MCDB 1150:Biofundamentals '2012 Midterm 2 Name: _____

Multiple choice (15 questions, each worth a maximum of 7 points). If your first choice is correct you get +4 points. If it is incorrect, you get 0 points.

You then need to select a wrong response and explain why it is wrong- if your argument is backed by data and is logical, you get +3 points.

1. Two molecules will be attracted to one another by van der Waals interactions as long as ....

- ❑ **A**. they are composed of different types of atoms
- ❑ **B**. they are composed of the same type of atoms
- X **C**. they are further away from one another than their van der Waals radii
- ❑ **D**. they each contain bonds between atoms of different electronegativities.

because the forces involved arise from the structure common to all atoms (as opposed to ions).
a and b and c: are wrong because it does not matter whether the atoms (or molecules) are different or not.

2. If the electronegativities of H and O were equal what would happen to the boiling point of water?

- ❑ **A**. it would be unchanged
- ❑ **B**. it would increase
- X **C**. it would decrease

because in such a scenario, the molecules would interact ONLY through van der Waals interactions; the H-bonds normally present between water molecules would be absent, so that the attraction between the molecules would be weaker.
a: is wrong because the absence of H-bonds would lead to a change in intermolecular interactions, which would influence the boiling point.
b: is wrong because less energy would be required to disrupt the interactions between water molecules, which would lead to a liquid to vapor transition at a lower temperature.

3. You are given samples of two compounds with similar molecular weights. One compound (A332) is composed of atoms of very different electronegativities, while the other (G221) is composed of atoms with very similar electronegativities. You are asked to predict which compound is likely to be more soluble in water - you are most likely to be right if you say ....

- X **A**. A332
- ❑ **B**. G221
- ❑ **C**. they will be equally water soluble

because the differences in electronegativities would produce bonded atoms capable of making H-bonds with water, which is the major determinant of solubility.
b: is wrong because the inability to make of H-bonds with water would lead to thermodynamically unfavorable entropic effects if the molecule were placed in the aqueous phase.
c: is wrong because the two compound differ in their ability to make H-bonds, a primary determined of water solubility, they are not the same and so will not be equally water soluble.

4. Lipids are characterized primarily by the fact that …

❏ **A**. they have a highly elongated shape
X **B**. they contain both hydrophilic and hydrophobic domains
❏ **C**. they are composed 5 to 10 repeating amphipathic units
❏ **D**. they are found only in living organisms

which result in one part being water soluble and another discrete region being in soluble.
a: is wrong because a elongated shape is not the defining feature of a lipid (even though many lipid molecules are elongated
c: is wrong because lipids are not composed of repeating units, and certainly not "amphipathic" ones.
d: is wrong because lipids can be synthesized and occur outside of organisms. Also, this would not distinguish them from many other "organic" molecules.

5. You are studying a cell in a solution of Na+ where the [Na^+] is higher on the outside than on the inside. You observe that glucose flows into the cell. You measure the glucose concentration and find that it is higher inside the cell than outside. What type of membrane molecule could be responsible for the observed movement of glucose.

X **A**. a glucose-Na+ symporter
❏ **B**. a glucose carrier
❏ **C**. a glucose-Na+ antiporter
❏ **D**. a glucose channel

because the movement of glucose is driven AGAINST its concentration gradient by coupling to the movement of Na+ down its concentration gradient, and both Na+ and glucose are moving the same direction (i.e. into the cell, in this case).
b and d: are wrong because a glucose carrier or channel would lead to movement of glucose out of the cell (down its concentration gradient).
c: is wrong because we know glucose is moving into the cell. An antiporter would there require that Na+ move out of the cell. But both movement are against their respective concentration gradients, and so could not occur.

