

Metabolism and Bioenergetics Supplemental Homework

- Overall, anabolic pathways are endothermic / exothermic and consume / produce ATP.  
circle one circle one
- Overall, catabolic pathways are endothermic / exothermic and consume / produce ATP.  
circle one circle one

3. Can an exothermic reaction be part of an anabolic pathway? Explain.

Yes, exothermic rxns can couple w/ endothermic rxns so that they will occur.

4. What are the two other names for the citric acid cycle (CAC)?

Krebs Cycle & Tricarboxylic Acid Cycle (TCA Cycle)

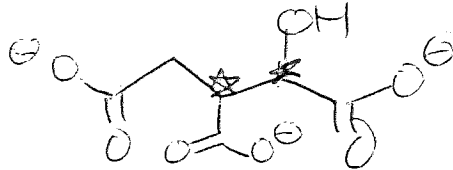
5. Refer to the CAC to answer the questions 5-7.

a) What is the product of step 1 of the CAC? citric acid

b) What is the substrate of step 2 of the CAC? citric acid

c) How many carboxylic acid groups are in citric acid? (3)

6. Draw the CAC substrate with two chiral carbons and star the chiral carbons.



isocitrate

7. Identify the class of enzyme for the following steps:

(oxidoreductase, transferase, hydrolase, lyase, isomerase, ligase)

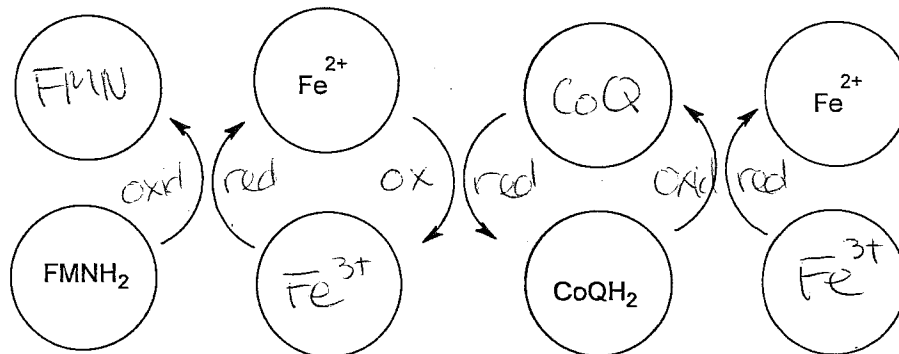
Step 2 isomerase

Step 4 oxidoreductase

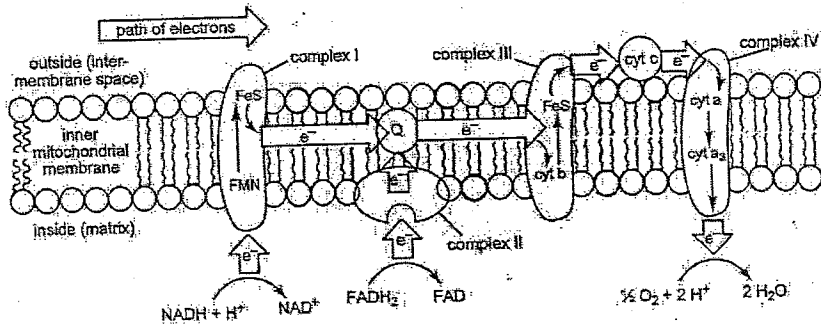
Step 5 ligase

Step 7 lyase

8. Complete the redox diagram below.



Use the diagram of the electron transport chain (ETC) below to help answer the following questions.



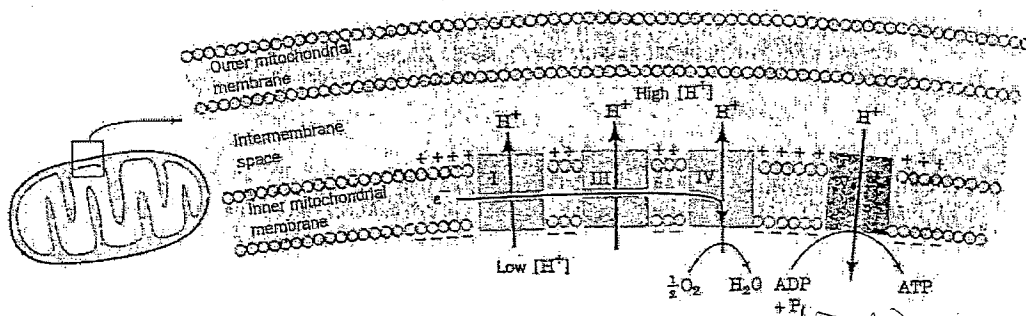
9. In the ETC, the coenzyme electron carriers are FMN and CoQ. They each carry 2 electron(s).

10. In the ETC, the protein electron carriers are classified as FeS complex and cytochromes. They each carry 1 electron(s) and contain iron ions and heme.

