does vertebrate phototransduction use cyclic GMP?
How do second messengers stimulate ionic transport?
How does pain sensation use transduction channels?
How do we define an excitable cell?

4. Nanobiotechnology and biosensors: Prospects of applied biophysics in nanotechnology

What are the primary aims of nanobiotechnology?
What are the risks of nanobiotechnology?
Why do we have to reduce the experiment to the *lab-on-chip* level?
Why does DNA have to be identified at the single-molecule level?
What is the efficiency of DNA chip arrays to detect pathogens?
Why do we need protein nanoarrays and protein engineering?
What can we learn by using natural and synthetic nanopores?

5. Other Modern Experimental Methods in Biophysical Nanotechnology

How does an atomic force microscope work?
How do the single-molecule tweezers (optic or magnetic) work?
How does a single-molecule fluorescence microscope work?
How does a total internal fluorescence microscope work?

6. Biomedical Imaging and Medical Physics

How do PET, CT, and MRI scanners work?
What do and don't we know about the biological effects of ionizing radiation?
How does the ultrasound imaging work?