BIOLOGY 311C - Brand
Spring 2009

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 37 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 38 – 41 directly on this exam, in the spaces provided with the questions. 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 written clearly on both, and that all questions have been answered in the appropriate locations. You must turn in your exam on or before 9:55 a.m.

1. Which one of the following would you expect to go in the reverse direction under standard conditions?
   a. The hydrolysis of ATP to ADP + P_i
   b. The hydrolysis of ATP to A + inorganic triphosphate
   c. The dehydration of glucose + P_i to glucose-6-phosphate
   d. The de-protonation of a carboxylic acid at pH 9

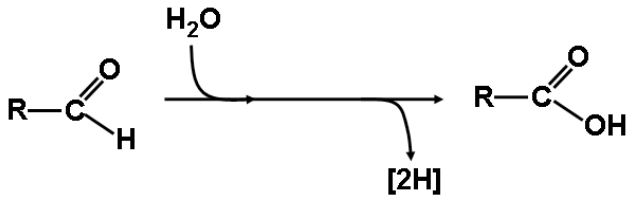
2. How many "high energy" phosphate bonds occur in the nucleotide dCDP?
   a. 0
   b. 1
   c. 2
   d. 3

3. Enzymes speed up the rates of chemical reactions by:
   a. lowering their energy of activation.
   b. increasing their energy of activation.
   c. decreasing their $\Delta G°$ value.
   d. increasing their $\Delta G°$ value.

4. An apoenzyme is a(n):
   a. enzyme that consists of less than 20 amino acids.
   b. surface to which an enzyme binds.
   c. substrate that also acts as an inhibitor of the enzyme.
   d. polypeptide component of a conjugated protein.

5. A typical enzyme is expected to:
   a. function rapidly over a narrow range of temperatures.
   b. function rapidly over a broad range of pH values.
   c. contain an adaptable binding site so it can react with many different kinds of substrate.
   d. be a fibrous protein.

6. The reaction shown at right is a(n):
   a. protonation.
   b. deprotonation.
   c. oxidation.
   d. reduction.



7. The primary function of FAD in living cells is to:
   a. carry hydrogen atoms.
   b. store metabolic energy.
   c. catalyze hydrolysis reactions.
   d. serve as a solar energy collector.

8. Which one of the following is not true of anabolic pathways?
   a. They increase the size and complexity of substrate.
   b. They typically require an input of energy in order to proceed in the forward direction.
   c. Substrate becomes oxidized.
   d. The final product is more valuable to the cell than the starting reactant(s).

9. Feed-back inhibition is an example of:
   a. allosteric regulation.
   b. non-enzymatic regulation.
   c. induction.
   d. repression.

10. The loss of one or more hydrogen atoms from a molecule is called a(n):
    a. protonation.
    b. de-protonation.
    c. dehydration.
    d. oxidation.

11. Transcription is the process of:
    a. duplication of a molecule of DNA to form a double helix.
    b. conversion of information stored in DNA into information expressed in RNA.
    c. conversion of information expressed in RNA into information expressed in a polypeptide chain.
    d. folding a polypeptide chain into a globular protein that serves as a functional enzyme.

12. Which one of the following is not a final product of the complete process of aerobic respiration?
    a. CO_2
    b. NADPH
    c. ATP
    d. H_2O

13. Which one of the following is oxidized in the overall process of respiration?
    a. Glucose
    b. ADP
    c. CO_2
    d. Mg^{2+}

14. Which one of the following is not a final product of glycolysis?
    a. Pyruvate
    b. ATP
    c. NADH
    d. Coenzyme A.

15. The overall efficiency of aerobic respiration is approximately:
    a. 0.15 %.
    b. 38 %.
    c. 76 %.
    d. 99.5 %

16. A product of glucose fermentation in human muscle cells is:
    a. ethyl alcohol.
    b. Acetyl-CoA
    c. NADH.
    d. lactate.

17. The hexokinase reaction of glycolysis:
    a. transfers a phosphate functional group from ATP to glucose.
    b. splits a C_6 sugar diphosphate into two C_3 sugar phosphates.
    c. transfers reducing units to O_2 in an electron transport chain.
    d. splits water to produce hydrogen atoms and release O_2.

18. When glycolysis is considered as two sequential phases, then a product of Phase 1 (the investment phase) is:
    a. NADH.
    b. pyruvate.
    c. ADP.
    d. α-ketoglutaric acid.

19. Pyruvate dehydrogenase is an enzyme complex that:
    a. occurs in the cytoplasmic matrix of eukaryotic cells.
    b. is required for ethanolic fermentation.
    c. functions in the dark reactions of photosynthesis.
    d. utilizes Coenzyme A as a reactant.

