Biology 265 Bevington
Cell Physiology Spring Term, 2006

COURSE SYLLABUS

Text: Alberts, B. et al. 2002. Molecular Biology of the Cell. Garland Publishing Co., New York. Fourth Edition.

Course Objectives:

The course will examine the structural elements of cells and their physiological functions. Both procaryotic and eucaryotic cells will be studied, but the emphasis will be on eucaryotic ones. Molecular interactions between complex molecules will be studied as a way to understand the cellular relationships between structure and function.

Considerable attention will be given to cell membranes, especially their roles in transport phenomena, cell-to-cell signaling, and protein targeting processes. Basic features of intermediate metabolism and metabolic control will be covered, particularly those pathways which cells use to derive energy. Genetic mechanisms to be studied include the basic elements of gene structure and control in procaryotes and eucaryotes. The cell cycle and its control will be examined, and some time will be devoted to cancer cells where control of the cell cycle has been lost.

The laboratory will emphasize techniques and methodology in cell biology. Since the accurate interpretation of data presupposes a firm understanding of how the data were acquired, it is hoped that you will develop an interest in the techniques and procedures we use in the laboratory. You should understand not only the theory behind the experiments but also principles underlying the protocols. In science, the methods one uses are as important as the results one observes.

Prerequisites:

Chemistry 113 and 114; Biology 112 and/or 119.

About the text:

Reading assignments will cover about half of the textbook. In addition to its use in this course the text should be an good reference for other biology courses. From time to time the instructor will provide handouts and copies of recent journal articles to supplement certain lecture topics. Handouts and especially the articles from the literature should be considered as important as the reading assignments from the text.

Grading:

Item	Point Value	Percentage of Final Grade
Three hour exams (160 points each)	480	48%
Four lab quizzes (65 points each)	260	26%
One final exam (comprehensive)	260	26%
	1000	100%

LECTURE SEQUENCE[1]

Introduction: scope and objectives of the course

A brief review of cell structure

Fractionation of cellular organelles

Molecules in cells

- Chemical bonds and molecular interactions
- Important characteristics of water
- The major classes of small molecules (sugars, amino acids, fatty acids, and nucleotides)
- Nucleic acids
- Proteins
  - Structure
  - Protein functions and factors which affect function
  - Assembly and turnover
- Enzymes: kinetics and factors affecting catalytic action
- Lipids and carbohydrates*

How cells synthesize proteins

- Basic mechanisms of the process
- RNA synthesis, RNA processing, RNA export from the nucleus
- Molecular chaperones and protein folding
- Ubiquitin, proteasomes, and protein destruction
- Transcriptional control of gene expression
- Posttranscriptional control

Methods used by the cell biologist

- Isolation and characterization of macromolecules*
- Radioisotopes in cell biology
- Cell and tissue culture[2]
- Recombinant DNA technology*

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1. Because of time limitations, the topics marked with asterisks (*) may not be covered in lecture. However, these are important and you should plan to complete the reading assignments about them in the text. They will be included on exams.

2. Cell and tissue culture techniques will be covered in the laboratory during the week of 14 February. Experiments will be monitored over the next 8 weeks.

Cell growth and control of the cell cycle

The mechanics of cell division*

Cancer cells and loss of control of the cell cycle

Cellular membranes

- Architecture
- Cell junctions*
- Transport phenomena

Cellular compartmentalization and protein sorting:

- How are proteins targeted to and from the nucleus, mitochondria, chloroplasts, and peroxisomes?

Endoplasmic reticulum

- Signal hypothesis and the role of SRPs in directing proteins to the ER
- Vectorial transport of proteins into the ER lumen
- Protein glycosylation
- How the ER deals with improperly folded proteins
- Synthesis of membrane lipids

Vesicular traffic: How do vesicles arrive at the correct destination in the cell?

The Golgi complex

- Structure and origin
- Posttranslational modification of secretory, membrane, and glycoproteins
- Sorting, packaging, and targeting of proteins from the Golgi

Lysosomes and cellular digestion

Receptor-mediated endocytosis

Exocytosis and secretion

Cell signaling

- General principles
- Signaling via G-protein linked cell surface receptors

Cytoskeleton*

- Nature of the cytoskeleton
- Motor proteins
- Cilia and flagella

Cell metabolism

- Overview and general concepts
- The major metabolic pathways of cells
- How cells regulate metabolism

Glyolysis in the cytoplasm

The mitochondrion

- Oxidation of pyruvate and fatty acids in the citric acid cycle
- Electron transport, proton-motive force, and oxidative phosphorylation

Metabolic regulation of glycolysis and citric acid cycle

The Glyoxylate cycle and lipid metabolism

Pentose shunt

The chloroplast and photosynthesis

- Photochemical events and the light reactions
- Photolysis, electron transport, and photophosphorylation
- C_3 and C_4 metabolism

