

This test is take-home and open book, and it is intended that all members of the group contribute to completing it. Only one copy is to be submitted by the group, and all members who participated should sign their names below. **Test is due at the end of class on Monday, October 4.**

Page Points

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____

Please use dark pencil or ink and write legibly.

Total _____

Points

- (6) 1. Phosphorylase is an allosteric protein, existing in an **R** (active) and a **T** (inactive) conformation. The **T/R** ratio is affected by several allosteric "effectors", which activate or inhibit enzyme activity. For each of the following compounds, indicate whether it primarily affects the **phosphorylated** or **non-phosphorylated** form of the enzyme, whether it shifts the **T/R** ratio toward the **T** form or the **R** form, and whether the effect is an **activation** or **inhibition** of enzyme activity.

<u>Effector</u>	<u>Phosphorylated or Non-phosphorylated</u>	<u>T or R</u>	<u>Activation or Inhibition</u>
ATP	_____	_____	_____
AMP	_____	_____	_____
Glucose	_____	_____	_____
Glucose-6-phosphate	_____	_____	_____

- (6) 2. Identify which of the respiratory complexes I, II, III, or IV fit the following descriptions (more than one may apply).

_____ contains cytochromes _____ contains Cu
 _____ contains Fe/S proteins _____ reduces CoQ
 _____ acts as a proton pump _____ interacts with cyt c

Use the standard reduction potentials found in Table 15.1, page 525, and ΔG° of hydrolysis of ATP as -31 kJ/mol. Use the following constants in your calculations:

$$R = 8.3 \times 10^{-3} \text{ kJ mol}^{-1} \text{ K}^{-1}; \ln x = 2.3 \log x; T = 310 \text{ K};$$

$$F = 96.5 \text{ kJ volt}^{-1} \text{ equiv.}^{-1}$$

Points

3. (a) Calculate ΔG° for the following reaction:



- (4) (b) This reaction can be catalyzed by submitochondrial particles, created by sonication of mitochondria in which the inner mitochondrial membrane recloses *inside out* to form closed spherical vesicles. Diagram such a particle, showing the location and orientation of each protein complex involved in the catalysis and how they participate in the reaction. Identify the intermediate electron carriers (A,B,C,D,E) involved in the reaction.



- (4) (c) Such vesicles as described above should pump protons from the solution to the interior of the vesicle. Assuming the proton stoichiometry proposed for the complexes involved, calculate the proton motive force (Δp) that would be created if the NADH/NAD⁺ and fumarate/succinate ratios were each maintained at 1:1.

4. ATP synthesis in chloroplasts is coupled to proton transport as it is in mitochondria, but there are some differences from the mitochondrial system.
- (4) (a) The ATP synthase is on the matrix side of the inner mitochondrial membrane. Describe its location and orientation in the chloroplast.
- (4) (b) Electron transport pumps protons out of the mitochondrial matrix into the space between the inner and outer membranes. Between what spaces and across what membrane is the gradient formed in chloroplasts?
- (4) (c) A cytochrome complex in mitochondria catalyzes transfer of electrons from coenzyme Q, a quinone, to cytochrome c, a protein, and consists of cytochromes b and c₁ and an iron-sulfur protein. The cytochrome complex in photosynthesis catalyzes transfer of electrons from what quinone to what protein, and consists of what cytochromes?
- (4) (d) The proton-motive force generated in mitochondria involves both a pH and an electrical potential gradient across the membrane. What is different in the proton-motive force in chloroplasts?

(10) 5. The light reaction of photosynthesis involves two separate pigment systems. For each of the following statements, indicate in the blank whether the statement refers to pigment (or photo) system I (**P.S.I**), pigment (or photo) system II (**P.S.II**), **both**, or **neither**.

_____	Contains a pigment with an absorption maximum of 680 nm.	_____	Is involved in cyclic photophosphorylation.
_____	Absorption of light produces a strong reductant and a weak oxidant.	_____	Is concentrated along the stromal surface of the thylakoid membrane.
_____	Contains antenna chlorophyll.	_____	Contains bacteriorhodopsin.
_____	Contains a manganese cluster.	_____	oxidizes reduced plastocyanin.
_____	Produces a tyrosine radical.	_____	contains pheophytin.

6. Following is the overall reaction catalyzed by the Calvin-Benson cycle:



Give the structures of reactants and products for the **step** or **steps** of the cycle which:

- (4) (a) Incorporate CO_2 into an organic form.
- (4) (b) Uses ATP as a substrate.
- (4) (c) Uses NADPH as a substrate.
- (6) 7. Tropical plants have an additional reaction for converting CO_2 into an organic compound. Give the reactants and products of this reaction, and explain what it accomplishes and why it is important.

- (12) 8. Under some conditions the liver oxidizes fatty acids to acetoacetate, which is secreted into the blood and then oxidized in peripheral tissues (such as heart muscle) to produce energy.
- Give the overall pathway, indicating by name or structure all intermediates, by which palmitic acid ($C_{16:0}$) is oxidized to acetoacetate in liver.
 - Identify the steps at which ATP, NADH, and $CoQH_2$ are utilized or produced.
 - Assuming reoxidation of NADH and $CoQH_2$ by the electron transport chain, calculate the net yield of ATP in liver for oxidation of one mole of palmitate when 2.5 ATP are made from each NADH and 1.5 ATP from each $CoQH_2$.

- (12) 9. For the four plasma lipoproteins, (a) chylomicrons, (b) VLDL, (c) LDL, and (d) HDL, put the letter or letters corresponding to the lipoprotein(s) for which the following statements are true in the blank to the left of the statement:

- _____ Contains apoprotein B-100.
- _____ Contains apoprotein B-48.
- _____ Contains apoprotein A-1.
- _____ Contains apoprotein C-1.
- _____ Source of cholesterol for tissues.
- _____ Transports dietary triacylglycerols.
- _____ Transports endogenous (made in liver) triacylglycerols.
- _____ Is degraded by lipoprotein lipase.
- _____ Is taken up by cells via receptor-mediated mechanisms.
- _____ Is a precursor of LDL.
- _____ May remove cholesterol from cells.
- _____ Is acted on by the enzyme LCAT.

- (8) 10. Both HDL and LDL contribute to blood cholesterol levels. Contrast these two lipoproteins with respect to:
- (a) apoprotein content
 - (b) density
 - (c) electrophoretic mobility
 - (d) function
 - (e) effect on health