BIOLOGY 311C - Brand
Spring 2007

NAME (printed very legibly) _____**KEY**_____ UT-EID _____

EXAMINATION 3

Before beginning, check to be sure that this exam contains 7 pages (including front and back) numbered consecutively, and that you have been provided with a clean Answer Sheet. Then immediately print your name and UT-EID legibly at the top of this page. Also print and bubble in your name and your UT-EID (not your social security number) on the front of the answer sheet in the spaces provided. The first 41 questions are "multiple choice", with only one correct answer. Mark the letter corresponding to the correct answer to each of these questions in the appropriate location on the Answer Sheet, using a No. 2 pencil. Write answers to Questions 41 – 45 directly on this exam, in the spaces provided with the questions. Write in complete sentences if an explanation or a description is required. Print neatly if your handwriting is likely to be difficult to read. Turn in both this exam and the Answer Sheet after checking to be sure that your name is clearly written in both places and all questions have been answered in the appropriate locations. You must turn in you exam on or before 9:50 a.m.

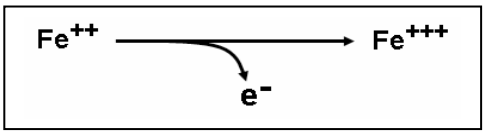
1. The sum of all chemical reactions of a living cell is called the cell's:
   a. energy balance.
   b. homeostasis.
   c. signaling sequence.
   d. metabolism.

2. The chemical substance often referred to as the energy currency of cells is:
   a. ATP.
   b. DNA.
   c. NADH.
   d. cyclic AMP.

3. Consider an enzyme that consists of a single polypeptide chain. The enzyme becomes denatured when a solution of the enzyme is heated to 50ºC. This denaturation is likely caused by a change in the enzyme's:
   a. primary structure.
   b. secondary structure.
   c. tertiary structure.
   d. quaternary structure.

4. The binding domain for a regulatory molecule of a regulatory enzyme is called a(an):
   a. allosteric site.
   b. active site.
   c. signal receptor.
   d. membrane receptor.

5. The half-reaction shown at right can be described as a(n):
   a. oxidation.
   b. reduction.
   c. de-protonation.
   d. hydrolysis.



Questions 6 - 8 relate to the reaction $X \rightleftharpoons Y$, with a K_{eq} value of 0.01. Recall that free energy changes for chemical reactions under standard conditions can be expressed as: $\Delta G^o = (-5.7 \text{ kJ/mole}) (\log_{10} K_{eq})$. [The K_{eq} was determined in that absence of any enzyme or other catalyst]

6. This chemical reaction may be described as:
   a. exergonic.
   b. spontaneous.
   c. endergonic.
   d. exothermic.

7. The ΔG^o value of this chemical reaction is:
   a. +11.4 kJ/mole.
   b. -5.7 kJ/mole.
   c. +5700 kJ/mole.
   d. -0.057 kJ/mole.

8. If this chemical reaction is measured in the presence of an enzyme that increases the rate of the reaction by 1,000 times. Then:
   a. the enzyme-catalyzed reaction will become exergonic.
   b. the K_{eq} of the enzyme-catalyzed reaction will be the same as that of the un-catalyzed reaction.
   c. the ΔG^o of the enzyme-catalyzed reaction will be 3 times that of the un-catalyzed reaction.
   d. the ΔG^o of the enzyme-catalyzed reaction will be much closer to 0 than that of the un-catalyzed reaction.

9. A competitive inhibitor of an enzyme-catalyzed reaction would be expected to:
   a. be an allosteric inhibitor.
   b. prevent transport of a substrate across a biological membrane.
   c. change the ΔG^o of the reaction.
   d. bind to the active site of the enzyme.

Questions 10 - 12 relate to the following chemical reaction, which is one of the steps of glycolysis.

$$\text{fructose-6-phosphate + ATP} \xrightleftharpoons[Mg^{2+}]{\text{phosphofructokinase}} \text{fructose-1,6-bisphosphate + ADP}$$

10. Which one of the following is a reactant in this reaction?
    a. Phosphofructokinase
    b. ATP
    c. Fructose-1,6-bisphosphate
    d. Mg^{2+}

11. Which one of the following is a cofactor in this reaction?
    a. Phosphofructokinase
    b. ATP
    c. Fructose-1,6-bisphosphate
    d. Mg^{2+}

12. Which one of the following is an enzyme in this reaction?
    a. Phosphofructokinase
    b. ATP
    c. Fructose-1,6-bisphosphate
    d. Mg^{2+}

13. Consider the oxidation state of a ketone and an aldehyde functional group. Then:
    a. the ketone functional group is more oxidized.
    b. the ketone functional group is more reduced.
    c. the two functional groups are at the same level of oxidation.
    d. both functional groups are more oxidized than is a carboxylic acid.