20. In the first enzyme-catalyzed reaction of the Krebs Cycle, Acetyl-CoA reacts with:
    a. α-ketoglutaric acid.
    b. FAD.
    c. a C_4 molecule.
    d. Fe^{2+}.

21. The electron transport chain of mitochondria occurs in the:
    a. matrix.
    b. intermembrane space.
    c. outer membrane.
    d. inner membrane.

22. Which one of the following components of mitochondria has a "spinning" structure that generates ATP?
    a. Cytochrome oxidase
    b. ATP synthase
    c. Pyruvate dehydrogenase
    d. Ribosome large subunit

23. The electron transport chains of chloroplasts and mitochondria generate stored energy in the form of:
    a. ATP.
    b. heat.
    c. a reduced C_6 compound.
    d. a proton gradient.

24. Prokaryotic cells can produce slightly more net ATP per molecule of glucose used in respiration than can eukaryotic cells (38 vs. 36) because:
    a, eukaryotic cells divert a portion of an intermediate substrate to fermentation.
    b. prokaryotic cells generally have a larger surface-to-volume ratio than do eukaryotic cells.
    c. the Krebs Cycle operates faster in prokaryotic cells than in eukaryotic cells.
    d. eukaryotic cells use ATP to transport respiration substrates into and out of mitochondria.

25. The metabolic pathway that is called the Calvin Cycle (or dark reactions) of photosynthesis can most accurately be described as:
    a. an endergonic pathway.
    b. an anabolic pathway.
    c. an electron transport chain.
    d. a light-harvesting unit.

26. How many quanta of light (photons) are required to produce one molecule of O_2 during photosynthetic linear electron transport through both photosystems?
    a. 1
    b. 2
    c. 4
    d. 8

27. The solar light collector molecule used in photosynthesis is:
    a. cytochrome.
    b. RUBISCO.
    c. chlorophyll.
    d. glycolipid.

28. In photosynthesis, NADPH is an immediate product of:
    a. Photosystem 1.
    b. Photosystem 2.
    c. the Calvin Cycle (dark reactions).
    d. light harvesting and primary electrical charge separation.

29. Which one of the following four processes of photosynthesis does <u>not</u> involve any chemical reaction?
    a. Light energy capture
    b. Photosynthetic electron transport
    c. Photophosphorylation
    d. The Calvin Cycle (dark reactions)

30. The main purpose of cyclic electron flow in photosynthesis is to:
    a. maximize the amount of oxygen produced per photon of light absorbed.
    b. enhance photorespiration.
    c. increase the ratio ATP to NADPH.
    d. convert metabolism in the chloroplast from C_3 to C_4 photosynthesis.

31. Which one of the following is not a component of a molecule of chlorophyll?
    a. A hydrophobic tail
    b. An aldohexose phosphate
    c. A magnesium ion
    d. A nitrogen-containing ring structure

32. The ATP synthase of chloroplasts occurs:
    a. in the stroma.
    b. in the lumen of thylakoids.
    c. within thylakoid membranes.
    d. within the inner membrane of the envelope.

33. The two products of the light reactions of photosynthesis that are required reactants for the dark reactions (Calvin Cycle) are:
    a. $NADP^+$ and ATP.
    b. $NADP^+$ and $(ADP + P_i)$.
    c. NADPH and $(ADP + P_i)$.
    d. NADPH and ATP.

34. The initial reaction of the Calvin Cycle of photosynthesis assimilates CO_2 into a product that immediately becomes:
    a. pyruvate.
    b. two C_3 molecules.
    c. a monomeric globular protein.
    d. Acetyl CoA.

35. Which one of the following is the least true of RUBISCO as it occurs in green plants?
    a. It is an oligomeric protein consisting of two kinds of monomeric polypeptide chains.
    b. It is a highly efficient enzyme for CO_2 fixation.
    c. It catalyzes a reaction of O_2 with a C_5 molecule.
    d. A component of it is synthesized in the cytoplasmic matrix.

36. A feature of C_4 photosynthesis that differs from C_3 photosynthesis is that:
    a. the initial assimilation of CO_2 into an organic molecule and photosynthesis occur in different cells.
    b. the initial assimilation of CO_2 into an organic molecule occurs only in the dark.
    c. photorespiration occurs at a much higher rate, reducing overall photosynthetic efficiency.
    d. Photosystem 1 is active, but not Photosystem 2.

37. A feature of CAM (Crassulacean Acid Metabolism) that differs from C_3 photosynthesis in that:
    a. the initial assimilation of CO_2 into an organic molecule and photosynthesis occur in different cells.
    b. the initial assimilation of CO_2 into an organic molecule occurs only in the dark.
    c. photorespiration occurs at a much higher rate, reducing overall photosynthetic efficiency.
    d. Photosystem 1 is active, but not Photosystem 2.

