

BIOL 1005 – Concepts in Biology

Outline of topics covered for Midterm I: September 23, 2008 (*final version! posted Sep. 17, 2008*)

DISCLAIMER: This outline is meant to help you organize your lecture notes. It is not intended to be a substitute for your lecture notes. Furthermore, it is NOT EXHAUSTIVE. Just because a word or phrase does not appear on this study guide, doesn't mean you "don't have to know it." In general, you are best off studying your lecture notes and letting this outline serve as a guide to help you get your notes organized.

Overriding topic for this portion of the class: what do living things have in common?

I. Introduction to biology

- A. What is biology, and what properties distinguish life from non-life?
- B. Levels (or scales) at which biology is studied
- C. What are the major groupings of organisms and the characteristics of each group?
 1. Before Whittaker: 2 categories. Limitations to that system.
 2. Whittaker's 5 kingdoms
 3. Woese's 3 domains
 4. Where viruses fit into the classification schemes
- D. Introduction to evolution as a major theme; natural selection as one mechanism of evolution

II. Nature of science

- A. What is "the scientific method"?
- B. Types of hypotheses that are/are not scientifically testable
- C. Elements of an experiment: independent & dependent variables, control, standardized variable

III. Chemical basis of life

- A. Introduction: what is the relationship between cells, molecules, and atoms? What is the difference between the terms "organic" and "inorganic"? What are the main molecules that make up cells?
- B. Essential elements: four most abundant, and those required in smaller amounts; "vitamins" vs. "minerals"
- C. Structure of the atom
 1. Particles that make up the atom: proton, neutron, electron. Where is each located, and what is its charge (if any)?
 2. Define and apply the terms *atomic number*, *mass number*, *isotopes*, and *radioactivity*
- D. How atoms bond to form molecules
 1. How electron arrangement in "shells" determines numbers/types of bonds an atom forms
 2. Types of strong chemical bonds
 - a. ionic bonds (what is an ion, and how does it form?)
 - b. covalent bonds – what are they and how do they form? how many do C, H, O, and N "like" to make, and why?
 1. the difference between single vs. double vs. triple covalent bonds
 2. polar vs. nonpolar covalent bonds; use differences in "hoggy-ness) to be able to tell if any bond with C, H, O, or N is polar or nonpolar. Why do polar bonds lead to molecules with partial positive/negative charges?
- E. Major molecules in cells: water, plus four classes of organic molecules (lipids, carbohydrates, proteins, and nucleic acids)
 1. The molecular structure of **water (H₂O)**
 - a. what are hydrogen bonds and how do they relate to the molecular structure of water?
 - b. four reasons why water is essential to life as far as we know
 - c. acids, bases, the pH scale, and buffers
 2. **Lipids:** what do they all have in common? Molecular structure and function of **fats**; what emulsifiers do; saturated vs. unsaturated fats; why Olestra is calorie-free "fake fat"; molecular structure and function of **steroids**; (phospholipids described later, with membranes)
 3. Polymers made of monomers (attached to each other via the reaction *dehydration synthesis*; conversely, the reaction *hydrolysis* breaks polymers into monomers)

- a. **Carbohydrates:** Molecular structure and function of monosaccharides (e.g. glucose, $C_6H_{12}O_6$) and polysaccharides; why health advocates push whole grains over refined sugar and starch; why saccharin and sucralose are low- or no-cal artificial sweeteners
- b. **Proteins:** categories of protein functions; what makes life's 20 amino acids different from each other; how amino acids join to form polypeptides; Nutrasweet (aspartame) as a dipeptide; importance of protein "shape"; denaturing proteins; dietary sources of protein
- c. **Nucleic acids:** types and functions of nucleic acids; what makes nucleotides different from each other; how nucleotides join to form a DNA or RNA molecule

IV. Tour of the cell

- A. Features all cells have in common
 1. Cell (plasma) membrane
 - a. Molecular structure of phospholipids, including hydrophilic and hydrophobic parts
 - b. How (and why) phospholipids form a bilayer in water
 - c. Selective permeability of the membrane; role of membrane proteins
 2. DNA (what's it for?)
 3. Ribosomes (what are they for?)
- B. Why aren't there any huge, round cells? (In other words, why are all cells tiny and/or thin?)
- C. *Learn these on your own:* (1) differences between prokaryotic & eukaryotic cells; (2) functions of nucleus, rough/smooth ER, Golgi, chloroplasts, mitochondria, cilia, flagella, plant cell wall; (3) differences between plant and animal cells.

V. Metabolism = all reactions in the cell

- A. Enzymes: what they are, what they do, and why their shape is critical to their function (I actually talked about enzymes directly after nucleic acids so that folks in Tuesday lab could learn about them, but it makes sense to understand enzymes as proteins that are involved in metabolism).
- B. ATP chemical structure; ATP hydrolysis ($ATP + H_2O \rightarrow ADP + P_i$) as the energy source for cell's energy-requiring processes
- C. Relationship between photosynthesis and respiration
 1. Photosynthesis: autotrophs harvest sun's energy to make glucose and O_2 from CO_2 and H_2O
 2. Respiration: uses O_2 to harvest glucose's chemical energy to make ATP (from ADP and P_i); yields CO_2 and H_2O as waste products.
- D. Are all diets (of same calorie count) equally healthy? Why or why not?

A few study tips:

- You can't learn something if it doesn't make sense to you. If you've studied your notes and your textbook and something still doesn't make sense, ASK.
- The biggest mistake students make is to study by "going over" notes. You must prove to yourself, BEFORE the exam, that you can remember and understand, not simply memorize or recognize a term. How can you tell if you really understand everything?
 - Use the old exams wisely! Don't just look up the answers to questions on a blank exam; instead, try taking an exam without using your notes. When you've done your best, look up the answers and ask about those you are unsure of. This is a great way to see where you need to brush up a bit.
 - WRITE the answer to every possible question you can ask over the material. (Write, because you can't prove you know something until you actually try to write it down.)
 - Construct a concept map with any 15-20 words from lecture (without using your notes); try this with friends, because you can learn by comparing your maps.
 - Try explaining the material clearly to someone else without using your notes (warning: if your understanding is shaky, try explaining it to someone who really knows it!).
- Remember, material I cover changes slightly from semester to semester. If you have never heard of something I asked in an old exam question (and your notes are complete), it's probably something I skipped this time. By the same token, there may be things I covered this time that I haven't in the past.

Real learning is never easy – it is supposed to take practice and make your brain hurt.

And if you're "studying" but your brain isn't retaining anything, you're not REALLY studying.

Remember! Office hours Tue./Thurs. mornings 8:30-10 and Wed. afternoons from 2-3.

Also, the Action Center is Mon. from 5:00-7:00 p.m. in the Housing Learning Center.