Physical Chemistry for the Life Sciences

Course Syllabus

Chem/MBB 381/581
Tuesday/Thursday: 10:30-11:50 AM
Hall Atwater 84
Spring 2016

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Office Hours:
Mukerji: 2:30 – 4:00 pm, Wednesdays, 157 Hall Atwater
If you cannot make the scheduled office hours, I am always available at other times by appointment. I will try to accommodate drop-ins, and students are encouraged to send question or queries at any time by e-mail.

Prerequisites: Chem 141 and 142; Math 117; Chem 251 OR Chem 143 and 144; Math 121; Chem 251
Chem 251 can be taken concurrently.
There are no other prerequisites for this course. Interested, highly motivated students without all prerequisites may be enrolled provisionally with the permission of the instructors.

Course Description:

The course is concerned with the basic physicochemical principles and model systems essential to understanding, explaining, and predicting the behavior of biological systems in terms of molecular forces. PCLS integrates fundamental concepts in thermodynamics, kinetics, and molecular spectroscopy with the structures, functions, and molecular mechanisms of biological processes. The objectives of the course are to (a) familiarize life
science students at the advanced undergraduate and beginning graduate level with basic physico-chemical laws, theories, and concepts important to the life sciences, (b) provide a working knowledge of mathematical methods useful in the life science research, (c) develop a critical perspective on explanation of biological processes and understanding biological systems, and (d) survey the main applications of physical chemistry in the life sciences with an emphasis on spectroscopy and microscopy. Theory, methodology, and biophysical concepts are distributed throughout the course and are presented in the context of case studies including respiration, light harvesting and photosynthesis, ATP hydrolysis, NAD/NADH redox, energy transfer, FRET spectroscopy, with an emphasis on single molecule as well as ensemble experiments and their interpretation.

**Required Text:**

**General References:**

“Physical Chemistry with Applications to the Life Sciences,” D. Eisenberg, D. Crothers, Benjamin/Cummings, Menlo Park, CA, 1979

**Protein Structure references:**


**Homework Assignments:**
Homework assignments are an extremely important aspect of the course and you are expected to complete and turn in all of them. These assignments are designed to supplement and enhance the material being taught in class. Homework assignments will consist of approximately one problem set or response paper per week. In these assignments, you will need to use the textbook and other sources to supplement the material discussed in class.

**Grading and Evaluation:**
Your performance in this course will be evaluated on the basis of your class attendance and participation, homework assignments, your exams.
The percentage breakdown of your grade is the following:

- 3 in-class Exams (@20% each) 60%
- Final project 15%
- Homework assignments: 20%
- Class participation and attendance 5%

**General Classroom Policies:**

Class attendance is required in order to ensure your success in the course. As 25% of your grade is based upon your class participation and the response papers, unexcused absences from class will be reflected in your grade. The use of cell phones is prohibited during class and laptops/ipads should only be used for taking notes.
Course Plan
These are approximate dates and readings for the course. The course plan is subject to change and will be updated throughout the semester.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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| 1/25-1/27  | Introduction of Case Studies and Intermolecular Forces of Biological Molecules  
Energetics of Protein folding  
Kuriyan, Chapter 6 |
| 2/2-2/4    | First law of Thermodynamics, Energy is Conserved  
Tinoco, Chapter 2; Kuriyan, Chapter 6 |
| 2/9-2/11   | Second Law of Thermodynamics, Entropy is Increasing  
Counting Statistics and the Boltzmann Distribution  
Tinoco, Chapter 3; Kuriyan, Chapters 7-8 |
| 2/16-2/18  | Free Energy, Chemical Potential and Chemical Equilibria  
Tinoco, Chapter 4; Kuriyan, Chapters 9-10 |
Tinoco, Chapter 5; Kuriyan, Chapter 8 |
| 3/1        | 1st EXAM                                                             |
| 3/3        | Origins of Quantum Theory, Wave Particle duality  
Tinoco, Chapter 11 (pp. 408-416) |
| 3/22-3/24  | QM calculations, Schrödinger Equation, Particle in a Box, Harmonic Oscillator  
Tinoco, Chapter 11 (pp. 416-430) |
| 3/29-3/31  | Electron distribution, Molecular orbitals, UV-Vis and Fluorescence Spectroscopy  
Tinoco, Chapters 11 (pp. 436-442); Chapter 12 (pp. 453-466); Chapter 13 (pp. 489-520) |
| 4/5        | Spectroscopy (cont'd)                                               |
| 4/7        | 2nd EXAM                                                            |
| 4/12-4/14  | Rates of Chemical Reactions and Molecular Processes  
Tinoco, Chapter 9; Kuriyan, Chapter 15 |
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<th>Date</th>
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<tbody>
<tr>
<td>4/19-4/21</td>
<td>Transition State Theory, e-transfer reactions</td>
<td>Tinoco, Chapter 9; Kuriyan, Chapter 15</td>
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<td>4/26-4/28</td>
<td>Enzyme Kinetics, Michaelis-Menten, Inhibitors</td>
<td>Tinoco, 10; Kuriyan, Chapter 16</td>
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<td>5/3</td>
<td>3rd EXAM</td>
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