Spring 2-1-2017

BIOB 425.01: Advanced Cell & Molecular Biology

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Biology 425 (BIOB 425)
Advanced Cell & Molecular Biology
CRN 31562, Spring Term 2017

Lectures: MWF 1:10-2:00 p.m.; Health Science 411.

Web Page: Course Handouts and Messages will be posted on Moodle.

Instructor: Dr. Jesse C. Hay
e-mail: jesse.hay@umontana.edu
Office Hours: Mon. 2-4 p.m. and by appt.
Office: Skaggs #390A (New Addition).
Research Lab: Skaggs #385

Course Text: *Molecular Cell Biology,* Seventh Edition, by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, and Matthew P. Scott, published by W.H Freeman and Company. **Available at the University of Montana Bookstore.**

Coursepack: available at the University of Montana Bookstore.

BIOLOGY 425
LECTURE SYLLABUS

Day	Date	Topic	Readings
M	1/23	Introduction to Class, start Methods	******
W	1/25	Methods I: Cells	1-22; 397-404; 424-430
F	1/27	Methods II: Microscopy and Biochemistry	93-106; 404-424
M	1/30	Methods III: Genetics and Genomics	171-182; 198-206; 212-219; 252-256
W	2/1	finish methods lectures	-------
F	2/3	Protein Conformation Regulates Cell Events	59-92
M	2/6	Protein Conformation (cont.)	-------
W	2/8	Membrane Structure and Function	443-470
F	2/10	Membranes (cont.)	-------
M	2/13	Transporters	473-494
W	2/15	Regulation of the Cellular Ionic Environment*	495-511
F	2/17	Posttransl. Protein Transport into Organelles	601-614
M	2/20	President's Day, no class	-------
W	2/22	Posttransl. Transport (cont.)	-------
F	2/24	**Exam I (65 pts.)**	-------
M	2/27	Transport Across the Nuclear Envelope	615-622
W	3/1	Cotranslational Protein Transport into the ER	579-594
F	3/3	Transport into ER (cont.)	-------
M	3/6	ER/Golgi Posttranslational Modifications	594-601; 644; 651-652
W	3/8	and Quality Control	-------
F	3/10	Vesicle Formation & Cargo Sorting	627-637
M	3/13	Vesicle Targeting and Fusion*	638-650
W	3/15	Cytoskeleton I: Actin Dynamics, Muscle	773-815
F	3/17	**Exam II (65 pts.)**	-------
M	3/20	Spring Break; no class	-------
W	3/22	Spring Break; no class	-------
F	3/24	Spring Break; no class	-------
M	3/27	Actin Dynamics (cont.)	-------
W	3/29	Cytoskeleton II: Microtubules, Motors, Mitosis	821-859
F	3/31	Cytoskeleton III: Intermediate Filaments	860-867

M	4/3	Cell Signaling Pathways	673-713; 721-768
W	4/5	Cell signaling (cont.)	-------
F	4/7	Cell Cycle I	873-889
M	4/10	Cell Cycle II	890-913
W	4/12	Cell Cycle (cont.)*	-------
F	4/14	**Exam III (65 pts.)**	-------
M	4/17	Apoptosis	1006-1017
W	4/19	Mechanisms of Cancer I	1113-1130
F	4/21	Mechanisms of Cancer II	1131-1150
M	4/24	Extracellular Matrix and Cell Adhesion I	925-945
W	4/26	Extracellular Matrix and Cell Adhesion II	945-967
F	4/28	ECM (cont)	-------
M	5/1	Regulated Protein Degradation	661-666
W	5/3	Nerve Cells and Action Potentials	1019-1047
F	5/5	Cellular Basis of Learning and Memory*	-------
M,W,F	5/8-5/12	Finals Week, no class	-------
Th	5/11	**Final Exam (140 pts); 3:20-5:20 p.m.**	-------

*end of material for next exam

COURSE POLICIES

Course Structure

Biob. 425 is designed as an advanced course in Cell Biology for students majoring in the life sciences. To fully absorb the material, it is important that you meet the suggested prerequisites for the course. Some knowledge of both molecular biology and genetics will be assumed. Thus, it is especially important to have previously completed coursework in these areas. It is recommended, but not required, that coursework in biochemistry be taken before or concurrently with this course. Whether you have had the prerequisites or not, if you feel that you are deficient in molecular biology, biochemistry or genetics, be sure you have access to good textbooks to use as background references.

