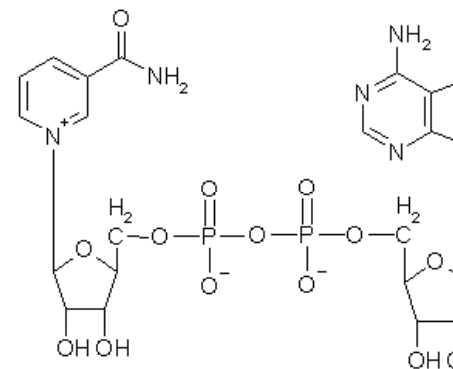


MCB 102 Quiz #3: Answers
Wed, March 7, 2007
GSI: Nadia Taylor



1. a. What is the name of the molecule depicted? (1pt)

NAD+

b. Is this the reduced or oxidized form? (1pt)

Oxidized

c. What is the structure of the alternate form (draw modifications on the picture)? (1 pt)

See chapter 13

d. What role does this molecule play in metabolism? (1 pts)

It is an electron carrier (glycolysis, citric acid cycle → oxidative phosphorylation)

2. Given $\Delta G'^{\circ}$ for each of the following reactions,



Show how you would calculate the standard free-energy change ($\Delta G'^{\circ}$) for the reaction (3 pts): **3. $\text{ATP} + \text{glucose} \rightarrow \text{glucose 6-phosphate} + \text{ADP}$**

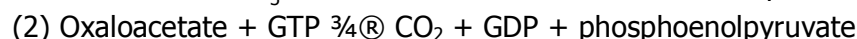
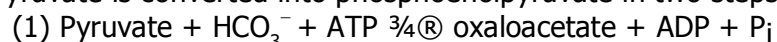
Ans: Reaction 3 is the sum of reaction 1 and the reversal of reaction 2. Because of the additivity of free energy changes, the overall $\Delta G'^{\circ}$ for reaction 3 is the sum of the free energy changes for reaction 1 and the reversal of reaction 2:



$$\Delta G3'^{\circ} = \Delta G1'^{\circ} + \Delta G2'^{\circ} = (-30.5 + 13.8) \text{ kJ/mol} = -16.7 \text{ kJ/mol}$$

3. a. In gluconeogenesis, how do animals convert pyruvate to phosphoenolpyruvate? Show structures, enzymes, and cofactors (6 pts).

Ans: Pyruvate is converted into phosphoenolpyruvate in two steps:



The first reaction is catalyzed by pyruvate carboxylase, which requires biotin as a cofactor; the second, by phosphoenolpyruvate carboxykinase. [See Fig. 20-3, p. 727].

b. In which types of cells does gluconeogenesis occur? (1 pt)

Primarily in the liver (a small amount in the kidney). Not the muscles! The muscles don't have glucose-6-phosphatase, so gluconeogenesis gets stuck at Glucose-6-phosphate (which can be shunted to other pathways, such as...?)

c. What is the functional purpose of gluconeogenesis? (1 pt)

To make glucose to release into the blood, in order to maintain blood glucose levels for cells that do not store their own glycogen, such as the brain and erythrocytes.

4. Rat liver is able to metabolize glucose by both the glycolytic and the pentose

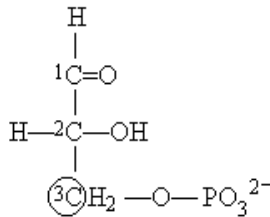
phosphate pathways. Indicate in the blanks if the following are properties of glycolytic (G), pentose phosphate (P), both (G + P), or neither (0): (5 pts)

- _____ NAD^+ is involved.
- _____ CO_2 is liberated.
- _____ Phosphate esters are intermediates.
- _____ Glyceraldehyde 3-phosphate is an intermediate.
- _____ Fructose 6-phosphate is an intermediate.

Ans: G; P; G + P; G; G

7. When glucose labeled with a ^{14}C at C-1 (the aldehyde carbon) passes through glycolysis, the glyceraldehyde 3-phosphate that is produced from it still contains the radioactive carbon atom. Draw the structure of glyceraldehyde 3-phosphate, and circle the atom(s) that would be radioactive. (2 pts)

Ans: The labeled carbon is C-3.



8. During transfer of two electrons through the mitochondrial respiratory chain, the overall reaction is: $\text{NADH} + 1/2 \text{O}_2 + \text{H}^+ \rightarrow \text{NAD}^+ + \text{H}_2\text{O}$ For this reaction, the difference in reduction potentials for the two half-reactions ($\Delta E'^\circ$) is +1.14 V. Show how you would calculate the standard free-energy change, $\Delta G'^\circ$, for the reaction. (The Faraday constant is 96.48 kJ/V·mol.)

Ans: $\Delta G'^\circ = -n I \Delta E'^\circ$

For reactions involving NADH, two electrons are transferred ($n = 2$). So $\Delta G'^\circ = (-2)(96.48 \text{ kJ/V}\cdot\text{mol})(1.14 \text{ V}) = -220 \text{ kJ/mol}$.