14. Which one of the following represents an oxidation reaction?
    a. The protonation of an amine functional group.
    b. The conversion of an aldotriose to a ketotriose.
    c. The hydrolysis of a polypeptide chain to produce individual amino acids.
    d. The conversion of two sulfhydryl functional groups to a disulfide.

15. Which one of the following is generally not true of a metabolic pathway?
    a. All of the reactions occur within the same compartment of a cell.
    b. Each reaction of the pathway must have a negative ΔG^{o} value.
    c. The product of one reaction is a reactant of the next reaction in the pathway.
    d. Regulation typically occurs at the enzyme catalyzing the first reaction of the pathway.

16. The difference between lactate and lactic acid is that lactic acid:
    a. is chemically more reduced.
    b. is protonated.
    c. is the D enantiomer of lactate.
    d. contains a bound molecule of H_2O.

17. Which one of the following takes place in the cytoplasmic matrix of eukaryotes?
    a. The Kreb cycle
    b. The Calvin Cycle
    c. Glycolysis
    d. Transcription

18. During the first few reactions (Phase 1) of glycolysis, ATP is:
    a. a product.
    b. a reactant.
    c. converted to cyclic AMP.
    d. converted to GTP.

19. Which one of the following is a product of Phase 2 (the pay-off phase) of glycolysis?
    a. Gluyceraldehyde-3-phosphate
    b. NADH
    c. Acetyl-Co-A
    d. Glucose-6-Phosphate

20. Which one of the following is not generally a fate of the pyruvate produced during glycolysis in humans?
    a. It is metabolized further in respiration.
    b. It is chemically reduced during fermentation.
    c. It is excreted from cells as a waste product.
    d. It serves as a food source for producing larger and more complex molecules.

21. Consider the complete fermentation of a molecule of glucose by baker's yeast or brewer's yeast. Then which one of the following is not a final product of this metabolic pathway?
    a. ATP
    b. NADH
    c. Ethyl alcohol
    d. CO_2

22. Pyruvate dehydrogenase may be considered a metabolic pathway, but it differs from most metabolic pathways in that:
    a. it involves transport of a substrate across a membrane.
    b. it is a cyclic metabolic pathway.
    c. it operates only in the light.
    d. its enzymes are bound together as a single enzyme complex.

23. The process of decreasing the rate of reaction of a metabolic pathway by decreasing the rate of synthesis of the enzymes that catalyze the reactions of the pathway is called:
    a. allosteric control.
    b. signal transduction.
    c. inhibition.
    d. repression.

24. Which one of the following is not a direct product of the Kreb cycle?
    a. Co-A
    b. ATP
    c. $NADP^+$
    d. CO_2

25. The function of oxidative photophorylation which is of most value in a respiring cell is:
    a. the synthesis of ATP.
    b. the production of organic molecules as substrates for anabolic pathways.
    c. to remove hydrogen atoms in fermentation.
    d. to reduce the concentration of O_2 in the cell.

26. ATP synthesis by the enzyme complex called ATP synthase in mitochondria and chloroplasts is driven by:
    a. phosphate transfer from a high energy molecule to ADP.
    b. dissipation of a proton gradient across a membrane.
    c. sliding actin filaments past each other through the use of motor molecules.
    d. the reduction of NAD^+.

27. Photosynthetic tissues appear green in color because of the presence of:
    a. carotenoids.
    b. electron transport molecules.
    c. pigments in the central vacuole.
    d. chlorophyll.

28. In considering the overall equation of photosynthesis as it occurs in green plants, which one of the following becomes oxidized?
    a. O_2
    b. CO_2
    c. H_2O
    d. Sugar

29. The two kinds of photosystems in plant chloroplasts are connected together chemically by a(n):
    a. electron transport chain.
    b. allosteric enzyme.
    c. metabolic pathway.
    d. signal transduction pathway.

30. Which one of the following is more closely associated with Photosystem 2 than with either Photosystem 1 or the Calvin cycle?

a. $NADP^+$ reduction
b. Cyclic photophorylation
c. CO_2 reduction
d. O_2 production

31. The two products of the light reactions of photosynthesis that are reactants for the dark reactions (Calvin cycle) are:
a. CO_2 and ATP.
b. sugar and NADH.
c. ATP and NADPH.
d. ADP and $NADP^+$.

32. The CO_2-fixing enzyme, rubisco, also uses a non-productive reactant, which causes photorespiration. This non-productive substrate is:
a. NH_4^+.
b. N_2.
c. HCO_3^-.
d. O_2.

33. CAM plants differ from normal C_3 plants in that CAM plants:
a. capture carbon dioxide from the atmosphere only at night.
b. first capture CO_2 in one kind of cell, then move it to an adjacent cell for C_3 photosynthesis.
c. do not produce any rubisco, and thus have only a modified Calvin cycle.
d. perform cyclic photophosphorylation, but not non-cyclic photophosphorylation.

