BCH 4054 **HOUR TEST 1** **NAME_____________________**
September 15, 2000

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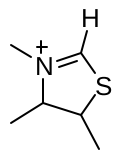
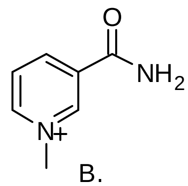
(28) 1. In the complete oxidation of glucose to CO_2 and water, there are seven enzymatic steps that are removed from equilibrium (i.e. which have large negative ΔG values). For each of the seven, give the **name** of the enzyme and show the reaction it catalyzes, identifying all substrates, products,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

(28) 2. Below are the **partial** structures of seven coenzymes you have studied.

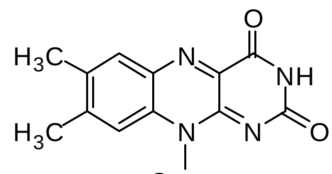
(a) Below each structure, draw an alternative form of the coenzyme to which it is converted during the course of a reaction.



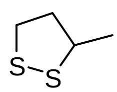
A.



B.



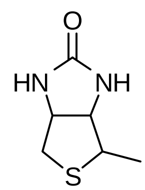
C.



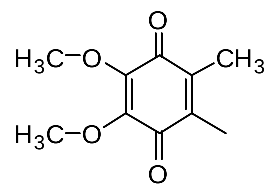
D.

$HSCH_2CH_2-$

E.



F.



G.

(b) Complete the following table by giving the name of the coenzyme, identifying it as a **cosubstrate** or **prosthetic group**, and give the name of an enzyme that it reacts with.

Structure	Coenzyme	Cosubstrate or Prosthetic Group?	Enzyme
A			
B			
C			
D			
E			
F			
G			

(16) 3. The reactions of the TCA cycle are classified as **amphibolic** because they can act in both anabolic and catabolic pathways. They can be used, for example, to convert one amino acid to another. As a simple example, the anaplerotic reaction **pyruvate carboxylase** can be used to convert alanine to aspartate. The conversion requires a reaction we haven't studied yet, a **transamination** between alanine and oxaloacetate as follows:

Transamination: alanine + oxaloacetate $\rightleftarrows$ pyruvate + aspartate

Add this step: pyruvate + ATP + CO_2 $\rightleftarrows$ oxaloacetate + ADP + P_i

To get the overall net: alanine + ATP + CO_2 $\rightleftarrows$ aspartate + ADP + P_i

Show in a similar way how **glutamate** can be converted to **alanine**, using reactions of the TCA cycle together with the following transamination:

glutamate + pyruvate $\rightleftarrows$ alpha-ketoglutarate + alanine

(In other words, list a set of reactions that convert alpha-ketoglutarate to pyruvate, add them to the above reaction, and give the overall net stoichiometric reaction for the conversion of glutamate to alanine. You should have two CO_2's as net products, and show the net use or production of other coenzymes such as NADH, $CoQH_2$, and GTP).

(18) 4. Following is an alphabetical list of the intermediate electron carriers found in the mitochondrial electron transport chain. Identify the carriers that fit each description on the right by placing the letter of the carrier(s) in the blank next to the description. A carrier may be used more than once.

Electron Carrier	**Description**
(a) Coenzyme Q	A component of Complex I ____________________________
(b) Cu_A	
(c) Cu_B	A component of Complex II ___________________________
(d) cytochrome a	
(e) cytochrome a_3	A component of Complex III __________________________
(f) cytochrome b_H	
(g) cytochrome b_L	A component of Complex IV __________________________
(h) cytochrome c	
(i) cytochrome c_1	Carries electrons from Complex II to Complex III ________
(j) FAD	
(k) Fe/S center	Carries electrons from Complex III to Complex IV _______
(l) FMN	
	Forms a binuclear center for oxygen reduction ___________
	Accepts electrons directly from succinate _______________
	Accepts electrons directly from NADH _________________

(10) 5. Suppose the proton gradient across the inner mitochondrial membrane has a proton motive force (Δp) of 0.20 volts. If the stoichiometry of the ATP synthase is such that three protons are coupled to the synthesis of one ATP, then this gradient can provide an energy drop (ΔG) of $-nF\Delta p$, or $-(3)(96.5 \text{ kJ/mol-volt})(0.20 \text{ volts}) = -57.9$ kJ/mol, which is sufficient energy to drive the synthesis of a mole of ATP.

Suppose further that the proton motive force is **equally divided** between ΔpH and $\Delta\Psi$. Calculate the **magnitude** of ΔpH and $\Delta\Psi$.

(R = 8.315 J/K-mol; F = 96.5 kJ/mol-volt; T = 310 K; ln x = 2.3 log x)