

## MABB 475/575: Molecular **Biology of Cells**

Allan Caplan (e-mail: [acaplan@uidaho.edu](mailto:acaplan@uidaho.edu)) (TEL: 885-9441)

Textbook: Molecular Cell Biology (Lodish, Berk, Kaiser, Krieger, Scott, Bretscher, Ploegh, and Matsudaira, 2008.) I would encourage you to use the electronic version, if possible, since it is easier to search, and comes with great graphic features.

**Prerequisites:** Biology 115 (or equivalent) **and** 300-level course in biochemistry, **or** permission of instructor.

- Students entering this class are expected to know the fundamental molecular processes that were taught in introductory biology, genetics, and microbiology courses. These include, but are not limited to, replication, transcription, and translation. **These topics will not be reviewed in this class.** If you do not know the basic descriptive terms, substrates, products, and enzymes involved in each as they apply to eukaryotes, you are responsible for reading those sections of the textbook that cover them.

**Course format:** This course is intended to provide students with a survey of topics in cellular biology. Attention will be focused on learning the identity, location, and properties of molecules involved in cell locomotion, nutrient uptake, membrane excitation, intracellular communication, and several representative signal transduction processes that operate post-translationally. Special attention will be given to oncogenes and anti-oncogenes that regulate and restrict cell growth.

 **Class will meet in TLC 249.**

### **Role of the textbook/ ebook in this course:**

The textbook is an indispensable part of the course.

Those who have looked at it have seen that it is truly encyclopedic and contains enough material for two classes. Rather than trying to speed through everything, I have chosen to cover a few topics at a

more leisurely pace. You will note, though, that these topics will not be presented in the order that they are given in the book. Because of this, you may need to read some of the previous pages (OR, ASK ME QUESTIONS IN CLASS) in order to appreciate those topics that we are going to discuss.

- Always keep in mind that **the lectures are not intended to duplicate the text, but rather complement it.**

**Testing:** There will be 3 in-class exams (2 midterm, 1 final) as well as 4-6 quizzes announced 1 week before hand. Students will be held responsible for any information given in lecture, *or* in the assigned pages of the text, *or* in handouts. Examinations will primarily require short answers. Students in MMBB 575 will have extra questions on each test.

- Depending on the pace of the course and on enrollment numbers, students in MMBB 575 may also have to prepare and present a 30 min. summary and analysis of a topic on cell biology chosen from a list to be distributed later.

**In case you missed this plea, *Please* ask questions during lecture as soon as they arise. They will not only help you, but help me determine how I delivered and how you perceived the information.**

**Projected schedule of topics** (Please note: The dates below are targets. They may be adjusted to ensure that the majority of information presented is understood by the majority of the students. While the particular date of the lecture may be altered, students will be responsible for completing the reading assignments as listed below.)

## **Cells in isolation**

### 1. 13 January

Introduction to the cell (These pages are based on the printed text; please point out any problems you might have finding these on line. Text Pgs: 1-30; 371-394)

***(This course will concentrate on the morphological and biochemical features that are common to all cell types, and introduce a few of the special properties found in some cells of multicellular organisms).***

- a. Introduction to the diversity of cell shapes, polarity and cortical patterning, and to the roles of special cells in multicellular organisms.
- b. Introduction to the structural architecture of cells, and to the internal divisions with cells.
- c. The cell cycle and development.

### 2. 20 January

Chemical components of cells (Text Pgs: 31-49; 409-434)

***(The orderly development of the organism arises from an energetically costly reduction in disorder at the molecular level.)***

- a. Structure of water, interactions of water and hydrophilic and hydrophobic substances, partitioning processes of small molecules in solution (with special attention to fatty acids).
- b. Membrane structure, heterogeneity, and fluidity.

### 3. 25 January

Protein architecture and folding (Text Pgs: )

***(The chemical properties of proteins allow them to stick to themselves via specific domains.)***

- a. Classes of macromolecules.
- b. Proteins.
- c. Spontaneous folding vs. Chaperone-assembly processes.

4. 27 January

Self-assembly processes and dynamic equilibria (Text Pgs: 757-798; review article by Misteli (The Journal of Cell Biology, Volume 155,181-186))

***(Interactions between specific domains of proteins can lead to ordered macromolecular structures arising from disordered solutions of subunits.)***

- a. Self-assembly as typified by virus assembly.
- b. Microtubule assembly as an example of directed and regulated assembly.

5. 1 February

Cell growth in tissue culture (Text Pgs: 371-404; 407-408; 801-838.)

***(The maintenance of a living cell depends on continually importing and exporting molecules from one location to another.)***

- a. Prerequisites for growth and division of cells in tissue culture.
- b. Anchorage-dependent growth, contact inhibition, and immortality.

