WEEK NO.2

METABOLISM

DOCTOR 2019 | MEDICINE | JU

DONE BY :

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-BIOENERGETICS:

-Refer to the following equation when answering questions 1 and 2. Consider the reaction catalyzed by fumarase:
fumarate + H2O= malate

1. When measured in the absence of fumarase, the delta Go for this reaction is O kcal/ mol (neglecting any terms associated with h2O). The equilibrium constant for this reaction would, therefore, be

which one of the following?

(A) 0
(B) 0.5
(C) 1
(D) 10.0
(E) 50.0

2. Fumarase was added to a solution that initially contained 20 µM fumarate. After the establishment of equilibrium , the concentration of malate was which one of the following?
(A) 2µM
{B) 5µM
(C) l0µM
(D) 20µM
(E) 50µM

3-A genetic mutation caused the cellular concentration of an enzyme to increase 100-fold for a biochemical reaction. Therefore, the equilibrium constant for the reaction catalyzed by the enzyme would change in which one of the following ways?
(A) It would decrease two-fold.
(B) It would remain the same.
(C) It would increase in proportion to the enzyme concentration.
(D) It would change inversely with the enzyme concentration.
(E) It would decrease 100-fold.

4-Which one of the following statements about the free energy change (ΔG) in a biochemical reaction is CORRECT?

A. If ΔG is negative, the reaction proceeds spontaneously with a loss of free energy.

B. In an exergonic reaction, ΔG is positive.

C. The standard free energy change when reactants are present in concentrations of 1.0 mol/L and the pH is 7.0 is represented as ΔG0

D. In an endergonic reaction, ΔG is negative.

5-If the ΔG of a reaction is zero:

A. The reaction goes virtually to completion and is essentially irreversible.

B. The reaction is endergonic.

C. The reaction is exergonic.

D. The reaction proceeds only if free energy can be gained.

E. The system is at equilibrium and no net change occurs.

6-ΔG0' is defined as the standard free energy charge when:

A. The reactants are present in concentrations of 1.0 mol/L.

B. The reactants are present in concentrations of 1.0 mol/L at pH 7.0.

C. The reactants are present in concentrations of 1.0 mmol/L at pH 7.0.

D. The reactants are present in concentrations of 1.0 μmol/L.

E. The reactants are present in concentrations of 1.0 mol/L at pH 7.4.

7-If ΔG^0 = -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

8-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

9-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

10-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 ⟶ B	> 0	< 0
2. C ⟶ D	> 0	> 0
3. E ⟶ 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

11-The following reaction: A-> B reaches equilibrium when the concentration of A is two times greater than B. ΔG^0 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 :)

12-The nucleoside triphosphate UTP serves primarily in:
A) Protein synthesis
B) Triglyceride metabolism
C) Phospholipid synthesis
D) Polysaccharide synthesis
E) TCA cycle

13-Calculate ΔG^0(kcal/mole) for the following reaction: A + D → B + C Given that: A → B ΔG^0= 7 kcal/mole
C → D ΔG^0= 8 kcal/mole
A) +1
B) -1
C) +15
D) -15
E) -2

14-Reactions that lose heat are termed as _____
a) endothermic
b) exothermic
c) chemical
d) physical

15-According to laws of thermodynamics, the energy of the Universe is _____ whereas the entropy _____
a) constant, increases
b) constant, decreases
c) increases, remains constant
d) decreases, remains constant

16-Exergonic processes are thermodynamically unfavorable.
a) True
b) False

17-Cellular metabolism is a non-equilibrium metabolism.
a) True

b) False

18-If enthalpy change for a reaction is zero, then ∆G equals to _____

a) -T∆S
b) T∆S
c) -∆H
d) lnkeq

19-For a reaction if ∆G° is positive, then _____

a) The products will be favored
b) The reactants will be favored
c) The concentration of the reactants and products will be equal
d) All of the reactant will be converted to products

20-The relationship between K‘eq and ∆G‘° is?

