

**Multiple choice questions – 4 points each (Best 12 out of 13).**

1. Which of the following correctly ranks the structures in order of **size**, from *smallest to largest*?
  - a. chromosome → gene → codon → nucleotide
  - b. nucleotide → chromosome → gene → codon
  - c. codon → gene → nucleotide → chromosome
  - d. nucleotide → codon → gene → chromosome
  - e. chromosome → codon → gene → nucleotide
  
2. To obtain free energy, heterotrophs require a source of?
  - a. partially reduced organic compounds
  - b. water
  - c. carbon dioxide
  - d. light energy
  - e. kinetic energy
  
3. A major function of the mitochondrial inner membrane is to convert the energy in electrons *to* the energy in ATP. To accomplish this function, the inner membrane must have all of the following features EXCEPT:
  - a. an electron transport chain of proteins
  - b. integral transmembrane ATP synthase
  - c. proton pumps embedded in the membrane
  - d. high permeability to protons
  - e. All of these features are necessary
  
4. In comparing the life cycles of plants and animals, a stage found in plants but not in animals is a:
  - a. multicellular diploid
  - b. multicellular haploid

5. In bright light, the pH of the thylakoid space can become \_\_\_\_\_ ?
- neutral at a physiological pH of 7.0
  - more basic
  - more acidic
  - nothing happens, this compartment's pH never changes
  - none of the above
6. Hydrogen bond interactions are important components in the overall structure of which of these biological polymers?
- nucleic acids
  - polysaccharides
  - proteins
  - any two of the above
  - all three of the above
7. How does an enzyme catalyze a reaction?
- by supplying the energy to speed up the reaction
  - by lowering the activation energy
  - by lowering the  $\Delta G$  of the reaction
  - by increasing the entropy of the reaction
  - by a, b, and c
8. All of the following cellular activities require energy, usually in the form of ATP, EXCEPT:
- movement of organelles inside cell
  - osmosis of  $H_2O$  across cell membranes
  - cytoplasmic streaming
  - glycolysis
  - Calvin cycle
9. How many molecules of ATP are produced during the fermentation of one glucose molecule?
- exactly 6
  - about 36
  - exactly 2
  - about 38

10. Isocitrate dehydrogenase is an important control enzyme. The following features correspond to this enzyme EXCEPT:
- It is activated by  $\alpha$ -ketoglutarate & citrate
  - It is inhibited by ATP & NADH + H<sup>+</sup>
  - It is activated by ADP & NAD<sup>+</sup>
  - It modulates the rate of the citric acid cycle
  - It is an allosteric enzyme
11. In cyclic photophosphorylation, chlorophyll is reduced by which of the following?
- ATP
  - NADPH + H<sup>+</sup>
  - Ferredoxin
  - Plastocyanin
  - Hydrogens liberated by the splitting of a water molecule
12. During which stage of cell division are centromeres split apart with sister chromatids moving towards opposite poles of the elongating cell?
- telophase
  - interphase
  - metaphase
  - prophase
  - anaphase
13. Electron transport within NADH-Q reductase, cytochrome reductase, and cytochrome oxidase can be coupled to proton transport from the mitochondrial matrix to the space between the inner and outer mitochondrial membranes because those protein complexes are located \_\_\_\_\_ ?
- within the inner mitochondrial membrane
  - in the mitochondrial matrix
  - in the space between the inner and outer mitochondrial membranes
  - in the cytoplasm
  - loosely attached to the inner side of the inner mitochondrial membrane

14. **Matching – 2 points each.** Use the lettered answers to match the structure with the cell type.

- A. is a feature of all cells
- B. structure is found in prokaryotic cells only
- C. structure is found in all eukaryotic cells
- D. structure is found in most eukaryotic cells, but NOT all
- E. structure is found in plant cells only
- F. structure is found in animal cells only

\_\_\_\_\_

ribosomes

\_\_\_\_\_

centrioles

\_\_\_\_\_

endoplasmic reticulum

\_\_\_\_\_

desmosomes

\_\_\_\_\_

chromoplasts

\_\_\_\_\_

mitochondria

\_\_\_\_\_

plasmids

\_\_\_\_\_

cell membrane

\_\_\_\_\_

plasmodesmata

\_\_\_\_\_

microtubules

15. **Another matching question - 2 points each.** Indicate if the following reactions occur in photosynthesis only (**P**); respiration only (**R**); or both photosynthesis and respiration (**B**).

