Bioenergetics

1. **If ΔG^{o}= -10 kcal/mole, this means that:**

   A) This reaction is nonspontaneous
   B) This reaction can be coupled to an endergonic reaction
   C) This reaction is slow
   D) This reaction may be a hydrolysis reaction
   E) B+D

2. **If a non-spontaneous reaction is accompanied by an increase in entropy, you can most likely conclude that:**

   A) This reaction MUST be endothermic
   B) Heat is liberated from the reaction
   C) Randomness decreases
   D) The rate of the reaction is high
   E) None of the above

3. **Choose the false statement regarding Delta G (Gibbs free energy change):**

   A) ΔG reflects spontaneity of reactions
   B) ΔG approaches zero as the reaction approaches equilibrium
   C) ΔG is concentration-dependent
   D) ΔG = 0 when reactant and product concentrations are equal
   E) None of the above

4. **The table below provides information concerning a set of reactions at standard conditions, choose the FALSE statement:**

Reaction	Change in Enthalpy	Change in Entropy
1. A $\longrightarrow$ B	> 0	< 0
2. C $\longrightarrow$ D	> 0	> 0
3. E $\longrightarrow$ F	< 0	> 0

A) Reaction 1 is endergonic
B) Reaction 2 is endothermic
C) Reaction 3 proceeds spontaneously
D) Keq of reaction 1 > Keq of reaction 3
E) None of the above

5. The following reaction: A $\rightleftharpoons$ B reaches equilibrium when the concentration of A is two times greater than B. ΔG^o for this reaction equals (in units of kcal/mol):
***(Assume standard conditions at a temperature of 25 degrees Celsius, R = 0.001987 kcal/(K*mol))**

A) +0.0344
B) +0.4
C) -0.344
D) -0.4
E) Cannot be computed :)

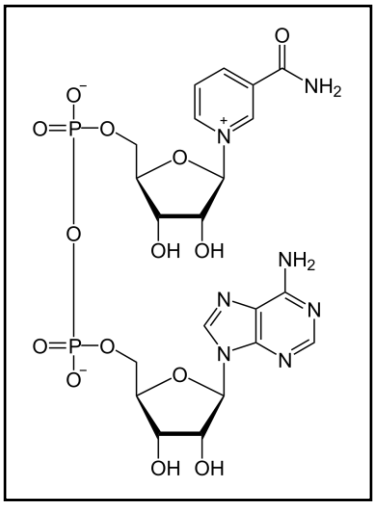
6. The nucleoside triphosphate UTP serves primarily in:

A) Protein synthesis
B) Triglyceride metabolism
C) Phospholipid synthesis
D) Polysaccharide synthesis
E) TCA cycle

7. Calculate ΔG^o(kcal/mole) for the following reaction: A + D → B + C
Given that: A → B ΔG^o= 7 kcal/mole
C → D ΔG^o= 8 kcal/mole

A) +1
B) -1
C) +15
D) -15
E) -2

8. Identify the adjacent structure:



A) FMN
B) FADH2
C) ATP
D) Coenzyme A
E) NADH

❖ **Based on the following table, answer questions 9 and 10:**

Oxidized + e-	→ Reduced	ΔE^o (Volts)
NAD+	NADH	-0.32
Pyruvate	Lactate	-0.19
Oxygen	Water	+0.82

9. Choose the FALSE statement:

A) Pyruvate accepts electrons more readily than NAD+
B) Lactate + Oxygen → Pyruvate + H2O is exergonic at standard conditions
C) Oxygen can oxidize both lactate and NADH
D) NAD+ + Water → NADH + O2 is spontaneous at standard conditions
E) None of the above

10. Calculate ΔG^o for the following reaction:
(Hint: n=2, F= 23.06 kcal/volt)

Pyruvate + NADH → Lactate + NAD+

A) -23.5
B) +23.5
C) -6
D) +6
E) -3

Answers

1. E	2. A	3. D	4. D	5. B
6. D	7. B	8. E	9. D	10. C

1. E

Explanation: A negative ΔG represents an exergonic reaction, and exergonic reactions can be coupled to endergonic reactions (so "B" is correct).

