2nd Semester Final Exam Study Guide

The following questions will potentially be on the final exam. Answer all questions in an outline form. At least four of these questions will be on the final exam. Please note: all of the following questions must be answered in full before you will be allowed to take the final exam. Those that fail to turn this packet in on time and complete will forfeit their opportunity to take the final exam and any and all points associated with the exam.

1) An experiment on a species of small freshwater fish recorded their behavioral responses to different temperatures. Ten fish were each tested once, one at a time.
To begin the experiment, a fish was removed from a stock tank (maintained at 22°C) and placed in the temperature-gradient tank drawn below. After the fish had spent 30 minutes in the temperature-gradient tank, the section where the fish was located was recorded. Additional observations were recorded every 5 minutes, for a total of 7 observations per fish. A summary of the combined data for all 10 fish appears below.

a) On the axes provided, construct the appropriate type of labeled graph showing the relationship between water temperature and fish distribution. Summarize the outcome of the experiment.
b) Identify two variables that were not specifically controlled in the experimental design, and describe how these variables might have affected the outcome of the experiment.
c) Discuss two ways that water temperature could affect the physiology of the fish in this experiment.

2) ATP and GTP are primary sources of energy for biochemical reactions.

a) Describe the structure of the ATP or the GTP molecule.
b) Explain how chemiosmosis produces ATP.
c) Describe two specific cell processes that require ATP and explain how ATP is used in each process.
d) An energy pyramid for a marine ecosystem is shown below. Label each trophic level of the pyramid and provide an example of a marine organism found at each level of this pyramid. Explain why the energy available at the top layer of the pyramid is a small percentage of the energy present at the bottom of the pyramid.
3) Phylogeny is the evolutionary history of a species.
   a) The evolution of a species is dependent on changes in the genome of the species. **Identify** two mechanisms of genetic change, and **explain** how each affects genetic variation.
   b) Based on the data in the table below, **draw** a phylogenetic tree that reflects the evolutionary relationships of the organisms based on the differences in their cytochrome c amino-acid sequences and **explain** the relationships of the organisms. Based on the data, **identify** which organism is most closely related to the chicken and **explain** your choice.
   c) **Describe** two types of evidence—other than the comparison of proteins—that can be used to determine the phylogeny of organisms. **Discuss** one strength of each type of evidence you described.

THE NUMBER OF AMINO ACID DIFFERENCES IN CYTOCHROME c AMONG VARIOUS ORGANISMS

<table>
<thead>
<tr>
<th></th>
<th>Horse</th>
<th>Donkey</th>
<th>Chicken</th>
<th>Penguin</th>
<th>Snake</th>
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<td>0</td>
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<td>21</td>
<td>20</td>
<td>20</td>
<td>17</td>
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4) The flow of genetic information from DNA to protein in eukaryotic cells is called the central dogma of biology.
   a) **Explain** the role of each of the following in protein synthesis in eukaryotic cells.
      • RNA polymerase
      • Spliceosomes (snRNPs)
      • Codons
      • Ribosomes
      • tRNA
   b) Cells regulate both protein synthesis and protein activity. **Discuss** two specific mechanisms of protein regulation in eukaryotic cells.
   c) The central dogma does not apply to some viruses. **Select** a specific virus or type of virus and **explain** how it deviates from the central dogma.

5) The physical structure of a protein often reflects and affects its function.
   a) **Describe** three types of chemical bonds/interactions found in proteins. For each type, **describe** its role in determining protein structure.
   b) **Discuss** how the structure of a protein affects the function of two of the following.
      • Muscle contraction
      • Regulation of enzyme activity
      • Cell signaling
   c) Abnormal hemoglobin is the identifying characteristic of sickle cell anemia. **Explain** the genetic basis of the abnormal hemoglobin. **Explain** why the sickle cell allele is selected for in certain areas of the world.

6) Flowering plants have evolved various strategies for fertilization.
   a) **Describe** the process of fertilization in flowering plants.
   b) **Discuss** two mechanisms of pollen transfer and the adaptations that facilitate each mechanism.
   c) **Discuss** an evolutionary advantage of preventing self-fertilization.
   d) **Describe** two mechanisms that prevent self-fertilization.