ATP synthesis by chemiosmosis

\_\_\_\_\_

reduction of NADP<sup>+</sup>

\_\_\_\_\_

electron flow along a cytochrome chain (ETC)

\_\_\_\_\_

substrate level phosphorylation

\_\_\_\_\_

oxidation of water

\_\_\_\_\_

16. **True or False – 2 points each.**

- \_\_\_\_\_ Condensation reactions decrease the entropy within a system.
- \_\_\_\_\_ The regeneration of ATP from (ADP and P<sub>i</sub>) is endergonic.
- \_\_\_\_\_ Translocation involves the movement of tRNA in the A-site to the P-site.
- \_\_\_\_\_ There is more energy in two molecules of pyruvate than in one molecule of glucose.
- \_\_\_\_\_ A carbohydrate produced during the Calvin cycle is a 7-carbon sugar.
- \_\_\_\_\_ Photosynthesis stores energy in complex organic molecules and respiration releases it.
- \_\_\_\_\_ Hydrogen bonds are among the strongest of all chemical bonds.
- \_\_\_\_\_ The elongation of the *leading* strand during DNA replication produces Okazaki fragments.
- \_\_\_\_\_ RNA polymerase transcribes both introns and exons.
- \_\_\_\_\_ Chiasmata represent a crossing of sister chromatids during prophase I of meiosis.
- \_\_\_\_\_ The oxygen released during photosynthesis comes from water.

**Short answer (and not-so-short) – Number of points in parentheses.**

- 17. (5 points)** An ancient sequoia tree living in an old growth forest is the tallest organism on Earth (so light is not limiting). Why would it be more advantageous for this organism to store its' *excess* glucose as cellulose rather than starch?
- 18. (6 points)** Microtubules and microfilaments are important components of the cell's cytoskeleton. Compare and contrast these cellular components: (a) What are the subunits or building blocks used to construct each of these structures? **AND (b)** Describe a

function that these structures have in common? **AND (c)** Describe two functions that are unique for each structure?

- 19. (6 points)** Name **three** mechanisms (be specific) used for the introduction of genetic variation during meiosis **AND** briefly describe each process:

**20. (8 points)** Life is the cumulative product of interactions among the many kinds of chemical substances that make up the cells of an organism. When considering the origins of life, what are four basic steps that must be overcome for life to proceed from abiotic surroundings?

**21. (6 points)** Chloroplasts and mitochondria generate ATP by chemiosmosis.  
**(a)** What is meant by the term *chemiosmosis*? Please be brief in your explanation.

**(b)** List **two** similarities between oxidative phosphorylation in mitochondria and photophosphorylation in chloroplasts.

**(c)** What are two noteworthy differences between oxidative phosphorylation in mitochondria and photophosphorylation in chloroplasts.

22. **(6 points)** The citric acid cycle was a major advancement in cellular respiration. **(a)** Why is succinate dehydrogenase membrane bound, while the majority of the TCA enzymes are dissolved in the matrix?

(b) What is the significance of  $\text{FADH}_2$  **AND** how many ATP molecules can it produce?

(c) What other TCA enzyme complex (reactants and products will suffice for partial credit) is also membrane bound **AND** to what membrane is it integrally bound?

23. **(5 points)** We know that life began relatively quick on our planet after a period of impact frustration. Describe why the Banded Iron Formations (BIFs) are an important indicator of this process **AND** describe for what metabolic process the formation of BIFs is an indicator?

24. **(8 points)** Compare and contrast the ways in which C<sub>4</sub> and CAM plants deal with the problem of photorespiration.

25. **Extra Credit (5 points)** Describe (briefly) how the **lac operon** determines the rate of transcription *using* positive gene regulation.