BIO-372 "MICROBIOLOGY" EXERCISES (WEEK 9)

Your Name : _____ Grade : _____

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EXERCISE 1 "GLOBAL CARBON CYCLE AND METABOLIC SYMBIOSIS" :

1. Symbiotic relationships can be parasitic, commensal, or mutualistic. Explain what these terms means.

2. Symbiotic relationships can be epibiotic or endobiotic. Explain what these terms mean. Endobiotic relationships can be extracellular, intracellular, or organellar. Explain what these terms mean.

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3. Lichens are mutualistic symbiotic associations of a host and a symbiont. Explain how this partnership works. What are the roles of the host? What are the roles of the symbiont?

4. Compare and contrast the metabolism of photo-litho-autotrophic microbes and chemo-organo-heterotrophic microbes, which represent the two "extremes" of metabolic lifestyles.

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5. Explain the complementary roles of each "extreme" metabolic lifestyle (photo-litho-autotrophic vs. chemo-organo-heterotrophic) in the global carbon cycle.

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EXERCISE 2 "GLOBAL CARBON CYCLE AND METABOLIC SYMBIOSIS" :

1. Draw a diagram of the "universal scheme" for energy conservation in microbes. Explain how it works, step by step. You do not need to know the names of any of the proteins but you should be able to explain the pathway's general "logic".

2. Imagine a microbe that can perform a two-electron transfer reaction between the redox couples NAD^+/NADH (E_0' = –0.32 V) and SO_4^{2-}/HSO_3^- (E_0' = –0.52 V). Which molecule is the electron donor? Which molecule is the electron acceptor? Explain:

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3. Anoxygenic photosynthesis requires only ONE input of light energy, whereas oxygenic photosynthesis requires TWO inputs of light energy. Why? What is the role of light energy in both anoxygenic and oxygenic photosynthesis? In oxygenic photosynthesis, the two inputs of light energy are "absorbed" by Photosystem II (PSII) and Photosystem I (PSI). What is the role of PSII (and its associated electron-transport chain) in photosynthesis? What is the role of PSI (and its associated electron-transport chain) in photosynthesis?

4. Draw a diagram of the pathway for oxygenic photosynthesis and explain how it works. You don't need to remember the names of any of the proteins (or even how many proteins there are), but you should be able to explain the pathway's general "logic".

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5. In class we saw six pathways for carbon fixation. The chemical reactions in each pathway are distinct (and you don't need to memorize the details), but there are three "inputs" that all of these pathways require. What are they?

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EXERCISE 3 "GLOBAL CARBON CYCLE AND METABOLIC SYMBIOSIS" :

Imagine that you have isolated a new microorganism from a deep-sea hydrothermal vent. You find that this organism has a complete Calvin-Benson-Bassham cycle. You also find that this organism can perform a 2-electron-transfer reaction between the redox couples NO_3^-/NO_2^- (E_0' = +0.42 V) and $2H^+/H_2$ (E_0' = –0.42 V).

1. Write out the Nernst equation relating Gibbs free energy to the difference in reduction potential of an electron donor and an electron acceptor (redox pair) in a redox reaction. Define each term.

2. Calculate the amount of free energy liberated in the 2-electron-transfer reaction between the redox couples NO_3^-/NO_2^- (E_0' = +0.42 V) and $2H^+/H_2$ (E_0' = –0.42 V). Show your work:

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3. Which molecule is the electron donor? Which molecule is the electron acceptor? Explain:

4. How do you think this microbe obtains the energy, electrons, and fixed carbon that it needs to satisfy its biosynthetic requirements? Explain:

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5. Is this organism a chemo-litho-autotroph or a chemo-organo-heterotroph? Is this organism a "producer" or a "consumer" in the global carbon cycle? Explain: