BCH 4054 **HOUR TEST 1** **NAME**_____
February 1, 2002

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(24) 1. In the complete oxidation of glucose to CO_2 and water, there are seven enzymatic steps that are removed from equilibrium (i.e. which have large negative ΔG values). For **six** of the seven, give the **name** of the enzyme and show the reaction it catalyzes, identifying all substrates, products, coenzymes and prosthetic groups. (Either names or structures are acceptable for the reactions.)

(22) 2. Upon starvation, your body begins to break down muscle protein to provide energy and to produce glucose needed by the brain for fuel. As an example, glutamate is oxidized by an enzyme called **glutamate dehydrogenase**, producing α-ketoglutarate by the following reaction:

Give a pathway by which glutamate can be completely degraded to CO_2 in order to produce energy. Identify steps in which substrate coenzymes (**NADH, ATP, GTP, $CoQH_2$**) are either used or produced, and write an equation giving the **overall stoichiometry** of the net reaction.

(16) 3. Give the stepwise mechanism catalyzed by the enzyme **pyruvate dehydrogenase**, showing the partial structure of all the enzyme-bound intermediates. Identify the protein components catalyzing each step and the coenzymes involved as either cosubstrates or prosthetic groups.

(16) 4. Mitochondria or submitochondrial particles can carry out the following coupled reaction:

$$2 \text{ cyt c (red)} + \tfrac{1}{2} O_2 + ADP + P_i \quad 2 \text{ cyt c (ox)} + H_2O + ATP$$

(a) Calculate the overall $\Delta G^{o'}$ for this coupled process. (E_o' for cyt $c_{(ox)}$/cyt $c_{(red)}$ is +0.25 V, E_o' for ½ O_2/H_2O is +0.82 V, R = 8.314 J-mol^{-1}-K^{-1}, F = 96.5 kJ-mol^{-1}V^{-1}, T = 298 K)

(b) Diagram the orientation of the two complexes in the inner mitochondrial membrane that carry out this coupled reaction, illustrating in the diagram how the coupling occurs.

(c) Explain how the proposed coupling leads to the proposed stoichiometry in the equation (1 ATP made per two cyt c's reduced).

(d) What effect would **cyanide**, **dinitrophenol**, and **oligomycin** each have on the overall reaction?

(12) 5. ATP synthesis in chloroplasts has many similarities to that in mitochondrial complex III. Compare and contrast these two systems by drawing diagrams of the mitochondrial inner membrane and the thylakoid membrane showing the **identity**, **location** and **orientation** of the following components in each: a quinone, cytochromes, a peripheral membrane protein, the ATP synthase. How does the nature of the proton motive force differ in the two systems?

(10) 6. A number of components are involved in the light reaction of plant photosynthesis. Match a component in the list at the right with each statement below by placing the appropriate letter in the blank. **Only one component may be used per blank**. (P700 is **photosystem I**, P680 is **photosystem II**).

_____ reduced directly by $P680^*$
____ reduced directly by $P700^*$
____ oxidized directly by $P680^+$
____ oxidized directly by $P700^+$
____ an accessory pigment
____ chlorophyll a without Mg^{2+}
____ reduced by cytochrome b/f complex
____ removes electrons from the Mn cluster
____ a Cu containing protein
____ an Fe/S protein

a. Z, a tyrosine residue
b. phycocyanin
c. plastocyanin
d. Ao, a chlorophyll molecule
e. pheophytin
f. cytochrome a_3
g. ferredoxin