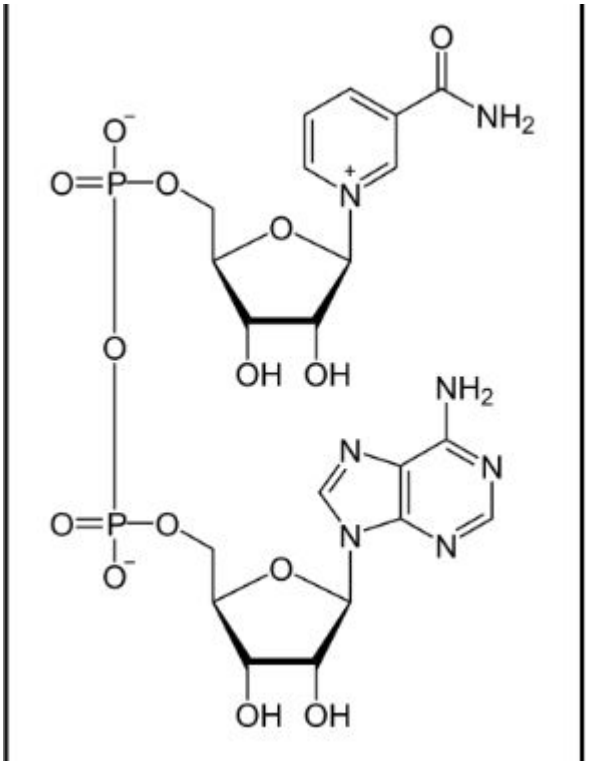
a) ∆G‘° = -RTlnK‘eq
b) ∆G‘° = -RTK‘eq
c) ∆G‘° = RK‘eq
d) ∆G‘° = -RK‘eq

21-If ∆G‘° of the reaction A → B is -40kJ/mol under standard conditions then the reaction _____

a) Will never reach equilibrium
b) Will not occur spontaneously
c) Will proceed at a rapid rate
d) Will proceed from left to right spontaneously

23-Identify the adjacent structure:

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



-Based on the following table, answer questions 24 and25:

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

24-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

25-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

26- In order for a cell to carry out its biologic functions, the intracellular reactions need to be directed to follow a certain pathway. Which one statement best describes the direction a chemical reaction will follow?

A) A reaction with positive free energy will proceed in the forward direction if the substrate concentration is raised high enough.

B) Under standard conditions, a reaction will proceed in the forward direction if the free energy ΔG0′ is positive.

C) The direction of a reaction is independent of the initial substrate and product concentrations because the direction is determined by the change in free energy.

D) The concentration of all of the substrates must be higher than that of all of the products for the reaction to proceed in the forward direction

E) The enzyme for the reaction must be working at >50% of its maximum efficiency for the reaction to proceed in the forward direction.

27-Many biologic reactions are oxidation–reduction reactions that use a biologic electron carrier. Which one of the following statements correctly describes reduction of one of these electron carriers, NAD+ or FAD

A. NAD+ accepts two electrons as hydrogen atoms to form NAD(2H).

B. NAD+ accepts two electrons that are each donated from a separate atom of the substrate.

C. NAD+ accepts two electrons as a hydride ion to form NADH.

D. FAD releases a proton as it accepts two electrons

E-FAD must accept two electrons at a time.

28-The ΔG0′ values are determined under standard biochemical conditions and reflect the energy either required, or released, as a particular reaction proceeds.

Given the ΔG0′ values below, determine the overall ΔG0′ for the following reaction:

creatine + ATP yields creatine phosphate + ADP

The half reactions are ATP + H2O yields ADP + inorganic phosphate ΔG0'= −7.3 kcal/mol

Creatine phosphate + H2O yields creatine + inorganic phosphate ΔG0'= −10.3 kcal/mol

A. −3.0 kcal/mol

B. −10.3 kcal/mol

C. −17.6 kcal/mol

D. +3.0 kcal/mol

E. +10.3 kcal/mol

F. +17.6 kcal/mol

-Answers and Explanations:

1. The answer is C.

If delta Go= 01 then - RTln Keq = 0, because delta Go' = - RTln Keq. For - RTln Keq to be equal to O, the ln.Keq must be 0, which means that Keq = l (the natural log of l = 0).

2. The answer is C.

From the answer to Question 1, we know that Keq = 1 = [Malate]/(Fumarate] = X/(20 - X). Therefore, (20 - X) = X, 20 = 2X, andX = 10 microM.

3. The answer is B.

An enzyme increases the rate at which a reaction reaches equilibrium but does not change the concentration of the reactants and products at equilibrium; that is, the keq is not affected by an enzyme, so a change In enzyme concentration will have no effect on the keq

4. A.

A reaction with a negative ΔG is exergonic, it proceeds spontaneously and free energy is released.