6. How does a catalyst work?

❏ **A.** by increasing temperature
❏ **B**. by decreasing the free energy of the products
X **C**. by decreasing the free energy of the reaction intermediate
❏ **D.** by increasing the free energy of the products ❏ **no idea**

since it is this step that determines the reaction rate.
a: is wrong because catalysts do not influence (directly) the temperature of the system, although if a thermodynamically favorable reaction occurs, energy (heat) can be released and temperature might increase.
b and d: are wrong because by definition a catalyst is not a part of the reaction, and does not contribute to or alter the free energy of reactants or products.

7. Increasing the temperature often increases the rate of a favorable reaction because ....

- ❑ **A**. the activation energy of the rate limiting step of the reaction is decreased
- X **B**. more collisions transfer enough energy to make the rate limiting step likely
- ❑ **C**. the nature of the rate limiting step of the reaction is altered
- ❑ **D.** the free energy of the reactants is reduced, while the free energy of the products increases

Increasing temperature increases average and maximum kinetic energy of the molecules within the system, so there are more collisions that deliver enough energy to overcome the higher energy of the rate limiting step of the reaction.
a: is wrong because temperature does not effects activation energy of any step of the reaction.
c: is wrong because temperature does not alter the reaction per se.
d: is wrong because the effects of temperature on rate are not due to changes in free energy, that said the thermodynamic favorability of a reaction can be influenced by temperature (since $\Delta G = \Delta H - \Delta DS$)

8. A channel in a membrane is like a catalyst because it …

- ❑ **A**. alters lipid structure
- ❑ **B**. changes water structure
- ❑ **C**. increases the speed at which molecules collide with the membrane
- X **D.** decreases the free energy needed to pass though the membrane

because if provide an "open" hydrophilic (although constrained) path the membrane
a: is wrong because channels sit in the membrane, but do not alter the structure of the lipid molecules.
b: is wrong because the channel does not alter water structure
c: is wrong because that would mean temperature increases, which channels do not (cannot) do.

9. Plants are eukaryotes, and have within their cells endosymbiotically derived organelles. Based on this observation, we might well assume that the cell walls of plants and bacteria are

- ❑ **A**. homologous structures
- X **B**. analogous structures
- ❑ **C**. unrelated in terms of origin or function.

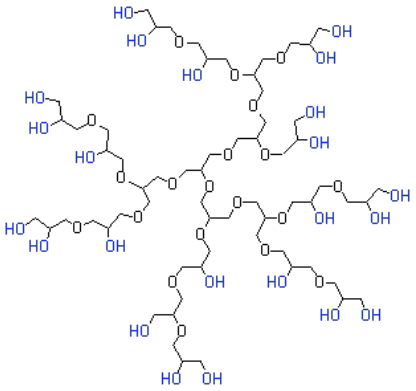
because to engulf the endosymbiont, the ancestral eukaryote lacked a cell wall.
a: is wrong because that would mean the ancestral eukaryote had a cell wall.
c: is wrong because the walls have similar functions

10. You find a species of plant without mitochondria, this could be possible if…

- ❑ **A**. its chloroplasts had retained all of their original respiratory functions
- ❑ **B**.its mitochondria never gained any non-respiratory functions
- X **C**. both A and B would **<u>have</u>** to be true
- ❑ **D**. the ancestor of plants did not have mitochondria

because our understanding is that all eukaryotes first acquired mitochondria, and later plants acquired chloroplasts. The mitochondria are specialized for respiratory function, the chloroplasts for photosynthesis.
a: is certainly true, assuming that b is also true. If either were not true, is has be the case.
d: is wrong because the ancestors of plants did not mitochondria, they are derived from the ancestral eukaryote after it acquired mitochondria.

11. Consider this strange compound. Based on its structure you might expect that it…



X **A**. dissolves in water
❑ **B**. forms micelles in water
❑ **C**. is insoluble in water
❑ **D**. would sit at the hydrophilic-hydrophobic interface of the membrane

because it can make and receive lots of H-bonds, a structure feature common to water soluble molecules.
b: is wrong because to make a micelle a molecule must have both hydrophilic and hydrophobic regions. This molecule is all hydrophilic.
c and d: are wrong because it can make H-bonds, and should be highly water soluble; there is no reason it would be localized to the hydrophilic-hydrophobic boundary of a membrane.

