

California State University, Los Angeles
Department of Biological Sciences
SPRING, 2012

Course title, number and units: Cell Biology, Biology 380 (4)

Instructor: Robert M. Nissen, PhD

Office Location: ASCL 216

Telephone: 323-343-2039

Email: rnissen@calstatela.edu

Website: www.calstatela.edu/faculty/rnissen/teaching.html

Class Location: SH-C141

Time: TuTh 8:25-9:40 AM

Office hours: W 9 - 10 AM

or by appointment

Description: Cell biology is the bridge between biochemistry and physiology. In this course we will explore the fundamental processes of cellular function at the molecular level.

Prerequisites: Biol 100ABC, Chem 301A

Course Requirements:

Textbook: Gerald Karp, *Cell and Molecular Biology – Concepts and Experiments*, 5th or 6th Ed.

Use the emphasis that I place on material in lecture as a guide to the extent of detail you should focus upon in the text. You are expected to read the assigned chapters or chapter sections before each class. Use the “specific lecture objectives” in this syllabus as a guide.

Attendance: Students are responsible for all material presented in class, including announcements about changes in course procedures. A fair calculation for the time required for this class should take into account the need to spend at least 2 hours of independent study for each class hour.

Evaluation:

Tests: There will be three exams. The tests will be a combination of multiple choice (requiring a scantron form) and short essays. This testing format allows for partial credit. The final exam will be comprehensive. No make-up tests will be scheduled. With an excused (i.e. discussed in advance or doctor’s note) absence for a test, the value of the final exam will be increased to compensate for the missed test. If evidence of emergency can be provided for a missed final, an Incomplete will be given. Several unannounced quizzes (requiring a scantron form) will be given at the beginning of class sessions. Be prepared for them by always having a scantron form with you for class.

Grading:	First Test	15%
	Second Test	20%
	Laboratory	15%
	Quizzes	10%
	Final Exam	40%

Grades in this course are not curved. Course grades will be assigned as follows:

A:	89% - 100%	C:	64% - 73%
A-:	86% - 88%	C-:	61% - 63%
B+:	84% - 85%	D+:	58% - 60%
B:	79% - 83%	D:	50% - 57%
B-:	76% - 78%	F:	below 50%
C+:	74% - 75%		

ADA Compliance: Reasonable accommodation will be provided to any student who is registered with the Office of Students with Disabilities and requests needed accommodation.

ACADEMIC HONESTY: Students are expected to read and abide by the University's Academic Honesty Policy, which can be found at <http://www.calstatela.edu/academic/senate/handbook/ch5a.htm> as well as in the current Schedule of Classes. Students who violate this policy will be subject to disciplinary action, and may receive a failing grade in the course for a single violation.

Late assignments will not be graded, resulting in a loss of points. Arrangements for “excused lateness” must be made in advance and approved by the instructor.

General Advice: To ensure that you will be seen promptly during office hours, arrange an appointment with me by email in advance. Drop-ins are fine, but if I am already meeting with another student you will have to wait. If you are unable to meet with me during regular office hours, we can arrange an appointment at another time. If you put in the effort required,

you should learn a lot from this course. If you are having trouble, or are not learning what you hoped to learn, talk to me. I benefit from your feedback.

Course Schedule:

Day	Date	Lecture Topic	Chap
Tu	3-Apr	Biomolecules: Proteins & Nucleic acids	Ch 2
Th	5-Apr	Bioenergetics and Enzymes	Ch 3
Tu	10-Apr	Metabolism I – Glycolysis	Ch 3
Th	12-Apr	Metabolism II – TCA Cycle & Oxidative Phosphorylation	Ch 5
Tu	17-Apr	Metabolism III – Photosynthesis	Ch 6
Th	19-Apr	Review session	
Tu	24-Apr	First Test (Energy - includes material through photosynthesis)	
Th	26-Apr	Transcription	Ch 11
Tu	1-May	Translation	Ch 11
Th	3-May	The Nucleus and Chromatin Structure	Ch 12
Tu	8-May	The Control of Gene Expression	Ch 12
Th	10-May	Interactions Between Cells and Their Environment (ECM)	Ch 7
Tu	15-May	Review session	
Th	17-May	Second Test (Information - Transcription through ECM)	
Tu	22-May	Introduction to Signal Transduction	Ch 15
Th	24-May	Introduction to Signal Transduction	Ch 15
Tu	29-May	Plasma Membrane	Ch 4
Th	31-May	Cytoskeleton	Ch 9
Tu	5-Jun	Cytoskeleton	Ch 9
Th	7-Jun	Review session	
Tu	12-Jun	FINAL: 8 - 10:30AM	