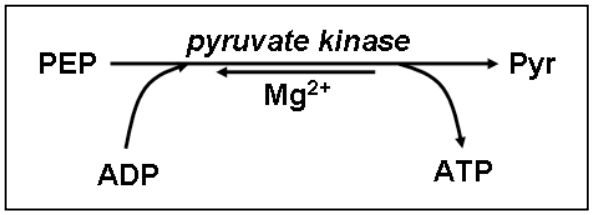
38. Show equations, in the correct order, for the first three reactions that occur at a reaction center of photosynthesis (i.e. primary electrical charge separation). Use the following designations: A (for electron acceptor), D (for electron donor), P (for reaction-center chlorophyll). Show energized and/or electrically charged forms of these components as were illustrated in presentation slides during the lectures.

(1) $D\ P\ A \longrightarrow D\ P^*\ A$

(2) $D\ P^*\ A \longrightarrow D\ P^+\ A^-$

(3) $D\ P^+\ A^- \longrightarrow D^+\ P\ A^-$

39. Answer the following questions regarding the metabolic reaction shown at right, by writing the correct names in the spaces provided. When writing components of the reaction, use the same designations as those shown at right. You must include all correct answers when more than one answer is correct, in order to receive full credit.



a. Which one(s) of the following terms apply to this reaction: [exergonic, endergonic, spontaneous]

exergonic, spontaneous

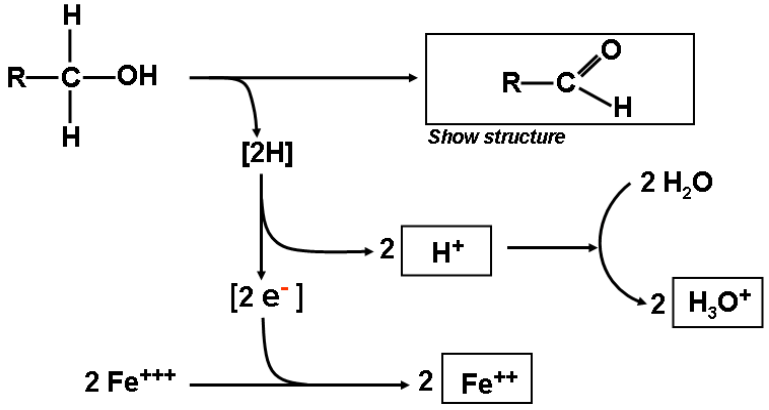
b. Which component(s) shown here is (are) substrate? **PEP, ADP, Pyr, ATP**

c. Which component(s) shown here is (are) product? **Pyr, ATP**

d. Which component(s) shown here is (are) enzyme? **pyruvate kinase**

e. Which component(s) shown here is (are) cofactor? **Mg^{2+}**

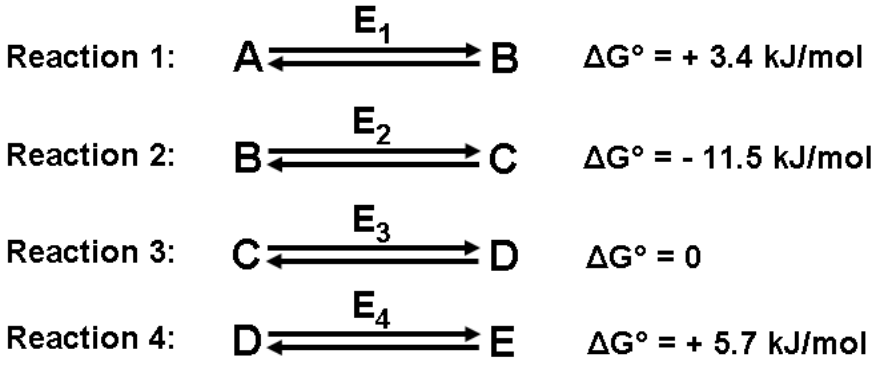
40. Answer each of the following questions, which pertain to the two coupled half-reactions shown at right.



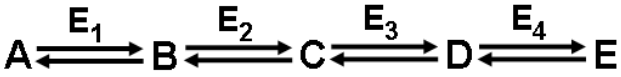
a. Show the missing component in each of the four boxes.

b. **aldehyde** What is the name of the functional group whose structure you showed in the top large box?

41. Answer the following questions regarding the 4 metabolic reactions shown below, which all occur in the same compartment of a cell. Parts c and d may have more than one answer.



a. In the space provided below, show these reactions coupled together as a metabolic pathway with all substrates and enzymes shown, as was illustrated in presentation slides during the lectures.



b. **- 2.4 kj/mol** In the space provided at left, write the ΔG° of this metabolic pathway.

c. ____**3**_____ In the space provided at left, write the number of all reaction(s) that have a K_{eq} value of exactly 1.

d. ___**1, 4**_____ In the space provided at left, write the number of reaction(s) have a K_{eq} value less than 1.