

MAT 406 Introduction to Nanoscience
Fall 2009

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Associates: Cem Servantie, İbrahim İnanç, and Ayşe Özlem Aykut contribute to the Discussion classes. Their e-mails are readily available through SU mailing system. Discussion Hours will be arranged in the first week.

Course Data: Time/Place: **T** 11:40-13:30 **L062**; **W** 08:40-09:30 **G015**; **R** 14:40-15:30 **L055**

Textbook:

Dill, K.A., Bromberg, S., and Stigter, D., *Molecular Driving Forces*, Statistical Thermodynamics in Biology. Garland Science, Taylor & Francis Group, 2002. QC311.5 .D55 2002.

References:

Israelachvili, J., *Intermolecular and Surface Forces*, Second ed. Academic Press, 1992.
Rubinstein, M, and Colby, R.H., *Polymer Physics*, Oxford University Press, 2003.
Phillips, R., Kondev, J., and Theriot, J., *Physical Biology of the Cell*, Garland Science, 2008.

Week

Commencing Topics

Sept 28	Introduction to soft-matter physics; Benjamin Franklin Spirit. Chemical equilibria; Le Chatelier's principle; qualitative effect of fluctuations.
Oct 5	Physical kinetics: Forces drive molecules to flow; diffusion controlled processes; biased random walk, <i>genetic drift</i> . (HW 1)
Oct 12	Brownian ratchets, <i>molecular motors</i> ; Onsager reciprocal relations; thermal-electrical effects.
Oct 19	Chemical kinetics: Rates; activated processes and transition state theory; catalysts self-assemble into reactions networks. (HW 2)
Oct 26	Principles of self-assembly-I: Free-energy for solutions and mixtures.
Nov 2	Amphiphiles, surfactants; critical micelle concentration (HW 3); review for the first exam.

First Exam

Nov 9	Coulomb's Law; dielectric constants; polarizability of atoms and molecules; interactions between ions and uncharged molecules.
Nov 16	Electrochemical equilibrium: Potentials in ionic solutions, electrostatic gradients cause ion flows; <i>channels and membrane permeability</i> . (HW 4)
Nov 23	Ions shield charged objects; strong and weak electrolytes, Debye theory.
Nov 30	Kurban Bayrami; colloids and DLVO approach.
Dec 7	Adsorption, binding and catalysis: The Langmuir model, Michaelis-Menten Model and its <i>single-molecule-experiment interpretation</i> . (HW 5)
Dec 14	Polymer solutions; statistics, conformations and difference from small molecules; review for the second exam.

Second Exam

Dec 21	Principles of self-assembly-II: Intra- and intermolecular interactions; aggregation of amphiphilic molecules into micelles; <i>biological membranes</i> . (HW 6)
Dec 28	Soft matter resists confinement and deformation; dynamics of macromolecules in solutions; coarse graining and its limitations.
Jan 4	Introduction to the <i>dynamics of life in the cell</i> (crowded and disordered environments); crowding and reactions.

Class Policies:

Homeworks: There are six different sets, for 30% of the final grade; assigned on Thursdays and must be turned-in the following Thursday. *Term exams:* Two in-class exams, 20% each of the final grade; each borrows heavily from Homework sets. *Final exam:* 30% of the final grade; covers all the material.