12. Assume that all of the Os in the molecule are replaced by Cs, then you would expect that the molecule would

❑ **A**. dissolve in water
❑ **B**. form micelles in water
X **C**. be insoluble in water
❑ **D**. would sit at the hydrophilic-hydrophobic interface of the membrane

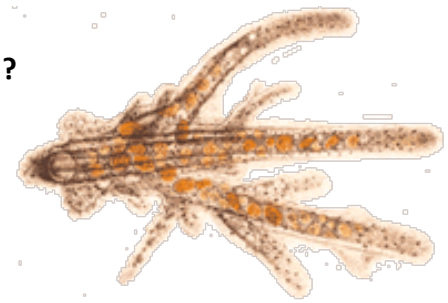
because it could not form H-bonds with water molecules.
a: is wrong because without H-bonding ability, it would be insoluble in water (due to entropic factors).
b: is wrong because to make a micelle a molecule must have both hydrophilic and hydrophobic regions. This molecule is all hydrophobic.
d: is wrong because there is no reason it would be localized to the hydrophilic-hydrophobic boundary of a membrane - it is not itself amphipathic.

13. Why are the oxidation of NADH, or other such molecules, and the hydrolysis of ATP similar?

❑ **A**. both are energetically unfavorable
X **B**. both can be used to drive thermodynamically unfavorable reactions
❑ **C**. both normally occur outside cell
❑ **D**. both occur only in the presence of light

Because they are both energetically favorable reactions, they can be coupled to, and use to drive energetically unfavorable reactions.
a: is wrong because both are energetically favorable
c: is wrong because both occur within cells (not outside of them).
d: is wrong because both can (and do) occur in the dark.

14. Consider an animal cell (like an amoeba) living in a fresh water pond. The amoeba engulfs some bacteria; these bacteria make and secrete a toxin that acts as an efficient H+ ion channel and is able to enter all cellular membranes. The bacteria is immune to the toxin because they also makes a specific inhibitor that blocks the ion channel's action within the bacteria. What happens to the amoeba ?



- ❑ **A**. Nothing
- ❑ **B**. its rate of ATP synthesis increases
- X **C**. water is no longer pumped out, so the cell swells and dies.

water pumping requires energy, which involves the synthesis of ATP, and then the coupling of the ATP hydrolysis reaction to the reaction that pumps out water. ATP synthesis, within the amoeba's mitochondria, depends upon H+ ion gradients, which are disrupted by the bacterial toxin, leading to decrease in ATP, decrease in pumping, net influx of water, bursting of amoeba.

a and b: are wrong because most ATP synthesis involves mitochondrial H+ gradients, and collapsing those gradients would decrease, not increase the ATP synthesis rate

15 . Consider the reactions (relax, read slowly, and take your time)

A + B + 3C ⇔ 2D + G (reaction 1)
G + H ⇔ N (reaction 2)
D ⇔ 2F (reaction 3)

Reactions 1 and 2 reach equilibrium very fast (in milliseconds), but are energetically highly unfavorable.

Reaction 3 does not occur to any significant extent, even though it is energetically very favorable (its equilibrium constant is 1000000).

You mix A + B + C + H and wait 10 minutes; then you add a catalyst that enables reaction 3 to reach equilibrium in 10 seconds. When you compare the concentration of H in the system before and after you added the catalyst, you will find that it has…

- ❑ **A**. increased
- X **B**. decreased
- ❑ **C**. remains unaltered

Allowing reaction 3 to proceed (by the addition of the catalyst, leads to the reaction (decrease) in [D]. This reduction in [D] will influence reaction 1, driving it to the right, leading to an increase in the [G]. Since G is component in reaction it, the increase in [G] will drive reaction 2 to the right (remember reactions 1 and 2 are at equilibrium). As reaction 2 occurs, **[H] will decrease.**

a: is wrong because (see logic above).

d: is wrong because the reactions are coupled.