Lecture Format

There are 3 lectures each week, given on Mon., Wed., Fri. from 1:10-2:00 p.m. in Health Sciences 411. The lectures are mandatory; you must attend the lectures. *It is important that you do not miss lectures, since lectures will often contain information or examples that are not covered in the readings.*

Exam Policy

Exam questions will be based primarily on the material covered in lectures. The final exam will contain a section covering the last block of new material in detail, as well as a cumulative section covering the whole semester.

Problem Sets

There will be a problem set distributed approximately one week in advance of each exam (4 total). These will provide practice for the more difficult types of questions that could appear on an exam, although there is no guarantee that the same precise topics are covered on the problem sets and exams. Students are welcome to work together and to seek the instructor's advice on the problem sets. Problem sets are due at the start of the exam.

Writing Assignment

This course includes one written paper of <u>at least five pages</u> exclusive of references and figures. The paper will consist of a critical review of current primary research literature and scientific (i.e. not political or social) discoveries/controversies surrounding the cell biology of a disease (human, animal, or plant). A detailed description of the assignment, including content and format requirements, will be distributed at the beginning of the semester. It is hoped that the assignment will help students achieve the following writing goals: 1) identification of sophisticated questions for inquiry; 2) synthesis of information from multiple sources; 3) presentation of multiple perspectives and interpretations; 4) learn appropriate citation and documentation practices for cell biology, and; 5) competence in searching the appropriate electronic databases. <u>A complete draft of the paper, including the appropriate, correctly formatted references, will be due at the start of Spring Break. In addition to the paper, students will turn in results from electronic searches documenting that the relevant literature database(s) was queried with appropriate search terms.</u>

GRADING

Problem Sets	**80 pts.**	**4 X 20 pts. (due the lecture preceding each exam)**		
Written Paper	**85 pts.**	**(draft due beginning of Spring Break; final by last day of class)**		
Exam 1	**65 pts.**	**Friday**	**Febr. 24**	**1:10-2:00 p.m.**
Exam 2	**65 pts.**	**Friday**	**March 17**	**1:10-2:00 p.m.**
Exam 3	**65 pts.**	**Friday**	**April 14**	**1:10-2:00 p.m.**
Final Exam	**140 pts.**	**Thursday**	**May 11**	**3:20-5:20 p.m.**
TOTAL	**500 pts.**			

All students are expected to take the exams at the scheduled time. If, however, you feel that you are near death and cannot make an exam, you will be allowed to take a make-up exam ONLY IF YOU CAN PROVIDE A NOTE FROM A CERTIFIED M.D. to that effect. Other emergencies will be considered on a case by case basis. **IN ALL CASES, YOU MUST CONTACT DR. HAY IN ADVANCE OF THE EXAM.** If you are unable to call, a family member or friend should call instead. If you miss an exam without making any prearrangements, you will receive 0 points for that exam. The dates for all exams are listed above. You have no excuse for not knowing when the exams are scheduled or for leaving before the scheduled final at the end of the semester. To preserve the academic integrity of the course, we reserve the right to alter the content and/or format of the original exam when creating a make-up exam. Make-up final exams will be oral.

Individual exam scores will not be curved in this class. Letter grades will be assigned after the semester has been completed, based on the total points accumulated. Adjustments will be made at that time, if necessary. Cutoffs will be no higher than 450 pts. (90%) for A-, 400 pts. (80%) for B-, 350 pts. (70%) for C-, and 300 pts. (60%) for D-.

