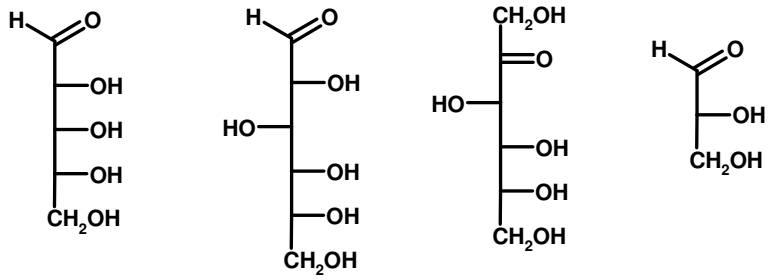
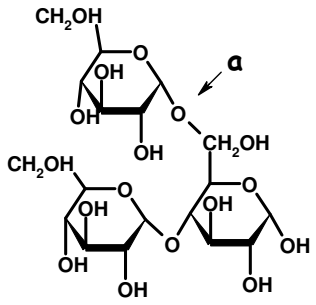
This exam consists of 7 pages and 12 questions. Total points = 100. Allot 1 min/2 points. Note: The last two questions account for 24 points.

1. (3 pts) Using the structures on the right:
   i) Place a box around the carbohydrate that is a ketose.
   ii) Circle the aldose that is found in nucleic acid.
   iii) Underline the aldose that will ***not*** form ring structures in solution.



2. (9 pts) A trisaccharide is shown on the right.
   i) This trisaccharide could have been produced from which of the following polysaccharides (1 pt)?
      a) cellulose
      b) bacterial cell walls
      c) glycogen
   ii) Briefly justify your choice (4 pts).



iii) Circle one anomeric carbon in the trisaccharide and indicate its chirality (α or β) (2 pts).

iv) Describe the linkage labeled with 'a' (e.g. β (1-3)) (2 pts).

3. (8 pts) Please do ***one*** of the following three choices. Please indicate your choice.

Choice A: Draw any **one** of the following three lipids (be certain to indicate your choice).

i) dibutyric phosphatidyl choline

ii) dibutyric phosphatic acid

iii) dibutyric phosphatidyl serine

(Butyric is a four carbon fatty acid.)

Choice B: Briefly explain why fatty acids form micelles in water while phospholipids form bilayers.

Choice C: Define the critical micelle concentration (CMC) and then briefly explain why the CMC would be lower for palmitic (16 carbons) than for butyric acid (4 carbons).

4. (10 pts) Bacteria can successfully grow over a large temperature range by changing the chemical structure of the lipids in their membrane to maintain a fluid membrane.

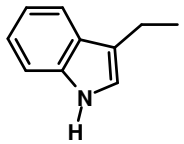
i) Why is it important for the bacteria to maintain a fluid membrane (2 pts)?

ii) Assuming that the growth temperature of the bacteria was shifted from 30 C to 10 C, describe the changes in the fatty acid composition that you might observe in the bacterial membranes after the temperature decrease. You should clearly state which molecular interaction(s) will be affect by this change (8 pts).

5. (6 pts) Please do one of the following two choices. Please indicate your choice.

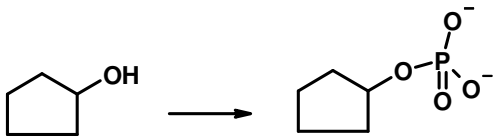
Choice A: Briefly explain why all integral membrane proteins are either α-helical or in a β-barrel conformation?

Choice B: Tryptophan, whose sidechain is shown to the right, is commonly found in membrane proteins. Where would you expect this amino acid to be found? In the middle of the bilayer or at the interface between the lipid and the aqueous solvent? Briefly justify your answer.



6. (10 pts) The reaction shown on the right occurs in a metabolic pathway. The standard free energy, ΔG^o, of this reaction is +15 kJ/mol.

i) (6 pts) *Briefly* describe how ***either*** direct ***or*** indirect coupling could be used to make the reaction proceed in the indicated direction (left to right) during the normal operation of the metabolic pathway.



ii) (2 pts) What is the sign of ΔG for the *coupled* reaction?

iii) (2pts) Give the *general* name of the enzyme that would catalyze the reaction. (Note that the name will depend on the type of coupling you elected to discuss.)

7. (8 pts) The principle source of energy in metabolism arises from oxidation of organic compounds. Select ***one*** oxidation reaction from those shown on the right. Please indicate your choice (A, B, C, or D).

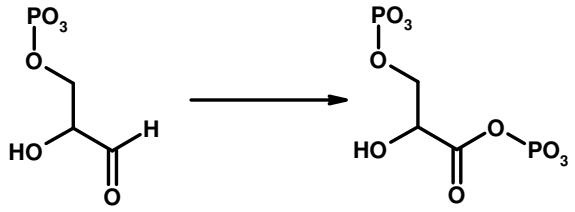
i) State the general name of the enzyme that catalyzes reactions of this type (2 pt).

ii) State the pathway(s) in which your selected reaction(s) occurs (2 pt).

iii) Draw (or list) any *redox* cofactors/cosubstrates and products that are involved in your chosen reaction (2 pts).

iv) Briefly discuss how the energy released from the oxidation is stored for subsequent conversion to ATP (2 pts).

