

## **BASIC INFO AND SYLLABUS (2011)**

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**ADMIN. ASSIST.:** Tanya Lichtenstein: NSB 4-103, [tlichten@ucsd.edu](mailto:tlichten@ucsd.edu)

**WHERE & WHEN:** York 4080-A; Tue/Thu 8:00-9:20 a.m.

### **COURSE GOALS**

Gain a basic understanding of the principles of transmission electron microscopy (TEM) and three-dimensional (3D) image reconstruction as applied primarily to the study of biological macromolecules, macromolecular complexes, and small organelles and cells. Knowledge of these principles form a foundation for those who may be interested in obtaining practical experience and training in TEM and 3D reconstruction. Even if you never record a TEM image or compute a 3D reconstruction, the course should help broaden your knowledge about powerful and rapidly evolving tools of structural biology and enable you to critically evaluate research results, as reported in the scientific literature, that rely on the use of these technologies.

### **COURSE FORMAT**

1. 80-minute lectures on Tuesdays and Thursdays (8:00-9:20am) from Jan 4 through Mar 10.
2. One or two optional lab demos *might* be offered outside of the normal class period (e.g. to tour a modern TEM facility) and will provide a means to earn some extra credit.

### **GRADING (Read Very Carefully)**

**Undergraduate students:** There will be two midterms (150 points each) and a final exam (300 points). The final grade will be based on an unweighted sum of the two midterms plus the final exam and points awarded for use of your *i-Clicker* remote (see below). There are **no make-up exams** but each student will be given a choice while taking the final exam to have one of the midterms dropped and have the final grade based on an unweighted average of one midterm plus the final plus *i-Clicker* participation points. This means that there are **no make-up exams** and, if for ANY reason a student misses a midterm exam, his or her grade will be based on the one midterm taken plus the final along with any *i-Clicker* points earned.

**Graduate students** (those taking CHEM 265 or BGGN 262): The rules are essentially the same as for undergraduates except that your grade **MUST** include both midterms in addition to the final and *i-clicker* points. You do have the option to replace one of the midterm exam grades by submitting a term paper (150 points), which involves critiquing a peer-reviewed publication concerning (1) a 3D image reconstruction study of a specific biological specimen, **or** (2) a development in the methodology of cryo-electron microscopy, cryo-electron tomography, or 3D image reconstruction. The article must have been published in 2009, 2010, or 2011. A list of acceptable publications and more details about this assignment will be provided at a later date. Each student must get approval from me for his or her choice before the term paper is written.

**Use of *i-Clickers*:** This device is used to enhance the learning experience and to reward participation and good study habits. Points will be awarded both for participation and for providing correct responses to questions. The final course grade will include a total of 32 participation points. To obtain maximum credit, you will receive two points for each of the last 16 class lectures in which you answer a question, regardless of whether your answer is correct. Bonus points will be awarded on occasion for submitting correct responses to some questions. For notes on how to register your *i-Clicker*, see the last page of this Syllabus.

### **CLASS HANDOUTS AND OTHER MATERIALS**

Course reading material is posted at <http://cryoem.ucsd.edu>. Access to this and additional material requires a username and password provided during the first class meeting. Lecture notes include most of the illustrations that will be shown as PowerPoint presentations. Having access to this should minimize the need for frantic note taking and allow you to listen carefully and concentrate more on understanding the basic principles being presented.

Lecture notes, PowerPoint slides, optional homework, and other supplementary materials (e.g. book and reading lists) are available as PDF documents to solidify your understanding of the topics being discussed. The lecture notes and selected literature articles are **required** reading because it is impossible to cover materials in adequate depth during lectures alone.