TARGET DATES FOR LECTURE TOPICS

Mon.	16 Jan.	Introduction, course objectives, begin review of cell structure
Wed.	18 Jan.	Review of cell structure
Fri.	20 Jan.	Complete review of cell structure; fractionation of cellular organelles; begin chemical bonds and molecular interactions
Mon.	23 Jan.	Properties of water, small molecules; begin nucleic acids
Wed.	25 Jan	Nucleic acids
Fri.	27 Jan.	Proteins
Mon.	30 Jan.	**1st Quiz** (labs 1 & 2); proteins
Wed.	1 Feb.	Proteins
Fri.	3 Feb.	Proteins, begin enzymes
Mon.	6 Feb.	**E**nzymes
Wed.	8 Feb.	Protein synthesis
Fri.	10 Feb.	**FIRST HOUR EXAM**
Mon.	13 Feb.	Protein synthesis
Wed.	15 Feb.	Protein synthesis
Fri.	17 Feb.	Control of gene expression
Mon.	20 Feb.	Control of gene expression
Wed.	22 Feb.	**2nd Quiz** (labs 3,4 & 5); control of gene expression
Fri.	24 Feb.	Cell cycle (MID TERM)
Mon.	27 Feb.	Cell cycle
Wed.	1 Mar.	Cancer cells
Fri.	3 Mar.	Cancer cells; begin cell membranes
Sat.	4 Mar. - Sun. 12 Mar.	**SPRING RECESS**
Mon.	13 Mar.	Cellular membranes
Wed.	15 Mar.	Cellular membranes
Fri.	17 Mar.	**SECOND HOUR EXAM**
Mon.	20 Mar.	Targeting proteins to the nucleus, mitochondria, and chloroplasts
Wed.	22 Mar.	Endoplasmic reticulum
Fri.	24 Mar.	ER and Golgi
Mon.	27 Mar.	**3rd Quiz** (labs 6,7, and 8); golgi
Wed.	29 Mar.	Golgi
Fri.	31 Mar.	Golgi

Mon.	3 Apr.	Lysosomes; receptor-mediated endocytosis
Wed.	5 Apr.	Cell signaling
Fri.	7 Apr.	**4th Quiz** (labs 9, 10, & 11); Cell signaling
Mon.	10 Apr.	An overview of metabolism, glycolysis
Wed.	12 Apr.	Glycolysis
Fri.	14 Apr. - Mon.17 Apr.	**EASTER RECESS**
Wed.	19 Apr.	TCA cycle
Fri.	21 Apr.	**THIRD HOUR EXAM**
Mon.	24 Apr.	TCA cycle and its control, cytochrome system, oxidative phosphorylation
Wed.	26 Apr.	The glyoxylate cycle and pentose phosphate pathway
Fri.	28 Apr.	Review and comparisons: respiratory metabolism and photosynthesis
Mon.	1 May. - Sat. 6 May	Final Exams

LABORATORY SCHEDULE

Lab. No.	Dates	Topics
1.	17, 18 Jan.	Laboratory orientation: protocols, preparing solutions and making dilutions, pipeting, pipeting devices, and safety precautions Spectrophotometry: Beer's Law, use of the B&L Spectronic 20 spectrophotometers
2.	24, 25 Jan.	Spectrophotometric assays for protein (Bradford and bicinchoninic acid methods) Constructing an absorption curve for cytochrome c and DCPIP Introduction to the Beckman DU recording spectrophotometer
3.	31 Jan,1 Feb.	Cell growth: growth kinetics in *Enterobacter aerogenes* 1. Determining generation time 2. Effects of temperature, chloramphenicol, peptone, and an amino acid analogue
4.	7, 8 Feb.	Manometric measurement of respiratory activity using the Gilson respirometer 1. Effects of temperature, substrates, and inhibitors on yeast cell suspensions (*Saccharomyces cerevisiae*) 2. Effects of washing and aging in discs of storage tissue from potato tubers (*Solanum tuberosum*)
5.	14, 15 Feb.	Tissue culture experiments 1. Initiating callus cultures from carrot roots (*Daucus carota*) 2. Growth regulator effects on callus cultures from tobacco (*Nicotiana tabacum*) 3. Cloning lilies (*Lilium longiflorum*) from bulb scales
6.	21, 22 Feb.	Enzyme assay: acid phosphatase 1. Effect of substrate concentration 2. Effect of phosphate ion
7.	28 Feb, 1 Mar.	Separation of proteins by column chromatography: 1. Extraction of acid phosphatase from raw wheat germ 2. Estimating molecular weight by gel filtration using the assay from last week

Sat.4 Mar. - Sun. 12 Mar. **Spring Recess**

8.	14, 15 Mar.	Isolating an organelle: 1. Mitochondria from cauliflower florets 2. Enzyme assay for succinic dehydrogenase and/or malate dehydrogenase Observe tissue culture experiments: 3 weeks
9.	21, 22 Mar.	Radioisotope laboratory: measuring protein and RNA synthesis in *Saccharomyces* and *E. coli* using leucine -^{14}C and UTP -^{14}C Observe tissue culture experiments: 5 weeks
10.	28, 29 Mar.	Radioisotope laboratory: 1. Prepare samples from last laboratory for counting 2. Introduction to scintillation counter Observe tissue culture experiments: 6 weeks
11.	4 Apr. 5 Apr.	Campus Service Day (no classes) To be announced
12.	11, 12 Apr.	Hill reaction and the Emerson enhancement effect in isolated chloroplasts Observe tissue culture experiments: 8 weeks
	Fri. 14 Apr. - Mon. 17 Apr.	**Easter Recess**
13.	18, 19 Apr.	Effects of ultraviolet radiation on *Paramecium*, *Tetrahymena*, and *Euglena*
14.	25, 26 Apr.	Effects of cycloheximide and colchicine on flagella regeneration in *Chlamydomonas reinhardi* (or) Review

SUMMARY OF DEADLINES

Mon.	30 Jan.	First lab quiz (No's. 1 and 2)
Fri.	10 Feb.	FIRST HOUR EXAM
Wed.	22 Feb.	Second lab quiz (No's. 3, 4 and 5)
Fri.	17 Mar.	SECOND HOUR EXAM
Mon.	27 Mar.	Third lab quiz (No's 6, 7, and 8)
Fri.	7 Apr.	Fourth lab quiz (No's. 9, 10, and 11)
Fri.	21 Apr.	THIRD HOUR EXAM