EDUCATIONAL OBJECTIVES

The lectures and reading assignments of BIS 2A are designed to convey a large number of facts and concepts that have evolved from modern studies of living organisms. In order to help you organize the large amount of material and evaluate which items are most important, we have compiled a list of objectives for the course.

The objectives, listed below by lecture, describe what we believe are important skills that a student should be able to demonstrate after having absorbed the relevant part of BIS 2A. In general, educational objectives come in various degrees of difficulty. Most of the ones below are of the simplest types: knowledge (the recall or recognition of specific ideas or concepts) and comprehension (translation, interpretation, and extrapolation of concepts). Much of the information required to satisfy these objectives can be obtained by attending and listening to the appropriate lecture, but some will require additional assigned reading in the textbook. A few of the objectives are of more difficult types: application (using an abstraction to solve a specific problem) and analysis (identifying the parts of a concept and the way they are organized.)

These objectives represent just one study guide--one way to see how well you understand the information in lectures and reading. There are others available to you--the problem sets that you will work with in discussion sections and the sample exams on the web. While this year’s examination questions will be written with the objectives and the problem sets in mind, they may require you to weave together many of the skills mentioned in different objectives. An ability to integrate the various skills and ideas can best be obtained by taking an active part, as often as possible, in discussions--both formal and informal--with other students and instructors.

BASIC PROPERTIES OF LIVING ORGANISMS

Lecture 9/23. Life and life science

List axioms of biology related to scientific method, the relation of chemistry to life functions, heredity, evolution, and ecology. Speculate on how each axiom relates to the topics of BIS 2A, B, or C.

List at least six properties characteristic of living systems; explain how these properties might be used to determine whether a given object—for instance, one on Mars—is alive or dead or whether a given phenomenon is caused by a living organisms or not.

Identify vitalistic and mechanistic statements concerning life and living organisms.
Explain why one must know chemistry in order to understand the fundamental properties of life, including complex organization, growth, reproduction, a requirement for energy, and complex responses.


List three tenets of the cell theory. Suggest situations in which these tenets may be useful in modern biology; give exceptions to them, if possible.

Cite evidence that new living organisms arise only from pre-existing living organisms under present day conditions.

Describe the main advantages and disadvantages of electron microscopy (scanning and transmission), light microscopy, and fluorescence microscopy; distinguish between contrast, magnification, and resolution and suggest ways to increase each. Explain why atomic force microscopy can have better resolution than light microscopy.

Describe the comparative advantages and disadvantages of microscopy and cell fractionation in the study of cells; given a specific problem, decide which technique would be most useful in its solution.


List the organelles generally present in a prokaryote cell (eubacterium or archebacterium); in plant, animal, fungal, and protist cells.

Given a description of the organelles present in a cell, specify whether the cell is a eukaryote or a prokaryote; if a eukaryote, whether it is plant, animal, fungal, or protist.

Given a micrograph of an unknown cell, state whether the cell is of plant, animal, or prokaryotic origin.

Recognize electron micrographic images and diagrams of the following organelles: nucleus, mitochondrion, chloroplast, vacuole, plasma membrane, cell wall, rough and smooth endoplasmic reticulum, Golgi apparatus.

Sketch the organelles listed in the above objective as they would be seen in light and electron microscopes.

Cite the chief functions of the nucleus, mitochondrion, chloroplast, vacuoles, plasma membrane, plant cell wall, rough endoplasmic reticulum, and Golgi apparatus.
Describe the dynamic relationship between the nuclear membrane, the endoplasmic reticulum, the Golgi apparatus, and the plasma membrane.

Describe the structure of microtubules and at least two situations in which they play an important role.

Describe the structure of microfilaments and at least two situations in which cells use them.

Contrast the effects of inhibiting microtubule function with those caused by inhibiting microfilament function.

Lecture 10/3-5. Cell components: lipids, carbohydrates, and proteins

Name the principal chemical elements that contribute to the structures of carbohydrates, lipids, and proteins.