GRADUATE CREDIT

Students may receive graduate credit by completing an additional writing assignment. This will involve reading primary research articles, identifying a current gap in our knowledge of cellular processes (or controversial model), and providing a synthesis of recent attempts and future directions to address it experimentally. Detailed instructions will be given for this assignment following Spring Break.

Academic Conduct

As you proceed through this course you may at times feel the pressure of course work, exams, and assignments. So much to do, and so little time! If you seriously fall behind in your work, you should talk to Dr. Hay. He will try to be sensitive to your individual problems, but to be fair to all students, he will enforce deadlines and grade your performance by standards that apply to everyone.

Whatever happens, don't be tempted to cheat; it's not worth it, and the penalties are very severe. If we believe that you have been dishonest on an exam, we reserve the right to award you 0 pts. for that exam. At this stage in your career, suspension and/or failing grades may significantly affect your chances of being able to graduate on schedule.

Students with Disabilities

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you have a disability that adversely affects your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

Advice on Mastering the Material in Cell Biology

1. Exam questions are based on the lectures. The readings are intended to supplement your understanding and provide additional examples. However, your lecture notes should always be the priority when studying for an exam. If you want to succeed, you must attend the lectures and take complete notes!

2. Review and outline your notes as soon as possible after lecture. Don't just read your notes. Cognitive science has shown that writing, for example, outlining your notes, is an important step in the learning process for most people.

3. Keep up with the class. Don't wait until just before the exam to master all the material! If you find yourself having difficulty with the material DO NOT WAIT until you have problems with the first exam before coming in for help. This is what office hours are for - to clarify material covered in the course.

4. Make use of all the resources available to you. There are many biochemistry, genetics, molecular biology, and other cell biology texts in the library that may serve as good references for you. Make use of office hours. Dr. Hay will also answer concise questions submitted by e mail.

5. It is very helpful for students to form a STUDY GROUP with whom you can meet to discuss the material in the course. Past experience indicates that these groups work best when they are relatively small (2-4 people). This allows everyone in the group to talk about the material. They are most helpful when the group meets on a regular basis (at least once a week - not just before exams

Guidelines for Preparing for the Exams

1. The best way to prepare for the exams is to keep up with the material as we go. Don't wait until just before the exam to read the textbook and go over your notes!!

2. Discuss the material regularly with a study group of 2-4 classmates. Talk about the information presented in lectures.

3. Make use of office hours to help you understand the difficult topics. If you have brief questions, use e-mail.

4. The exams will test your understanding of the material in three ways:

- Factual Recall: Do you understands the facts presented? These are the "regurgitation" questions - they require relatively straightforward answers.

- Concepts: These questions expect you to put several facts together into a concept you have already been introduced to in lecture. They test your understanding of how components fit together. They may be questions about models or mechanisms or processes (simple and complex).

- Application: These questions will test your ability to apply the information from lecture to real data examples. These are "story problems" that you will have to reason through. You may be asked to interpret a graph, propose an experiment, or explain some results. In each case, the necessary information will have been presented in lecture or discussion, but you must apply it to this new situation.

5. **Concentrate on the lecture notes, since *only material covered in lecture will be on exams.*** Use the textbook or other assigned readings as needed to provide further clarification of the material. Keep in mind that *certain information presented in lecture will not be found in the reading*. **Don't just memorize the information - make sure you <u>understand</u> it!!**