Also, hydrolysis reactions are exergonic, therefore this reaction may involve hydrolysis ("D" is also true). So the answer is E (B+D).

2. A

Explanation: The reaction is nonspontaneous, so delta G is positive.

- Delta G = Delta H – T*Delta S.

Since entropy increases (delta S > 0), then Delta H must be positive so that ΔG is > 0.

- So now we know that delta H must be positive, thus the reaction must be endothermic so that we obtain a ΔG that is > 0.

3. D

Explanation: ΔG = 0 when equilibrium is reached. At equilibrium, the concentration of reactants is not necessarily equal to the concentration of products. The statement is not always true, and therefore is a false fact which does not always apply.

4. D

Explanation: Remember the equation: ΔG= ΔH-TΔS

In reaction 1, ΔH is positive, and ΔS is negative, so ΔG= (+) - (-)= ++

Since ΔG>0**, reaction 1 is endergonic**.

Following the same logic for reactions 2 and 3, we conclude that **reaction 3** is **exergonic** while we cannot decide for reaction 2.

Rxn 1 → $\Delta G>0$ → $Keq<1$

Rxn 3 → $\Delta G<0$ → $Keq>1$

So Keq for rxn 1 < Keq for rxn 3, so option D is the false statement.

5. B

Explanation: At equilibrium, [A]=2[B]

- Keq= [Products]/[Reactants]= [B]/[A] = [B]/2[B] = ½ = 0.5
- Temperature must be in Kelvin (T = 25 + 273 =298 K)
- ΔG^o = -RT*InKeq
  = - 0.001987*298*In0.5
  = +0.4 kcal/mol

6. D

Explanation: Each nucleoside triphosphate specializes in certain cellular processes:

- GTP in protein synthesis.
- CTP in phospholipid synthesis.
- **UTP in polysaccharide synthesis.**

7. B

Explanation: To calculate ΔG^o for this reaction, we add the ΔG^o values of its "component" reactions. Notice that the reaction for which we wish we to calculate ΔG^o has D in the reactants and C in the products. So, we must first reverse the given reaction of C → D to D → C, and with this we must also multiply ΔG^o by (-).

A → B ΔG^o= 7

D → C ΔG^o= (-1) * 8 = -8

ΔG^o =(7) + (-8) = -1 kcal/mole.

8. E

Explanation: We must be familiar with the structure of NADH.

A Characteristic feature of this molecule includes the presence of two nucleotides attached to each other through their phosphate groups. Make sure you recognize it well.

9. D

Explanation:

- A: The reduction potential of pyruvate is higher than that of NAD+. A higher reduction potential means a higher tendency to accept electrons. True
- B: There are two ways to look at option B:
  1. Since oxygen has a higher reduction potential than that of pyruvate, the forward reaction proceeds spontaneously … hence exergonic.
  2. The mathematical approach:

     Oxygen → Water **ΔE^o= +0.82**

     Lactate → Pyruvate **ΔE^o= +0.19 (notice we multiplied by (-1) because it is the reversal of the reaction in the table)**

     - **ΔE^orxn= 0.82 + 0.19 = +1.01**
     - **From the equation ΔG^o= -nF* ΔE^o**
     - **If ΔE^o is positive, then ΔG^o is negative … hence exergonic**

- C: Oxygen has the highest reduction potential among those present in the table, and therefore has the highest electron-accepting tendency, meaning it can take electrons from lactate and NADH, oxidizing them. True.
- D: Same concept as option B (see above). False statement.

10. C

Explanation:

Use the equation: **ΔG^o= -nF* ΔE^o**

ΔE^o= -0.19 - -0.32= +0.13

- Plug in values → Answer: -6

Done by: Nabil G. Sweis