Name _____

Exam III - Review Questions

Potentially useful facts:

Ideal Gas Law constant, R = 8.314 J/(mol•K) = 0.08206 (L•atm)/(mol•K)

Faraday's Constant, F = 9.65 x 10^4 J/mol•V

1. Using a Fischer projection, draw a representative structure of a ketohexose:
   a. Ketohexose comprise how many stereoisomers? _____
   b. Is the structure you drew a "D" or an "L" sugar? _____
   c. Draw the *enantiomer* of the the structure you drew above:
   d. Draw a *diasteriomer* that is not an *epimer* of the structure you drew above:

2. In class we discussed the different types of polysaccharides produced from D-glucose monomers.
   a. Describe the differences, both *structural* and *functional*, between the polysaccharides that form when glucose monomers are connected by α (1→4) *versus* β (1→4) glycosidic bonds.

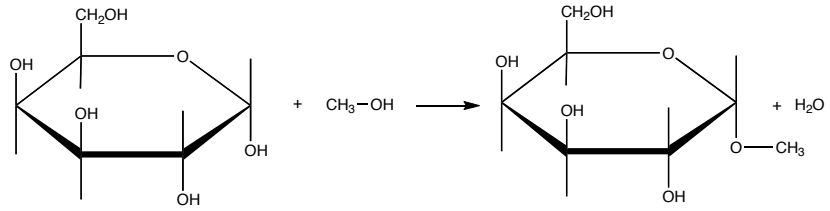
   b. What are the names of these polymers?
      α(1→4): _____ β(1→4):_____
   c. Using Haworth projections, draw a representative disaccharide unit for each of these polymers:
      α(1→4): β(1→4):

   d. What are the names of these disaccharide units?
      α(1→4):_____ β(1→4):_____

3. Monosaccharides in the cell are often chemically modified. Draw a structure for each of the following modified monosaccharides:
   a. α-D-glucose-6-phosphate, which is α-D-glucose that is phosphorylated at carbon 6:

b. β-D-N-acetylgalactosamine, which is β-D-galactose that has the hydroxyl group on carbon 2 converted to an amine which is then acetylated:

4. Monosaccharides, such as galactopyranose, can react with methanol to form methyl glycosides:



D-galactopyranose methanol methyl-D-galactopyranoside

a. Describe how a solution of copper(II)sulfate can be used to determine if this reaction has gone to completion.

5. Describe in general terms the molecular basis for the A, B, and O blood types and why individuals with blood type O are considered universal blood donors..

6. When phospholipids are mixed with water they will self-assemble into lipid bilayers. How is this self-assembly process similar to that for polypeptides when they fold to form protein tertiary structures and DNA polynucleotides when they combine to form double helices?

7. Draw the structure for the phospholipid *phosphotidylserine* with an oleoyl (18:1 *cis*-Δ^9) acyl group at position 1 and an palmitoyl (16:0) acyl group at position 2.

8. While sphingomyelin molecule has a different chemical structure than a phosphoglyceride molecule, the two carry out a similar biological role. Describe this role and explain what features these molecules share that make them both suited to this role.

9. In class we described how hydropathy plots can be used to analyze the primary structures of proteins.
   a. Explain how a hydropathy plot is generated. Include in your answer a description of how one is drawn and what the x and y axes represent. Also describe how each amino acid residue is scored.

b. What conclusions can be drawn from a hydropathy plot.

c. Sketch a hydropathy plot for two proteins:
• One with seven transmembrane helices:

• One with a transmembrane β-barrel.

10. In words, describe Singer and Nicholson's fluid mosaic model of a biological membrane.

a. An important concept that is the basis of this model is that the phospholipid membrane must be maintain a fluid state in order to remain functional. Describe how the fluidity of biological membranes is modulated and how plants and animals have devised different strategies for effecting this modulation.

11. Some antibiotics function by transporting ions across membranes
    a. Why must transporters be used to move ions across a membrane?

    b. Some ion transport antibiotics act as carriers that bind an ion on one side of the membrane, diffuse through the membrane, and release the ion on the other side. The conductance of a lipid bilayer membrane containing a carrier antibiotic decreased abruptly when the temperature was lowered from 40°C to 36°C. In contrast, there was little change in conductance of the same bilayer membrane when it contained a different channel-forming antibiotic. Explain why:

12. In class we discussed the concepts of cooperativity and allosteric regulation with respect to both the activity of hemoglobin, which is an oxygen binding protein, and the activity of aspartate transcarbamoylase (ATCase), which is an enzyme.
    a. In both cases the terms "Tense (T)" and "Relaxed (R)" states were used to describe two different states for these proteins. Specifically, how do these terms relate to the cooperativity and allosteric regulation for these two proteins?

    b. Identify an example of an allosteric regulator for each protein. Describe where they bind and how they exert their effects in terms of the T and R states.

