03-232 Biochemistry Exam III - 2012 Name:_____

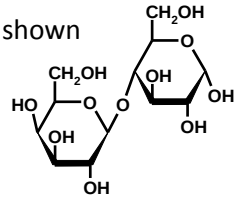
Instructions: This exam consists of 100 points on 5 pages. Please use the space provided to answer the question, or the back of the preceding page. In questions with choices, unless otherwise indicated all your answers will be graded and you will receive the best grade. Allot 1 min/2 points.

1. (3 pts) What fundamental principle allows one to determine the structure of proteins using X-ray diffraction techniques?

2. (2 pts) Fill in the blanks. The _____ carbon is always involved in the formation of the _____ bond that joins two monosaccharides to form a disaccharide.

3. (4 pts) Fill in the blanks. Under conditions of low _____, yeast will convert _____ to _____ in order to regenerate _____ for glycolysis.

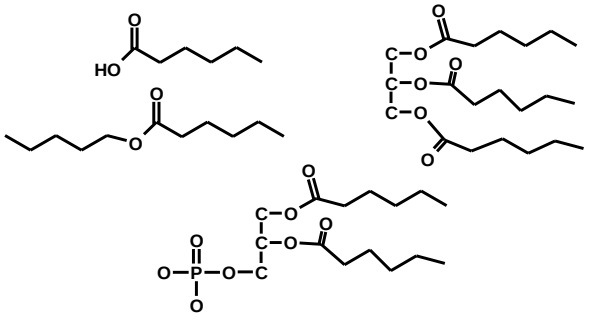
4. (5 pts)
   i) Indicate the reducing end with **"RE"** and one anomeric carbon with **"AC"** on the disaccharide shown on the right.
   ii) Fill in the six blanks to complete the name of this sugar:



_____-galacto_____osyl -(→)- ___ _____ose
1 2 3 4 5 6

5. (6 pts) Please do **one** of the following two choices.
   Choice A: Compare and contrast the structure and biological function of glycogen and cellulose. In what ways are they similar, and in what ways do they differ?
   Choice B: Bacterial cell walls contain a polysaccharide component that is similar to cellulose.
   i) In what ways does the polysaccharide component in bacterial cell walls differ from cellulose?
   ii) What additional component is found in bacterial cell walls?
   iii) We possess an enzyme (lysozyme) that can digest bacterial cell walls, why is it not possible for us to digest cellulose?

6. (3 pts) Four compounds are shown on the right.
   i) **Circle** the triglyceride,
   ii) Put a **box** around the phospholipid,
   iii) Draw an **'X'** through the wax.



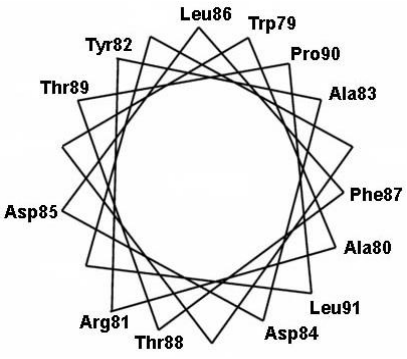
7. (6 pts) Please do **one** of the following four choices.

Choice A: What is the critical micelle concentration (CMC) and how would it depend on the number of carbons in a fatty acid?

Choice B: How does cholesterol affect the properties of membranes and why is this effect important for the function of biological membranes?

Choice C: In what way is the function of membrane transport proteins similar to soluble enzymes? In what ways do they differ?

Choice D: The diagram on the right is a helical wheel depiction of an α-helix in a membrane protein. Indicate which part of this helix is exposed to the lipids and what energetic features would stabilize this interaction? Briefly justify your answer (Hint: The plot on the last question may be helpful).

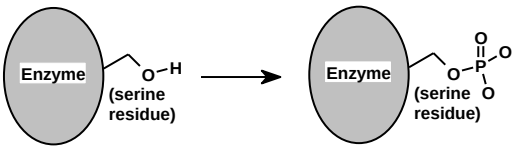


8. (12 pts) Please do **one** of the following two choices.

Choice A: Briefly explain why corn oil is a liquid at room temperature, but that corn oil margarine is a solid at room temperature. What fundamental thermodynamic interaction (e.g. H-bonds) is responsible for this difference?

Choice B: Explain why fatty acids form micelles in water while phospholipids forms bilayers. What fundamental thermodynamic interaction is responsible for the assembly of both of these structures?

9. (6 pts) Is the following reaction catalyzed by a kinase or a phosphatase? Briefly justify your answer and list any reactants or products that may be missing from the diagram.



10. (8 pts) Please do **one** of the following two choices. Be sure to discuss the sign of ΔG in your answer.