7) Cephalization and the development of the brain were important steps in animal evolution.
   a) **Discuss** the evolutionary origin and adaptive significance of cephalization in animal phyla.
   b) **Describe** the development of the nervous system in the vertebrate embryo.
   c) At the sound of shattering glass, people quickly turn their heads. **Discuss** how the human nervous system functions to produce this type of response to an external stimulus.
8) Consumers in aquatic ecosystems depend on producers for nutrition.
a) **Explain** the difference between gross and net primary productivity.
b) **Describe** a method to determine net and gross primary productivity in a freshwater pond over a 24-hour period. In an experiment, net primary productivity was measured, in the early spring, for water samples taken from different depths of a freshwater pond in a temperate deciduous forest.

c) **Explain** the data presented by the graph, including a description of the relative rates of metabolic processes occurring at different depths of the pond.
d) **Describe** how the relationship between net primary productivity and depth would be expected to differ if new data were collected in mid-summer from the same pond. **Explain** your prediction.

9) Regulation is an important aspect of all biological processes. For FOUR of the following processes, **describe** the specific role of the regulator and **discuss** how the process will be altered if the regulation is disrupted.

<table>
<thead>
<tr>
<th>Process</th>
<th>Regulator</th>
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<tbody>
<tr>
<td>Cell cycle</td>
<td>Cyclin</td>
</tr>
<tr>
<td>Metabolic rate</td>
<td>Thyroxine</td>
</tr>
<tr>
<td>Ovarian cycle</td>
<td>Follicle-stimulating hormone (FSH)</td>
</tr>
<tr>
<td>Prey population dynamics</td>
<td>Predators</td>
</tr>
<tr>
<td>Ecological succession</td>
<td>Fire</td>
</tr>
</tbody>
</table>

10) Membranes are essential components of all cells.
a) **Identify** THREE macromolecules that are components of the plasma membrane in a eukaryotic cell and discuss the structure and function of each.
b) **Explain** how membranes participate in THREE of the following biological processes:
   - Muscle contractions
   - Fertilization of an egg
   - Chemiosmotic production of ATP
   - Intercellular Signaling

11) A major distinction between prokaryotes and eukaryotes is the presence of membrane bound organelles in eukaryotes.
a) **Describe** the structure and function of TWO membrane bound organelles other than the nucleus.
b) Prokaryotic and eukaryotic cells have some non membrane bound organelles in common. **Describe** the function of TWO of the following and **discuss** how each differs in prokaryotes and eukaryotes.
   - DNA
   - Ribosomes
   - Cell walls
c) **Explain** the endosymbiotic theory of the origin of eukaryotic cells and **discuss** an example of evidence supporting the theory.
12) Compared with other terrestrial biomes, deserts have extremely low productivity.
   a) **Discuss** how temperature, soil composition, and annual precipitation limit productivity in deserts.
   b) **Describe** a four organism food chain that might characterize a desert community, and identify the trophic level of each organism.
   c) **Describe** the results depicted in the graph. **Explain** one anatomical difference and one physiological difference between species A and B that account for the CO2 uptake patterns shown. **Discuss** the evolutionary significance of each difference.

   ![Graph of CO2 uptake for two species of desert plants over 24 hours]

13) According to fossil records and recently published observations, two species of leaf eating beetles (species A and B) have existed on an isolated island in the Pacific for 100,000 years. In 1964 a third species of leaf eating beetle was accidently introduced on the island. The population size of each species has been regularly monitored as shown in the graph above.
   a) **Propose** an explanation for the pattern of population density observed in species C.
   b) **Describe** the effect that the introduction of beetle species C has had on the population density of beetle species A and species B. **Propose** an explanation for the patterns of population density observed in beetle species A and species B.
   c) **Predict** the population density of species C in 2014. Provide a biological explanation for your prediction.
   d) **Explain** why invasive species are often successful in colonizing new habitats.

14) The movement of water through vascular plants is important to their survival.
   a) **Explain** the mechanism of water movement through vascular plants during transpiration. Include a discussion of how the anatomy of vascular plants and the properties of water contribute to this process.
   b) **Explain** how gas exchange affects transpiration.
   c) **Describe** two adaptations that affect the rate of transpiration in desert plants.