11. For electrons entering the ETC from NADH, which complexes do the electrons pass through? List them. I, III, IV

12. For electrons entering the ETC from FADH<sub>2</sub>, which of the complexes do the electrons pass through? List them. II, III, IV

13. Use the diagram below to help explain why each NADH produces 3 ATP while each FADH<sub>2</sub> produces only 2 ATP.



NADH

Complexes I, III, & IV  
all pump H<sup>+</sup> into  
intermembrane space

FADH<sub>2</sub>  
only complexes  
III & IV  
pump H<sup>+</sup>  
less H<sup>+</sup>  
less ATP

14. What type(s) of enzymes would be involved in the hydrolysis of a cheeseburger?  
Where in the digestive tract would the hydrolysis reactions occur?

biological molecule	mouth	stomach	small intestine
carbs	amylase	∅	amylase
proteins	physical grinding	peptidases	proteases
fats	∅	∅	lipase

15. If exothermic reactions are spontaneous, then why do they need energy to start?

To overcome the activation energy ( $E_a$ )

16. What is the relationship between the activation energy and the transition state?

The  $E_a$  is the minimum energy for the reactants to reach the transition state a form products.

17. Which biomolecules are catalysts? How do they increase reaction rates?

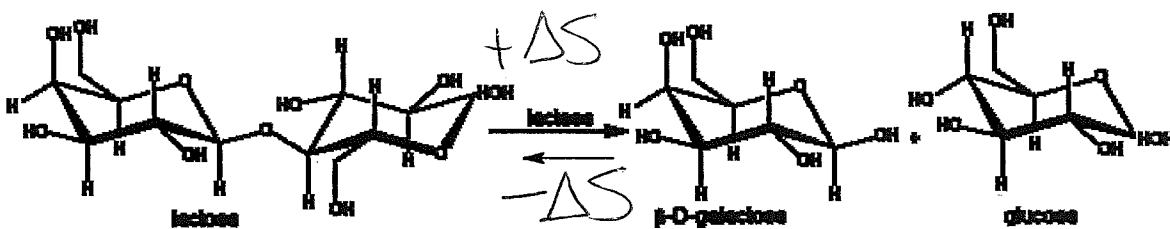
enzymes catalyze biochemical rxns by lowering the  $E_a$

18. An increase in entropy is considered spontaneous / nonspontaneous and has a positive / negative value.  
circle one circle one

Write the symbol to show an increase in entropy:



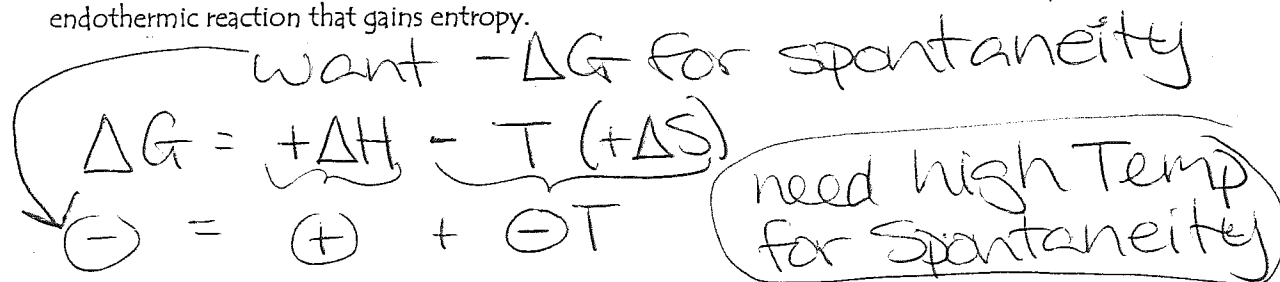
19. Label the forward and reverse reactions to indicate whether entropy is gained ( $+\Delta S$ ) or lost ( $-\Delta S$ ).



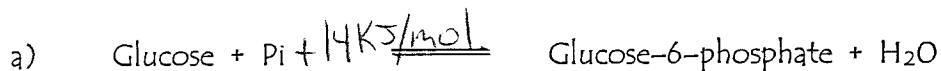
1 cpd

2 cpds more entropy

20. Using the Gibbs Free Energy equation, explain how temperature determines the spontaneity of an endothermic reaction that gains entropy.

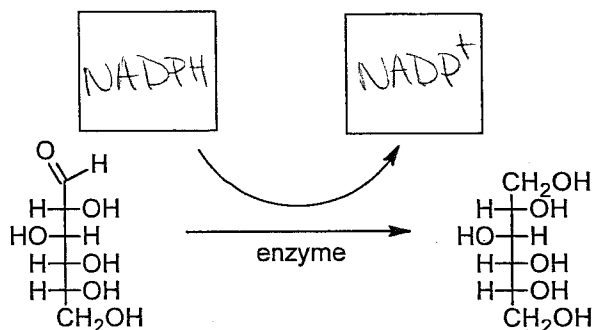


21. Add the free energy as a reactant or product to the reactions below if the  $\Delta G$  for the phosphorylation of glucose to form is +14 kJ/mol.



22. Glucose is converted to sorbitol according to the reaction below. Use this reaction to answer the following questions.

a) Add the coenzymes NADP<sup>+</sup> and NADPH to the reaction.



b) Which reactant is oxidized? NADPH

c) Which reactant is the reducing agent? NADPH

d) Which reactant is reduced? glucose

e) Which reactant is the oxidizing agent? glucose