A



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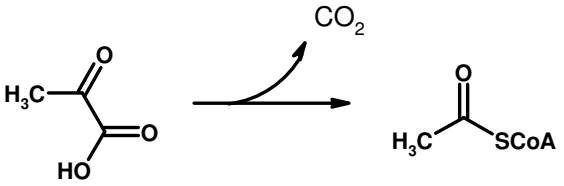

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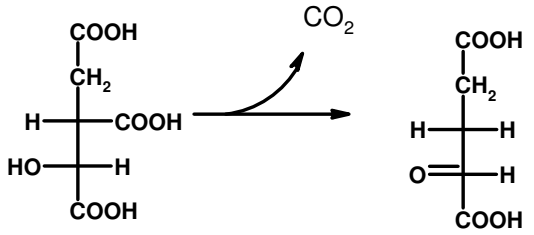

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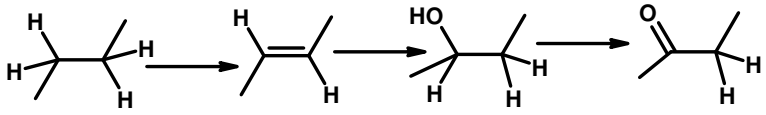

8. (12 pts) Please do **one** of the following two choices. Please indicate your choice.

Choice A: Protein phosphorylation is used to control glycogen/glucose levels in liver cells. Selecting ***either*** the hormones glucagon ***or*** insulin, briefly discuss how protein phosphorylation is used to regulate glycogen/glucose levels. *Briefly* discuss why this regulatory scheme is of benefit to the organism.

Choice B: PFK-1 in glycolysis and fructose-bis-phosphatase-1 in gluconeogenesis are regulated both by energy sensing as well as by hormones. Briefly explain how these two pathways are regulated by ***one*** of these regulatory methods. You need not discuss *how* the levels of F2,6P are regulated, by you should state the levels of F2,6P under different conditions. *Briefly* discuss why this regulatory scheme is of benefit to the cell/organism.

9. (6 pts) Electron transport reactions occur in the mitochondrial _____ (state location). In this pathway, electrons from $FADH_2$ would pass through complex _____ and would be carried on _____ to complex III. The electrons would then be carried on cytochrome C to complex IV where they would be deposited on _____ to give _____. The energy released during electron transport is stored as a _____ _____.

10. (4 pts) Please select ***one*** of the following three questions.

Choice A: Using succinate dehydrogenase ***or*** cytochrome C as an example, briefly discuss how metal ions are utilized in the electron transport process.

Choice B: In anaerobic metabolism, lactate is generated from _____ in the muscles to regenerate _____ for use in _____ (name of a metabolic pathway). The lactate is usually converted to glucose in the _____ (organ).

Choice C: In the reaction that involves the conversion of pyruvate to acetyl-CoA. Acetyl-CoA would be called a _____ inhibitor of the enzyme while citrate would be called a _____ inhibitor of the enzyme.

11. (12 pts) Please do ***one*** of the following two questions. Clearly indicate your choice.

Choice A: Mr. Couchpotato eats principally potato chips. *Briefly* describe how the carbon atoms contained within the starch of the potato chips end up as triglycerides on Mr. Couchpotato's waist. Your answer should state which pathways are involved, giving key intermediates.

Choice B: Ms. Couchpotato begins a *high intensity* aerobics exercise program to lose weight. She also begins a high protein diet at the same time. Is it likely that she will be able to maintain her intense exercise program on this diet. Yes or No? *Briefly* support your answer by stating which pathways are involved, giving key intermediates.

12. (12 pts) Please do ***one*** of the following ***two*** choices. Please indicate your choice:

Choice A: A fictitious enzyme can utilize the energy associate with a glucose gradient across the cell membrane to synthesize ATP from ADP and P_i. The standard free energy for hydrolysis of ATP is -30 kJ/mol and RT = 2.5 kJ/mol.

i) What *fundamental* property of all phospholipid bilayers would allows the persistence of the glucose gradient (2 pts)?

ii) Assuming that the intracellular concentration of glucose is 1 mM, determine the smallest concentration of glucose outside the cell that will provide sufficient energy to generate *one* ATP molecule. The voltage across the membrane is 0.1 V, inside positive. ($\Delta G = RT \ln \{[B]/[A]\} + Z\,F\,\Delta V$) (10 pts).

Choice B: Discuss how ATP synthesis is coupled to proton transport. Your answer should include a discussion of the mechanism (a suitable diagram is quite acceptable) and a *brief* discussion of the energetics involved.