Choice A: The reaction fructose-6-P + $P_i \rightarrow$ fructose-1,6-P has an unfavorable standard energy (ΔG^o = + 15 kJ/mol). Why is this reaction spontaneous in glycolysis? What form of coupling is this?

Choice B: How can indirect coupling be used to insure a reaction in a pathway is spontaneous? Give an example from either glycolysis or the TCA cycle.

11. (11 pts) Assume that you had a cream cheese bagel for breakfast.

i) Briefly discuss how the carbon atoms in the food are ultimately converted to CO_2 for any **two** of: a) fats, b) proteins, c) carbohydrates that were contained in the bagel. You only need to simply state the major pathways that would be involved in the production of CO_2. Also state the location of the pathway (6 pts).

ii) Why can't you convert most of the carbon in fats to sugars? (3 pts)

iii) Complete **only one** (i.e. only one will be graded) of the following fill in the blanks. The structures on the formula page may be useful. (2 pts)

a) Prior to entering the _____ pathway, pyruvate is converted to _____, using _____ as the electron acceptor. This reaction is catalyzed by a _____ (general name).

b) In the _____ pathway, an alkane is converted to a _____, using _____ as the electron acceptor. This reaction is catalyzed by a _____ (general name).

c) In the _____ pathway, an alcohol is converted to a _____, using _____ as the electron acceptor. This reaction is catalyzed by a _____ (general name).

d) In the _____ pathway, an aldehyde is converted to a _____, using _____ as the electron acceptor. This reaction is catalyzed by a _____ (general name).

12. (12 pts) Please do **one** of the following two choices related to the conversion of captured energy to ATP. Feel free to use a diagram to illustrate your answer.

Choice A: *Briefly* describe the second to last step in the conversion of the energy to ATP, i.e. electron transport. Be sure to indicate how energy released from this step is stored for the generation of ATP. **Also** indicate the relative energy content of the two compounds that enter this pathway.

Choice B: *Briefly* describe the last step in the conversion of the energy to ATP, i.e. the synthesis of ATP from the energy source generated in choice A of this question.

13. (12 pts) Please do **one** of the following three choices. If appropriate you should state the type of regulation (feedback, product, allosteric) in your answer.

Choice A: Glycolysis, gluconeogenesis, and the TCA cycle are all regulated by "energy sensing". Select **one** of the three pathways and describe:

i) the step that is regulated (2 pts).

ii) the compounds that regulate that step, and whether they activate or inhibit the step (6 pts).

iii) why this regulation is useful to the cell (4 pts).

Choice B: The liver cell responds to a number of different hormones, including insulin, glucagon, and epinephrine. Select any **one** of these hormones and:

i) State under what conditions the hormone would be released (e.g. low blood glucose levels) (2 pts).

ii) Whether proteins become phosphorylated or not, and the general mechanism for this event (4 pt).

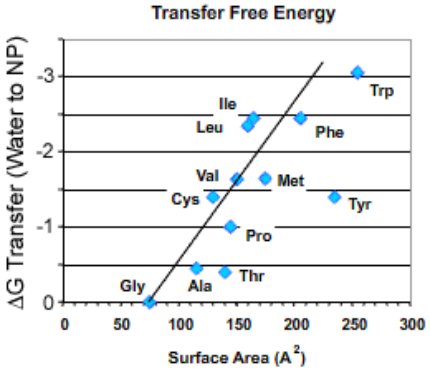
iii) How the response to the hormone affects the synthesis and degradation of glycogen and why this response is appropriate (6 pts).

Choice C: Discuss coordinated regulation of glycolysis and gluconeogenesis by hormonal regulation. Your answer should indicate why this form of regulation is useful to the cell.

14. (10 pts) Please do **one** of the following two choices.

Choice A: A hypothetical cell utilizes a chloride ion gradient to produce ATP by moving the ions from the outside of the membrane to the inside. Assuming that the concentration of Cl^- outside the mitochondrial membrane is 100 mM, and the concentration is 10 mM inside, what is the minimum number of chlorides required to provide enough energy to synthesize one ATP? You can assume that the membrane potential is -100 mV, with the inside **negative**, and that T=300K.

Choice B: The concentration of two short polypeptides in membranes is measured. One polypeptide, consisting entirely of alanine residues, is predominately found in the aqueous solution, while the other peptide, which consists of phenylalanine residues, is predominately found dissolved in the membrane. Explain, in **quantitative** terms, the different behavior of the two peptides. The diagram on the right may be helpful in your answer.



Bonus (2 pts): Why is it better to use maple syrup on your pancakes instead of syrup made from high fructose corn syrup?