34. A hormone affects a recipient cell during cell-to-cell communication within a multicellular organism by serving as a:
a. signal molecule.
b. receptor molecule.
c. critical component of a signal transduction pathway.
d. final response molecule within the cell.

35. Which one of the following kinds of signal molecule would you expect to bind to an intracellular receptor (as opposed to a transmembrane receptor)?
a. A small polar polypeptide like insulin
b. A glycoprotein
c. An oligosaccharide
d. A steroid

36. An enzyme that transfers a phosphate functional group from ATP to a protein is called a:
a. peptidyl transferase.
b. protein polymerase.
c. protein kinase.
d. ligand esterase.

37. An example of a final response in a signal pathway is:
a. replacement of GDP by GTP on a G protein.
b. phosphorylation of a protein.
c. binding of insulin to the plasma membrane.
d. repression of transcription.

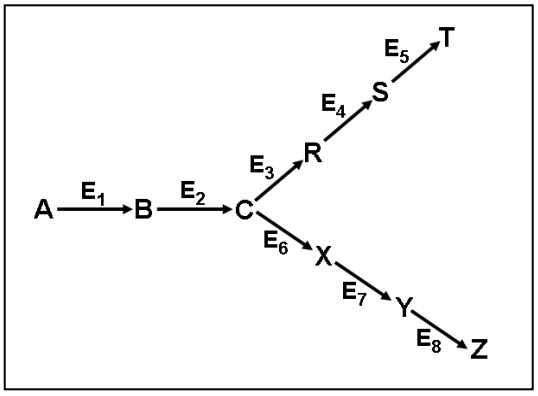
38. Which one of the following is not considered to be an information molecule in living cells?
a. Polysaccharide
b. DNA

c. RNA
d. Protein

39. The distinguishing feature of the S-phase of the cell cycle is:
a. reverse transcription.
b. DNA replication.
c. cytokinesis.
d. protein synthesis.

40. A reactant for the reaction catalyzed by DNA polymerase is:
a. ATP.
b. dGTP.
c. TDP.
d. $FADH_2$.

41. The illustration at right represents a branched metabolic pathway, where each letter "E" represents an enzyme. Which two of these enzymes are most likely to be under allosteric regulation?
a. E_1 and E_2
b. E_5 and E_8
c. E_3 and E_6
d. E_1 and E_8



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42. Explain, in three or less complete sentences, why the enzymatic activity of the two enzymes that you chose as an answer for Question 41 are most likely to be under allosteric regulation.

The cell might need more product T, but have sufficient product D. Then it should inhibit the enzyme that catalyzes the first reaction of the C-to-Z pathway (E_6) without slowing down the A-to-T pathway. By the same argument, the cell would inhibit enzyme E_3 in order to continue to produce product Z while inhibiting the production of product T.

43. Write a balanced equation for the complete respiration of a molecule of glucose in a eukaryotic cell. Include the harvested energy in your balanced equation.

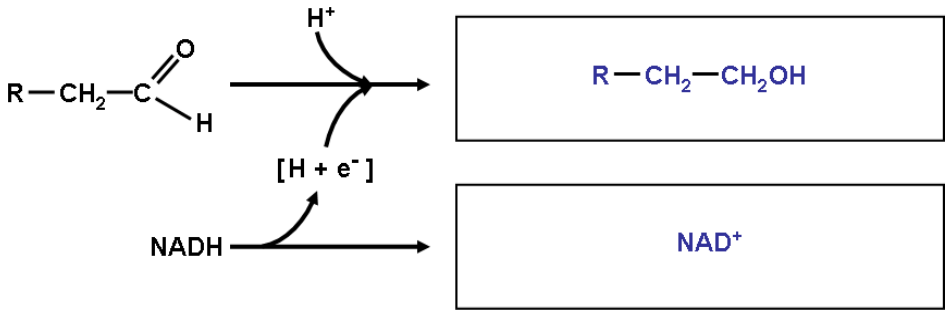
$$C_6H_{12}O_6 + 6\ O_2 + 36\{ADP + P_i\} \longrightarrow 6\ CO_2 + 6\ H_2O + 36\{ATP + H_2O\}$$

or

$$C_6H_{12}O_6 + 6\ O_2 \longrightarrow 6\ CO_2 + 6\ H_2O$$

$$36\ \{ADP + P_i\} \qquad 36\ \{ATP + H_2O\}$$

44. The equation illustrated below represents the chemical reaction catalyzed by the enzyme called alcohol dehydrogenase. It is shown as two half-reactions. The products of these half-reactions are not shown, except as empty boxes.



a. Write a structural formula of the product(s) of the top half-reaction in the upper box.

b. Write the name(s) or chemical formulas of the product(s) of the bottom half-reaction in the lower box.

45. Primary electrical charge separation is the first chemical process of photosynthesis. It can be illustrated by three sequential reactions. These three reactions are shown below, with intermediates replaced with empty boxes. Write these intermediates in the boxes to complete the equations.