Specific Learning Objectives:

Biomolecules:

- to understand the various types of chemical bonds that exist in biomolecules and how each impacts the molecules' properties and/or function
- to understand the concepts of electronegativity and polarity, and how these effect the properties of cellular molecules (including, for example, their polarity and reactivity)
- to know what free radicals are, and how they can affect living organisms
- to understand the general properties of carbohydrates (CHO's), proteins and lipids:
 - their functions within cells, and the properties which serve these (e.g. nutritional vs structural carbohydrates)
 - the structures and polarities of the 20 naturally occurring amino acids
 - to understand and identify the four levels of protein structure (primary through quaternary)

Bioenergetics and Enzymes

- to understand the concept of energy transformation (i.e. light—chemical—mechanical)
- to define energy, entropy, and to understand the first two laws of thermodynamics and the concept of equilibrium in chemical reactions
- to understand the function and properties of enzymes at the molecular level
- to understand and be able to work with basic enzyme kinetics (the relationships between substrate concentration, [S], maximal velocity, V_{max} , and the enzyme's affinity, K_m)
- to understand the characteristics of the major classes of enzyme inhibitors

Metabolism I: Glycolysis and the Tricarboxylic Acid (TCA) Cycle

- to know the major metabolic pathways and to understand their relationship
- to know the 2 principal forms in which chemical energy is stored
- to understand oxidation-reduction reactions, and their role in metabolic processes
- to know the essential characteristics of glycolysis (i.e. where the reaction cascade takes place in cells; what is the product compound (and the net energy gain), whether it requires oxygen, and where the product compound can go next in order to extract more energy for the cell)
- to understand the function and process of the TCA (or Krebs) cycle
 - where this takes place in cells (and more specifically, within the organelle)

- whether oxygen is required
- the net energy gain for cells
- how the cyclic pathway is initiated after glycolysis (i.e. what happens to pyruvate)
- to understand how the cells' other catabolic pathways (catabolism of fats and proteins) converge on this cycle
- to understand the primary products of the TCA cycle (i.e. reduced co-enzymes), and how they are produced
- to know the essential structure and function of the mitochondrion
- to know and understand the types of metabolic enzyme regulation and how they work
 - covalent modification, allosteric regulation

Metabolism II: Electron Transport and Oxidative Phosphorylation

- to understand the steps involved, at the inner mitochondrial membrane, in converting the chemical energy contained in the reduced co-enzymes from the TCA cycle to electrical energy
- to understand how this energy is then used to drive the synthesis of ATP
- to understand the concept of strength of oxidizing and reducing agents (and electron transfer potential)
- to know the functions of the major membrane complexes conducting electron transport
- to know three major types of electron carriers and their general properties
- to understand the process of generating a proton gradient ('proton motive force')
- to know the basic structure and function of ATP synthase
- to understand how this enzyme can be regulated by [ATP]

Metabolism III: Photosynthesis and the Chloroplast

- to define the process of photosynthesis, and to understand which organisms/cells can perform it
- To understand the photosynthetic process in terms of oxidation-reduction reactions
- To identify the two basic stages of the photosynthetic process ('light' and 'dark' reactions)
- To know the essential structure, function and properties of chlorophyll molecules
- To be able to explain the arrangement and function of photosynthetic units and reaction centers
- To identify the two photosystems and understand their functional organization, and also to be able to follow the flow of electrons through them
- To understand how the proton gradient is established during the light-dependent reactions, and the way that NADPH is generated
- To know the basic characteristics and function of the secondary light-absorbing pigments, b-carotenoids
- To understand the source(s) of energy required to drive the Calvin cycle ('dark reactions'). How is the energy generated?
- To know, and be able to follow, the three essential stages of the Calvin cycle:
 - CO₂ condensing with a 5-C compound to generate 2 X 3-C molecules of PGA
 - Phosphorylation and reduction to GAP (and to know how GAP can then be used by the cell)
 - Regeneration of the 5-C compound to accept CO₂ once again
- To understand what C4 plants are, and why this alternate pathway developed