13. We learned earlier in the semester that the First Law of Thermodynamics states that the total energy of the universe is a constant and therefore all processes involving energy must do so by transforming energy from one form to another. In our discussions of pumps, signal transduction pathways and molecular motors, we saw numerous examples of free energy transformations. Describe the free energy transformations that take place for each of the following systems:
    a. The bacterial flagellum:

    b. Lactose permease:

    c. The SERCA pump:

    d. Bacteriorhodopopsin:

    e. Kinesin:

14. In the August 8, 2010 issue of *Science* magazine a report with the following title appeared: "The crystal structure of a sodium galactose transporter reveals mechanistic insights into Na^+/sugar symport" (*Science 321*, 810-814). And in class we discussed that the Na^+/K^+ ATPase pump maintains a Na^+ concentration of 14 mM on the cytoplasmic side of the membrane relative to a 143 mM concentration on the outside of the cell membrane.
    a. In which direction does the Na^+/galactose transporter transport galactose? What evidence do you have for your claim?
    b. If the plasma membrane potential is -60 mV, with the outside more positive than the cytoplasmic side, what ratio of galactose concentration, inside to outside, can be maintained across the plasma membrane at 37°C?

15. The action potential of nerve cells involves both Na^+ and K^+ gated channels. Describe the events that lead to both the opening and closing of these channels:

    a. opening:

    b. closing:

16. In class we focused on four examples of signal transduction pathways. Based the descriptions below, identify the components for each pathway that fit the descriptions. "None" is a valid option:

signal	EGF	epinephrine	angiotensin II	insulin
Type of receptor (7TM or tyrosine kinase)				
Secondary Messenger				
Pathway involves a G-protein (Yes/No)				
Pathway involves an Pleckstrin domain (Yes/No)				
Protein Kinase				

17. In our discussions we have run across multiple examples of *P-loop NTPases*. Describe an example that uses each of the following nucleotides. Also describe what happens when the NDP is exchanged for NTP:

System Description	Example
GTP	
ATP	

18. A major theme of the signal transduction pathways is *signal amplification*. Describe what this means and how it works.

19. In our discussions we have encountered examples of the involvement signal transduction pathways and molecular motors in diseases. Explain the molecular role that each of the following has in relationship to a disease and the associated signal transduction pathway or molecular motor:
    a. The Ras protein:

    b. Tumor supressor genes:

    c. Chlolera toxin:

20. What evidence exists to support the claim that olfactory receptors distinguish odorants based on their shapes?

21. As I write this question I am staring at the label on the back of a bottle of Cabernet Sauvignon, which reads, "This wine accents flavors of blackberry and plum, rounded out with a smooth oak finish."
    a. Describe how it is possible that a trained pallet can paint such a nuanced description of what is essentially fermented grape juice.

    b. It is estimated that humans possess approximately 380 different olfactory receptors, each which binds a limited number of odorants. In reality, we can distinguish many more smells and tastes than this. Explain how this possible.

22. Describe what a Schiff base is and explain where in our discussions of sensory receptors it came into play.

23. When a painter creates her masterpiece, she has a collection of tubes of paint of different colors that can be mixed in a variety of ways to produce a rich pallet of colors to work with, which she can then place upon her canvas. Similarly, the human eye has a number of different color receptors, which can be used to view this canvas.

a. Typically, how may color receptors do humans use to discern the broad spectrum of colors that this artist may choose to layer on her canvas.

b. Some human males see fewer colors than normal, while some human females see a greater number of colors than normal. Explain why this is so

c. List two animals that have fewer color receptors to work with than humans:

i.

ii.

d. List two animal that have a a greater number of color receptors to work with than humans:

i.

ii.

24. The vision and olfactory signal transduction systems share many features in common, yet there are some very distinct differences between the two. Compare and contrast the vision and olfactory signal transduction systems.