

Format:

- Section I 22 multiple choice questions
Section II 1 essay question and 4 short free response questions

Reading: Hillis chapters 29–31, chapter 34 (and all previous readings, with an emphasis on concepts 5.5–5.6)

Concepts to Review:

- EVERYTHING FROM EXAMS 1 AND 2, AND SEMESTER I

- Homeostasis and Temperature Regulation
 - Be able to define the term *homeostasis*.
 - Be able to explain and give examples of *positive feedback* and *negative feedback* in plants and animals.
 - Be able to explain the difference between *ectotherms* and *endotherms*.
 - Be able to describe some ways in which endotherms can regulate their body temperature.
 - Understand what the Q_{10} value tells us about an organism.

- Endocrine System and Cell-Cell Signal Transduction
 - Understand the terms *autocrine*, *paracrine*, *endocrine*, and *exocrine*.
 - Understand the roles of the major glands and hormones in the human body.
 - Be able to explain how and why changing the levels of one hormone or substance in the body will affect other hormones.
 - Be able to compare the way *peptide hormones* and *steroid hormones* are transported and received by cells.
 - Be able to describe the sequence of events involved in a signal transduction pathway.
 - Be able to explain the roles of *ligands*, *receptors*, *kinases*, *phosphorylation*, and *gene expression* in cell signaling.

- Immune System
 - Understand the difference between *innate (nonspecific)* and *adaptive (specific)* immune responses.
 - Understand the difference between *humoral* and *cellular* immune responses.
 - Understand the difference between *primary* and *secondary immune responses*.
 - Be able to explain the role of each of the following in the immune system: *mucus*, *cilia*, *lysozyme*, *mast cells*, *histamines*, *interferon*, *natural killer cells*, *antigens*, *antibodies*, *naïve B cells*, *helper T cells*, *cytotoxic T cells*, *memory cells*, *Human Immunodeficiency Virus (HIV)*, *Acquired Immunodeficiency Syndrome (AIDS)*.
 - Be able to explain how plants protect themselves from pathogens and from herbivores.

- Nervous System
 - Understand the terms *membrane potential*, *action potential*, *depolarization*, and *repolarization*.
 - Be able to describe how an *action potential* moves from one end of a neuron to the other.
 - Be able to explain how the sodium-potassium ($\text{Na}^+\text{-K}^+$) pump maintains the *resting potential* of a neuron.
 - Be able to describe how a nerve impulse travels across a neuromuscular junction.
 - Be able to explain the roles of *sodium* (Na^+) channels, *potassium* (K^+) channels, and *calcium* (Ca^{2+}) channels in the propagation of an action potential, including the direction that each ion moves (into or out of the cell).
 - Be able to explain the role of *ion channels*, *neurotransmitters*, *enzymes*, and *receptors* in the transmission of a nerve impulse.
 - Be able to describe the path of a nerve impulse transmission, including the roles of *sensory neurons*, *interneurons*, and *motor neurons*.
 - Be able to compare a *reflex arc* with a normal impulse transmission pathway, and be able to explain how reflex arcs provide an evolutionary advantage.

- Lab Skills
 - Be prepared to discuss the following labs: *Transpiration Rate*, Q_{10} in *Drosophila*, and *Reaction Time*.
 - Be able to write null and alternative hypotheses and identify the *independent variable*, *dependent variable*, *control group*, *experimental group*, and *constants* (see Elements to Consider when Designing a Controlled Experiment handout).
 - Be able to graph data, including labeling axes with units.
 - Be able to predict how different environmental conditions will affect the transpiration rate in plants.
 - Be able to interpret data on plant or animal physiological function.

Overarching Questions to Consider:

****Suggestion: Answer all of these questions in writing, then compare answers with a classmate. I promise that taking the time to do so will be well worth it and much more useful than memorizing facts and definitions.****

1. Why is homeostasis sometimes referred to as dynamic equilibrium?
2. How does temperature change affect metabolism in ectotherms? How does temperature change affect metabolism in endotherms? What is the evolutionary advantage of endothermic temperature regulation? How do Q_{10} values differ in ectotherms and endotherms?
3. Why are organisms limited to a very narrow temperature range (i.e., why are temperatures that are too high or too low bad)? What are some ways that endotherms respond to high temperatures? What are some ways that endotherms respond to low temperatures?
4. How do the heart rates of different size mammals compare? Why does the size of a mammal affect its heart rate?
5. How do the size and polarity of molecules affect their ability to permeate the plasma membrane?
6. Why are second messengers necessary for the amplification of a signaling transduction pathway?
7. What does it mean when we say a cell signaling pathway results in a gene being “expressed”?
8. How is positive feedback different from negative feedback? Why is negative feedback so much more common in plants and animals than positive feedback?
9. How is it that having an overactive thyroid gland or an underactive thyroid gland both result in the same symptoms (goiter)? Why does taking anabolic steroids cause a man’s testes to shrink? How do these situations fit with negative feedback?
10. Why do the mechanisms for receiving steroid hormones differ from the mechanisms for receiving peptide hormones?
11. How are innate immune responses different from adaptive immune responses? What are the evolutionary advantages of innate responses? What are the evolutionary advantages of adaptive responses?
12. Why do mammals need two different types of white blood cells (B cells and T cells)? How are they different? In what specific ways do they work together?
13. How does the plasma membrane contribute to the resting potential and action potential of a neuron? How do diffusion and active transport allow for the transmission of an action potential?
14. What are all the steps that need to happen for you to walk across a room? What are all the steps that need to happen for you to reflexively move your leg? How does the brain fit into these processes?
15. In what ways are nerve messages and hormone messages similar? In what ways are they different? In what situations would it be more advantageous to send a nerve message? In what situations would it be more advantageous to send a hormone? How do the nervous system and endocrine work together to regulate life functions?
16. Why do you think Mr. Sprague chose to end the curriculum with plant and animal physiology? In what ways, is physiological function based on these concepts from earlier in the course: chemistry of cells, diffusion, cell signaling, photosynthesis and respiration, gene expression and protein synthesis, evolution? (Hint: After thoroughly considering this overarching question, it sure seems like there are a lot of older topics that might come up in a question about homeostasis or physiology...perhaps now would be a good time to practice some questions on these older topics.)

Practice Exam Questions:

Visit the course website and click on the “Multiple Choice Practice” link. Complete all practice questions for the relevant chapters and check your work against the answer key. Note: these items are password protected.