State the number of bonds and their arrangement in space around a nucleus of each of the following elements as they occur in biological molecules: carbon, hydrogen, nitrogen, oxygen, sulfur, phosphorus.

Given a set of structural formulas for molecules, be able to point out a generalized hydrocarbon, a fatty acid, glycerol, a triglyceride, a phospholipid, an amino acid, water, a polypeptide, a peptide bond, an ester linkage.

Illustrate a condensation reaction and a hydrolysis reaction.

Define the word "polymer" and cite three examples of polymers found in cells.

Identify the components of a triglyceride and a phospholipid.

Explain the polarity of water and the structure of liquid water.

Give the rule concerning the solubility of polar and non-polar parts of molecules in water.

Given the structures of a number of compounds, decide which would be most water-soluble.

Illustrate the behavior of phospholipid molecules "dissolved" in water; explain how and why they form micelles, bilayers, and vesicles.

Define primary, secondary, tertiary, and quaternary structure in proteins.
Describe the roles of the following bonds in stabilizing protein structure: peptide, hydrogen, hydrophobic, ionic, disulfide, Van der Waal's; identify the "weak" and the "strong" bonds in this list.

Name the chief acidic and basic groups in proteins and give their structures and ionization reactions.

Describe the principal hydrogen-bonding groups of proteins

Give the rule concerning the positions that are assumed by polar and non-polar side chains of proteins in water solution.

Explain the role of amino acid sequence in the folding of proteins.

Name three treatments that might be expected to denature proteins.

Explain why protein structure is so readily changed by mild heating.

Recognize a 3-dimensional model of a protein.

Estimate the number of possible different kinds of proteins of a given size.

Define the word "domain" as it describes protein structure and point out domains in a 3-dimensional model of a protein; explain how the concept of domains affects the estimate of the number of possible different kinds of proteins.

Lecture 10/7. Structure and function of membranes

Name the components of a biological membrane; describe a modern model for the structure of a membrane.

Explain how continuity and hydrophobicity are important in the role of membranes as transport barriers.

Cite four ways in which molecules may cross a biological membrane.

Describe the process of osmosis; explain how the plasma membrane, the cell wall, and the solutes inside a cell influence this process; distinguish among hypertonic, hypotonic, and isotonic solutions and contrast the effects of these solutions on cells with and without cell walls.

Describe models for transmembrane carriers, channels, and pumps, including the material of which they are made and the types of molecules on which the act.

Explain how the transport of ions by pumps can be used to force the transport of other molecules through channels and carriers.
Describe a model for transmembrane receptors and explain their function in general terms.

Lecture 10/10. Catalysis and enzymes.

Explain the role of activation energy in the stability of compounds.

Explain the relationship between activation energy and enzyme action.

Name the main substance of which enzymes are composed; explain the function of coenzymes.

Explain three ways in which enzyme catalysts may lower the activation energy of a reaction; recognize examples of these ways.

Explain the terms "active site" and "substrate" in reference to enzymes; describe bonds by which substrates are held in active sites.

Describe substrate specificity and reaction specificity in relation to enzyme action.

Explain how enzymes achieve substrate specificity.

Lecture 10/12. Concepts of metabolism

Define the term "metabolism" and the term "metabolic pathway" and give a general description of the metabolic system in a living cell.

Given a list of chemical reactions, show they fit into a metabolic pathway; given a list of chemicals and some relationships among them, show how they fit into a metabolic pathway.

Given a diagram of a metabolic pathway, determine what is used up and what is produced; show how a block in the pathway would affect the "flow" of compounds through the pathway.

Define terms "allosteric," "modulator," "regulatory enzyme," "regulatory subunit," and "catalytic subunit;" explain how a modulator acts on a regulatory enzyme; explain how regulatory enzymes differ in structure from most other enzymes.

Describe how phosphorylation can change the activity of an enzyme; compare this effect to the regulation of an allosteric enzyme.

Name two "high energy" compounds; explain why they are called such.
Describe the general role of high-energy compounds in the cell; name three activities in the cell that require the presence of high-energy compounds.