6. 3 February

Cell migration and the cytoskeleton (Text Pgs: 713-756)

***(Actin filaments provide an internal skeleton while myosin provides a motor that helps cells pull their bulk along from place to place.)***

- a. Introduction to actin and myosin.
- b. Architecture of the cytoskeleton.

c. Cell attachment and movement.

7. 8 February

Cell migration continued (Text Pgs 623-664; 684-697; 801-838:)

**(Cell movement requires signaling processes to coordinate different molecular machines.)**

- a. Varied roles of calcium in regulating polymerization processes.
- b. Myosin can act as a molecular motor.

8. 10 February

Molecular Motors (Text Pgs: 585-591)

SPECIAL LECTURE FROM DOUG COLE (MMBB)

- a. Molecular motors.
- b. Kinesins and dyneins.
- c. Moving cargo to the extremes of the cell.

9. 17 February

THERE WILL BE A SHORT QUIZ ON 13 FEBRUARY ON THE READINGS FROM 3-10 FEBRUARY.

Membrane transport and the acquisition of water (Text Pgs: 437-474.)

**(The process of importing water and carbon sources achieves high selectivity through the use of successive molecular sieves and screens.)**

- a. Introduction to the uptake of water and ions.
- b. Basics of membrane transport.

10. 22 February

FIRST EXAM COVERING ALL LECTURES AND READINGS UP TO AND INCLUDING THE 17<sup>TH</sup> OF FEBRUARY.

## **Molecular processes associated with specialized cells.**

11. 24 February

Properties of transporters (Text Pgs: 437-474.)

***(Different cells employ a variety of channels and pumps to obtain and retain critical molecules.)***

- a. Moving molecules against a gradient.
- b. Structure and regulation of glut1.
- c. ATP as an allosteric regulator.
- d. ATP hydrolysis as a way to make reactions irreversible.

12. 1 March (Text Pgs: 437-474.)

Coupled transport processes.

***(The uptake of rate-limiting nutrients often requires coupling uptake either to the import or the export of specific inorganic salts.)***

- a. Symporters and antiporters.
- b. Priming pumps through the hydrolysis of ATP

13. 3 March (Text Pgs: 437-474.)

Electrically-excitable membranes

***(The asymmetrical flow of ions creates a membrane potential.)***

- a. Introduction to the electrochemical gradients and membrane potential of cells.
- b. Ionophores.
- c. Specialized structure of neurons.

14. 8 March (Text Pgs: 586-95; 640-645; 1001-1039.)

Generation of action potentials

***(Neurons can rapidly change the electrical charge on their membranes. This change can release a chemical signal to adjacent cells to trigger an analogous change there.)***

- a. Action potentials.
- b. Neurotransmitters and their receptors.

15. 10 March (Text Pgs: 586-95; 640-645; 1001-1039.)  
Chemical events at the synapse

***(Cells can communicate with other cells through the release and perception of unique chemical signals.)***

- a. Synapses and neuromuscular junctions.
- b. Modulating nerve conduction.

16. 15 and 17 March  
BREAK

17. 22 March (Text Pgs: 1001-1039.)  
Muscle cell contraction and relaxation

***(Changes in  $Ca^{+2}$  levels trigger coordinated contraction of muscle cells.)***

- a. Arrangement of actin and myosin in specialized cells.
- b. Membrane depolarization and the release of  $Ca^{+2}$ .

18. 24 March

SECOND EXAM COVERING ALL LECTURES AND READINGS ON  
MEMBRANES TRANSPORT AND NEURON/ MUSCLE CELL  
BIOLOGY.

19. 29 March  
Introduction to the cell cycle (Text Pgs: 86-92; 847-891; 903-904.)

***(Cell division is conditional on the orderly completion of a defined set of biochemical pathways.)***

- a. Marking events in the cell cycle of *Saccharomyces*.
- b. Isolation of mutants.
- c. Cyclins and CDC kinases.

20. 31 March

Kinase/ phosphatase control over cell cycles; comparison of the yeast and mammalian cycles. (Text Pgs: 623-627; 847-863; 872-892; 903-904.)

***(Each step in the cell cycle is monitored for completion and checked for errors by redundant cell sensors.)***

- a. Check points.
- b. Contrasts between the yeast and mammalian cell cycle.

21. 5 April

Introduction to the cellular phenomenon of cancer (Text Pgs: 936-947; 1107-1135; 1136-1143.)

**(The loss of checkpoint constraints leads to excessive proliferation.)**

- a. Properties of transformed cells in vitro and in vivo.
- b. Invasiveness.
- c. Oncogenes and anti-oncogenes.

22. 7 April

I will be deciding later in the course how the remaining lectures will be done. I may give them, or I may ask graduate students to do these. We will discuss this during the course.