15) The evolution of circulatory systems allowed larger and more complex animals to arise.
   a) **Describe** the respiratory and digestive systems’ specialized structures that facilitate the movement of oxygen and glucose into the circulatory system of mammals.
   b) **Explain** how oxygen and glucose are transported within the circulatory system of mammals.
   c) **Explain** the transfer of oxygen and glucose from the blood and into the active cells of mammals.

16) The unit of genetic organization in all living organisms is the chromosome.
   a) **Describe** the structure and function of the parts of a eukaryotic chromosome. You may wish to provide a diagram as part of your description.
   b) **Describe** the adaptive (evolutionary) significance of organizing genes into chromosomes.
   c) How does the function and structure of the chromosome differ in prokaryotes?
17) Yeast cells are placed in an apparatus with a solution of sugar (a major nutrient for yeast metabolism). The apparatus detects bubbles of gas released by the yeast cells. The rate of respiration varies with the surrounding temperatures as indicated by the data below.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bubbles of gas produced per minute</td>
<td>0</td>
<td>3</td>
<td>7</td>
<td>12</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

a) **Graph** the results on the axis provided. **Determine** the optimum temperature for respiration in the yeast.
b) Respiration is a series of enzyme-catalyzed reactions. Using your knowledge of enzymes and the data above, **analyze** and **explain** the results of this experiment.
c) **Design** and experiment to test the effect of varying the pH of the sugar solution on the rate of respiration. Include an explanation of the expected results.

18) Angiosperms (flowering plants) have wide distribution in the biosphere and the largest number of species in the plant kingdom.
a) **Discuss** the function of FOUR structures for reproduction found in angiosperms and the adaptive (evolutionary) significance of each.
b) Mosses (bryophytes) have not achieved the widespread terrestrial success of angiosperms. **Discuss** how the anatomy and reproductive strategies of mosses limit their distribution.
c) **Explain** alternation of generations in either angiosperms or mosses.

19) An important defense against diseases in vertebrate animals is the ability to eliminate, inactivate, or destroy foreign substances and organisms. **Explain** how the immune system achieves THREE of the following:

- Provides an immediate nonspecific immune response
- Activates T and B cells in response to an infection
- Responds to a later exposure to the same infectious agent
- Distinguishes self from nonself
20) In most aquatic environments, primary production is affected by the light available to the community of organisms. Using measurements of dissolved oxygen concentration to determine primary productivity, design a controlled experiment to test the hypothesis that primary productivity is affected by either the intensity or the wavelength of light. In your answer, be sure to include the following:
   - A statement of the specific hypothesis that you are testing
   - A description of your experimental design (Be sure to include a description of what data you would collect and how you would present and analyze the data using a graph.)
   - A description of results that would support your hypothesis.

21) Prokaryotes are found throughout the biosphere. Answer two of the following:
   a) Provide three examples of adaptations found in various prokaryotes. Explain how these three adaptations have insured the success of prokaryotes.
   b) Discuss how prokaryotes early in Earth’s history altered environments on Earth.
   c) Discuss three ways in which prokaryotes continue to have ecological impact today.

22) Homeostasis, maintaining a steady state internal environment, is a characteristic of all living organisms. Choose THREE of the following physiological parameters and for each, describe how homeostasis is maintained in an organisms of your choice. Be sure to indicate what animal you have chosen for each parameter. You may use the same animal or different animals for your description.
   - Blood glucose levels
   - Body temperature
   - pH of the blood
   - Osmotic Concentration of the blood
   - Neuron resting membrane potential

23) Regulatory (control) mechanisms in organisms are necessary for survival. Choose THREE of the following examples and explain how each is regulated.
   - Flowering in plants
   - Water balance in plants
   - Water balance in terrestrial vertebrates
   - Body temperature in terrestrial vertebrates

24) Death is a natural and necessary part of life cycles at all levels of organization.
   a) Discuss TWO examples of how cell death affects the development and functioning of a multicellular organism.
   b) Discuss One example of how substances are degraded and reused in cells.
   c) Discuss the evolutionary significance of death.

25) Many populations exhibit the following growth curve:

   a) Describe what is occurring in the population during phase A.
   b) Discuss THREE factors that might cause the fluctuations shown in phase B.
   c) Organisms demonstrate exponential (r) or logistic (K) reproductive strategies. Explain and discuss how they affect population size over time.