5. E.

In an exergonic reaction ΔG is negative and in an endergonic reaction it is positive. When ΔG is zero, the reaction is at equilibrium

6.B.

When the reactants are present in concentrations of 1.0 mol/L, ΔG0 is the standard free-energy change. For biochemical reaction, the pH (7.0) is also defined and this is ΔG0'.

7.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).

8. 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.

9. 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.

10. 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 → ΔG>0 → Keq<1 Rxn 3 → ΔG<0 → Keq>1 So Keq for rxn 1 < Keq for rxn 3, so option D is the false statement

11-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^0 =
-RT*lnKeq = - 0.001987*298*ln0.5 = +0.4 kcal/mol

12-D

Explanation: Each nucleoside triphosphate specializes in certain cellular
processes: - GTP in protein synthesis. - CTP in phospholipid synthesis. - UTP in polysaccharide synthesis.

13-B

Explanation: To calculate ΔG^0 for this reaction, we add the ΔG^0 values of its "component" reactions.

Notice that the reaction for which we wish we to calculate ΔG^0 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^0 by (-). A → B ΔG^0= 7 D → C ΔG^0= (-1) * 8 = -8 ΔG^0 =(7) + (-8) = -1 kcal/mole.

14. Answer: b
Explanation: Energy can neither be created nor be destroyed. It is only transduced from one form into another. Heat is also a form of energy; reactions in which heat is lost to the surroundings are termed as exothermic reactions and those in which heat is gained from the system are termed as endothermic reactions.

15. Answer: a
Explanation: According to the first and second laws of thermodynamics, the energy of the universe remains constant however the entropy increases owing to the randomness.

16. Answer: b
Explanation: The processes having negative Gibbs free energy (-ΔG) are termed as exergonic; are thermodynamically favored and are spontaneous in nature. Processes having +ΔG are endergonic, thermodynamically unfavorable and non-spontaneous.

17. Answer: a
Explanation: Cellular metabolism is essentially a non-equilibrium metabolism; that is the ratio of reactants to products is maintained in a non-equilibrium state. This makes most of the reactions irreversible.

18. Answer: a
Explanation: From the equation, $\Delta G = \Delta H - T\Delta S$
If $\Delta H = 0$ then $\Delta G = -T\Delta S$.

19. Answer: b
Explanation: If $\Delta G°$ is negative, products are favored.

20. Answer: a

Explanation: If the system is in equilibrium ∆G° = 0 and ∆G• = -RTlnkeq is the correct relation between K‘eq and ∆G‘°.

21. Answer: d

Explanation: If ∆G‘° < 0, reaction proceeds from left to right that means products are favored.

23-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.

24-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^0= +0.82 Lactate → Pyruvate ΔE^0= +0.19 (notice we multiplied by (-1) because it is the reversal of the reaction in the table) ➢ ΔE^0rxn= 0.82 + 0.19 = +1.01 ➢ From the equation ΔG^0= -nF* ΔE^0 ➢ If ΔE^0 is positive, then ΔG^0 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.

25-C

Explanation:

Use the equation: $\Delta G^0 = -nF^* \Delta E^0$ $\Delta E^0 = -0.19 - -0.32 = +0.13$ - Plug in values → Answer: -6

26-The answer is A.

The concentration of the substrates and products influence the direction of a reaction. Answer B is incorrect because reactions with a positive free energy, at 1 M concentrations of substrate and product, will proceed in the reverse direction. Answer C is incorrect because substrate and product concentrations do influence the free energy of a reaction. Answer D is incorrect because the free energy must be considered (in addition to the substrate and product concentrations) to determine the direction of a reaction. Answer E is false; an enzyme's efficiency does not influence the direction of a reaction.

27- The answer is C.

NAD+ accepts two electrons as hydride ions to form NADH (thus, A and B are incorrect). Answers D and E are incorrect because FAD can accept two single electrons from separate atoms, together with protons, or FAD can accept a pair of electrons.

28-The answer is D.

$\Delta G0'$ values are additive for a series of reactions. In order to generate the overall reaction required, creatine + ATP yields ADP + creatine phosphate, the second reaction listed in the question needs to be reversed. Upon reversing a reaction, the sign of the standard free energy is reversed, in this case becoming +10.3 for the reaction creatine + inorganic phosphate yields creatine phosphate + H2O. Upon summing the first reaction, and the reversed second reaction, the overall reaction is obtained and the $\Delta G0' = 10.3 - 7.3$, or +3.0 kcal/mol.