**SYLLABUS (Tentative Schedule)**

Date(s)	Lec #	Topic(s)
Jan 4	1	Course introduction; Analogy between light and transmission electron microscopy
Jan 6	2	Electrons/waves/interference/resolution
Jan 11	3	Optics and electromagnetic lenses
Jan 13	4	Design of the TEM and lens aberrations (Top to bottom description of instrument)
Jan 18	5	Design of the TEM and lens aberrations (Continued)
Jan 20	6	Contrast and image formation (electron scattering)
<b>Jan 21</b>		<b>Help session for first midterm exam</b>
<b>Jan 25</b>		<b>Midterm Exam #1 (150pts) – Covers material through Jan 20 lecture</b>
Jan 27	7	Basics of TEM alignment, performance, operation, and image recording (film/CCD)
		Other modes of TEM operation – self taught from reading material (pp.119-139)
Feb 1	8	Overview of biological specimen preparation methods
Feb 3	9	Radiation effects; Introduction to image analysis; Sources of noise
Feb 8	10	Crystals, symmetry and diffraction
Feb 10	11	Crystals, symmetry and diffraction (Continued)
Feb 15	12	Fourier processing techniques
Feb 17	13	Fourier processing techniques (Continued)
<b>Feb 18</b>		<b>Help session for second midterm exam</b>
<b>Feb 22</b>		<b>Midterm Exam #2 (150pts) – Covers material through Feb 17 lecture</b>
Feb 24	14	Principles of 3D image reconstruction
Mar 1	15	3D reconstruction of thin 2D crystals and helical assemblies
Mar 3	16	3D reconstruction of macromolecular complexes with icosahedral symmetry
Mar 8	17	3D reconstruction of macromolecular complexes with no symmetry
Mar 10	18	Electron cryo-tomography of unique specimens, organelles, and cells
<b>Mar 10</b>		<b>Publication critiques due by 5pm for CHM 265 and BGGN 262 students</b>
<b>Mar 17</b>		<b>FINAL EXAM (300pts) – All inclusive, but focuses on 2nd half of course</b>

**OFFICE HOURS:** Tuesday and Thursday 9:30-10:30am; NSB 4-105

Call or email Tim Baker or Tanya Lichtenstein for appointments at different times.

### **READ THIS VERY CAREFULLY**

- Lectures begin **promptly** at 8:00 a.m. and end as close to 9:20 a.m. as possible to maximize the learning experience of all participants. As you will see, the time allotted to cover many new concepts is very limited. Being seated and ready to proceed at 8 a.m. sharp will minimize disruptions and be appreciated by all. As an added incentive to those who show up on time, classes will often be preceded by or begin with a multiple choice, *i-clicker* question that may well appear verbatim or in slightly modified form on a graded exam. These sample questions may also be presented at any time during a lecture, **BUT** they will **NOT** be posted on the web site.
- Come to class well prepared. For example, complete any assigned reading and be ready with questions, especially if something from a previous lecture or in the class notes needs clarification. An extensive set of practice homework questions will be posted on the web and updated regularly. These questions will often mimic the same type that will appear on exams. Students who take the time to do these problems **regularly** (*i.e.* not wait until right before an exam) will definitely be better prepared for lectures, *i-clicker* questions, and exams.
- All **cell phones, iPods, cameras, etc. should be turned off** during class.

**Registration of *i-clicker* remote:**

You are required to purchase an *i-clicker* remote for in-class participation. *i-clicker* is a response system that allows you to respond to questions that I pose during class; you will be graded on that feedback and/or participation. Each clicker has a unique serial number on the back of the remote. Place a piece of scotch tape over that bar code and ID to preserve it.

In order to receive credit for your votes, you will need to register your *i-clicker* remote in class or online as explained below. The *i-clicker* response system will be used every day in class, and you are responsible for bringing your remote for each class (exams excluded).

**FOR ROLL CALL/IN CLASS REGISTRATION:**

I will project a Registration screen with 3 steps to follow (look for your student ID, which will alphabetically scroll down the screen). Once your remote is registered, your student ID will no longer appear on that scrolling list and you are registered for the entire term. If for some reason you can't follow these steps, please register on the Web or come see me or my assistant, Tanya Lichtenstein (NSB 4-103).

**FOR WEB REGISTRATION:**

You must have come to class at least once and voted on at least one question, in order to complete this registration properly. Once you have voted on a question in my class, go to [www.iclicker.com/registration](http://www.iclicker.com/registration). Complete the fields with your first name, last name, student ID, and remote ID. Your student ID should be the ID assigned to you by UCSD. The remote ID is the series of numbers and sometimes letters found on the bottom of the back of your *i-clicker* remote.