Expected Learning Outcomes for Biob 425

1. Students should understand the experimental basis from which modern cell biological knowledge comes; this includes being able to interpret experiments and evaluate conclusions from studies using:
    a. Tissue culture (primary and clonal)
    b. Antibodies as specific probes for cellular components using several distinct protocols
    c. Recombinant gene expression studies and gene knockout and knockdown approaches
    d. Light and electron microscopy
    e. Protein purification and analysis
    f. Genetic analysis including epistasis experiments for ordering gene pathways
    g. Basic genomic algorithms and tools for predicting gene function
2. Students should understand the fundamentals of protein structure and how cellular stimuli regulate the activity of proteins. They should be able to describe example mechanisms for how posttranslational events like phosphorylation or GTP binding and hydrolysis translate into altered protein activity. Students should also be able to recognize a number of conserved protein domains and their functions.
3. Students should understand the makeup of cellular membranes throughout the cell; this includes phospholipid asymmetries between cytosolic and extracytosolic leaflets, the abundances of different lipids in different organelles, and the location of synthesis of the major lipid species. Students will also need to understand the different types of membrane proteins, their mechanisms of associations with membranes, and their mechanisms of constraint and micro-localization within membranes.
4. Students should understand how the cell regulates transport across its membranes. This will include knowledge of the major groups and biochemical mechanisms of membrane transporters, ion pumps and channels. It will also include knowing the major ionic equilibria and approximate ion concentrations in cellular compartments.
5. Students should have extensive and detailed knowledge of how proteins become targeted to cellular compartments. This includes mechanisms that occur co-translationally (proteins of the endomembrane system) as well as posttranlationally (mitochondrial, peroxisomal, chloroplast and nuclear proteins). They will also know the primary sequence of localization signals within proteins and how they are interpreted and effected by the targeting machinery.
6. Students should understand the details of protein trafficking within the endomembrane system, once a protein enters this system (see goal 5). This will include understanding and knowing the major examples of transport vesicle coats, cargo recognition and sorting mechanisms, and vesicle targeting and fusion. The students will be able to generalize these mechanisms to specific transport steps of physiological or medical importance such as the uptake of cholesterol via receptor mediated endocytosis, etc.
7. Students should understand the major posttranslational modifications and how protein quality control is maintained. This will involve knowing several pathways, for example the unfolded protein response, autophagy, and ubiquitin-mediated proteasomal activation, for the regulated degradation of inappropriate proteins.
8. Students will know the basic functions, mechanisms of synthesis and regulation, and structural characteristics of cytoskeletal elements, including microfilaments, intermediate filaments and microtubules. This will include understanding at a molecular level the process of treadmilling, branching, dynamic instability and other regulatory phenomena. Students will also know the

major cytoskeletal regulatory proteins and how they control muscle contraction, mitosis, cytokinesis and other cellular transformations. The students will also know the major classes of cytoskeletal motors and which movements and transport events they regulate and how.

9. The students should understand the cell division cycle and its regulation. This will include understanding the historical elucidation of maturation promoting factor and our current molecular understanding of these kinase complexes, their targets, and how they effect cellular events. Students will know about many cell cycle regulators and be able to predict the effects of changes in their activities on rates of cell division and potential roles in cancer.
10. Students will know the major pathways of cell signaling originating from ligand binding by cell surface receptors. This will include tyrosine kinase and G-protein coupled receptors and their entire signaling cascades, second messenger systems, scaffolds and cellular effects.
11. Students will understand the cellular and genetic basis of cancer. This will include understanding the different types of mutations that accumulate in cancer and how they promote cell mitogenesis, tumor production or invasiveness. Common cellular modifications observed in cancer, such as GTPase deficient Ras, should be learned. Students should be able to predict whether a given mutation or modification would have oncogenic vs. tumor suppressor characteristics.
12. Students will learn the major pathways leading to and inhibiting programmed cell death, or apoptosis, and understanding the integration of these pathways with oncogenic and tumor suppressor effects in cancer.
13. Students will know in detail the structure of the extracellular matrix and how it contributes to cell migration, tissue formation, and human disease.
14. Students will know the basic anatomy of neurons, propagation of action potentials, and formation of neuronal signaling circuits. The students should be able to successfully integrate this neuron-specific information into a cutting edge model of learning and memory at the cellular level in *Aplysia californica* that incorporates many of the cell biological concepts learned throughout the semester.
15. The students should be able to write a paper reviewing current research on the cell biology of a disease, incorporating scientific concepts from class that:
    a. Identifies a sophisticated question for inquiry
    b. Synthesizes information from multiple sources
    c. Presents multiple perspectives and interpretations
    d. Demonstrates appropriate citation and documentation practices for cell biology
    e. Demonstrates competence in searching the appropriate electronic databases