Transcription:

- To understand the general flow of information through a cell (from the gene to the proteins).
- To know the classes of RNA and their functions.
- To understand the mechanism and function of secondary RNA structures.
- To know the essential function and activity of RNA polymerases
- To understand the function of the sigma factor in prokaryotic cells.
- To know, and be able to follow, the steps of the transcription process.
- To understand the basic process of post-transcriptional processing of RNA, and the definition of exons and introns.
- To understand the function of a consensus sequence (i.e. TATA box) and also the functions of general transcription factors.
- To know the essential structure of mature, processed RNA, and to know the function of the various parts of the molecule (i.e. coding region, poly-A tail, etc.)

Translation:

- To know and understand the essential features of the genetic code, such as the code's degeneracy.
- To know the structure and function of tRNAs, and to understand the "wobble hypothesis".
- To know the steps of the translation process, and the places where energy is provided in the form of GTP.
- To understand the general function of the protein factors in the translation process.
- To understand the structure-function relationships of the ribosome during the elongation process (i.e. the three tRNA association sites).
- To know the structure and function of release factors during termination.
- To understand the mechanism (and results) of nonsense mutations.

Control of Gene Expression:

- To know the essential structural features of the nucleus and nuclear envelope, and the function of the nuclear pore complex.
- To know the basic processes controlling regulated nuclear import of protein cargo.

- To understand the packaging of DNA with histones, and to understand the function of heterochromatin.
- To know the components of the bacterial operon, and to understand the mechanism of inducible and repressible operons.
- To understand these basic mechanisms of transcriptional control:
 - The general mechanism of specific transcription factors.
 - The function of DNA methylation
- To understand the mechanism and rationale of processing-level control (alternate splicing)
- To understand the three essential mechanisms of control at the translational level
 - mRNA localization
 - control of translation
 - control of mRNA stability

Interactions Between Cells and Their Environment:

- To know the components of the extracellular matrix, and the functions of each component.
- To understand the functions of membrane integrins and cadherins, and the general way that they can transmit signals from the cell surface to the interior of the cell (including the nucleus).
- To understand the structures and functions of focal adhesions, hemidesmosomes, desmosomes, gap junctions, and tight junctions.
- To understand the importance of matrix proteins in cellular function and differentiation.

Introduction to Signal Transduction:

- To understand the basic types of cell signaling pathways, and to know the types of cellular responses which can be generated.
- To know the various types of second messengers which transmit receptor signals to the interior of cells, and to know their basic characteristics:
- G-protein coupled receptors (i.e. cAMP-mediated signal transduction)
- Lipid-derived second messengers (IP₃)
- Calcium as a second messenger
- Receptor tyrosine kinases
- Signaling from focal adhesions (from cell-surface interactions to the nucleus)

Plasma and intracellular membrane systems:

- To understand the essential functions of cellular membranes
- To understand the structure and composition of the plasma membrane:
 - Lipid bilayer and the three types of lipids contained (their general functions and properties)
 - The properties of liposomes
 - The three types of membrane proteins, their general properties and functions
 - Membrane carbohydrates (oligosaccharides)
 - The conditions influencing membrane fluidity
- To understand the four basic mechanisms of membrane transport
- To understand the movement of water and the phenomenon of osmosis
- To know the essential function of the two types of ion channels
- To understand the mechanism of facilitated diffusion
- To understand two mechanisms of active transport:
 - Na-K ATPase
 - Co-transport

Cytoskeleton:

- To understand the general properties of the three filamentous structures in eukaryotic cells
- To know the essential functions of the cytoskeleton.
- To understand the general function of molecular motors, and the types associated with microtubules and microfilaments.
- To know the specific functions and general structure of microtubules
- To understand the importance of microtubule-associated proteins
- To know the general function of kinesins and dyneins in anterograde and retrograde transport.
- To know the general structure (i.e. the axoneme) and function of cilia and flagella
- To be familiar with the two types of microtubule-organizing centers: centrosomes and basal bodies
- To know the essential structure, major protein composition and function of intermediate filaments and microfilaments (and to know that myosin is the molecular motor for microfilaments)

CELL BIOLOGY LAB BIOL. 380

General Objectives: These laboratory exercises are designed to complement the lecture course, to illustrate some of the concepts in a “live demonstration”, and to introduce the student to some techniques that are widely used in cell and molecular biology. This course also gives the student an opportunity to approach a series of experiments using a scientific model, and to prepare formal reports of experimental results.

Book: Biology 380 - Cell Biology Laboratory Manual. This book, explaining the background and procedures for eight laboratory exercises, is written by our department and is available in the campus bookstore or from Bookmart (323-262-5511).

Other required materials: a small laboratory notebook for the recording of results (containing paper suitable for making graphs)

Laboratory Schedule:

Week 1	Check-in, group assignments
Week 2	Lab Exercise #1: Instrumentation
Week 3	Lab Exercise #2A: Cellular fractionation
Week 4	Lab Exercise #2B: Protein quantification of cellular fractions
Week 5	Lab Exercise #2C: Enzyme markers to establish fractional purity
Week 6	Lab Exercise #3: The Hill Reaction; First Lab Report due
Week 7	Lab Exercise #4A: RNA Isolation
Week 8	Lab Exercise #4B: RT-PCR; Second Lab Report due
Week 9	Lab Exercise #4C: Agarose gel analysis of PCR products
Week 10	Third lab report due

Evaluation/Credit:

1. **Laboratory notebook:** Students will be expected to record the results of their experiments, and make important notes such as special conditions and problems encountered, during each class period. All notes should be written directly into the book, rather than transferred from ‘scrap paper’. This is the procedure used by most research laboratories, to ensure that all important information is recorded “live”, and so that one doesn’t have to rely on memory and “reconstruct” the events later. Therefore, the book is not required to be neat, and would naturally include mistakes, crossouts, etc. The book should be complete, however. A reader should be able to understand what you did and why by reading your notebook. Books will be collected and checked during lab at random intervals.
2. **Quizzes:** Five very short quizzes will be given at the start of laboratory exercises. The quiz questions will cover a central concept from the exercise for that day (easily answered if the student has reviewed the laboratory manual prior to coming to class). The lowest quiz grade will be dropped and the average of the rest will be normalized to a scale of 50.

3. Formal laboratory reports: Students will be expected to prepare three formal laboratory reports during this course. The first report will cover Laboratory Exercise 2, the second will cover Exercise 3, and the last report will cover Exercise 4. The reports are to be typewritten, and to contain the following:

Introduction (1/2 to 1 page)

- Explain the purpose of the experiment(s).
- Explain what results would be expected or anticipated.

Methods (1/2 to 1 page)

- Describe the manipulations you performed in paragraph format.

Results (3-4 pages, including graphs/tables)

- Describe the results of your experiment(s).
- Include tables and/or graphs where applicable.
- Refer to your tables/graphs as appropriate within your description.

Discussion (1-2 pages)

- Interpret your results. Explain what you think they mean.
- Are the results as expected? Discuss any variations or difficulties and offer possible explanations for any observed discrepancies.

Grading:	First Report	50 points
	Second Report	20 points
	Third Report	50 points
	Quizzes	50 points
	Laboratory notebook	30 points
	Maximum credit:	<hr/> 200 points total

Each report will be due at the beginning of the lab period on the dates shown in the course schedule above. Late reports will not be graded, resulting in a loss of points. Arrangements for "excused lateness" must be made in advance of the due date and approved by the instructor. Reports will be graded on completeness, clarity, brevity, and whether the student put effort into interpreting and/or explaining the actual results. Reports will not be graded according to whether the expected results were achieved. Note: Do not simply re-iterate the detailed instructions or discussions from the lab manual when preparing your report. Use your own words, and be as brief as possible while still "telling the story". Length limits are detailed above. Notebooks will be graded on completeness and timeliness (Are the notes up to date? Can a reader understand what they mean?)

The cumulative credit for this lab course will make up 15% of the total grade for Biol. 380.