Testing Your Knowledge

Multiple Choice

1. A molecule is oxidized when it
   a. changes shape.
   b. gains a hydrogen (H^+) ion.
   c. loses a hydrogen (H^+) ion.
   d. gains an electron.
   e. loses an electron.

2. The main function of cellular respiration is
   a. breaking down toxic molecules.
   b. making ATP that powers cell activities.
   c. making food.
   d. producing chemical "building blocks" for cell structures.
   e. breaking down ATP, so that ADP and P can be reused.

3. In cellular respiration, _____ is oxidized and _____ is reduced.
   a. O_2 . . . ATP
   b. ATP . . . O_2
   c. glucose . . . O_2
   d. CO_2 . . . H_2O
   e. glucose . . . ATP

4. Most of the ATP produced in cellular respiration comes from
   a. glycolysis.
   b. chemiosmosis.
   c. lactic acid fermentation.
   d. biosynthesis.
   e. the Krebs cycle.

5. _____ is used and _____ is produced in the overall process of cellular respiration.
   a. CO_2 . . . H_2O
   b. O_2 . . . glucose
   c. H_2O . . . ATP
   d. glucose . . . CO_2
   e. ATP . . . O_2

6. The energy given up by electrons as they move through the electron transport chain is used to
   a. break down glucose.
   b. make NADH and $FADH_2$.
   c. pump H^+ through a membrane.
   d. oxidize water.
   e. manufacture glucose.

7. Fermentation is essentially glycolysis plus an extra step in which pyruvic acid is reduced to form lactic acid or alcohol and CO_2. This last step
   a. removes poisonous oxygen from the environment.
   b. extracts a bit more energy from glucose.
   c. enables the cell to recycle NAD^+.
   d. inactivates toxic pyruvic acid.
   e. enables the cell to make pyruvic acid into substances it can use.

8. A small amount of ATP is made in glycolysis and the Krebs cycle
   a. by transfer of a phosphate group from a fragment of glucose to ADP.
   b. using energy from the sun to perform the process of photosynthesis.
   c. by transport of electrons through a series of carriers.
   d. when electrons and hydrogen atoms are transferred to NAD^+.
   e. as a product of chemiosmosis.

9. The ATP synthase in a human cell gets energy for making ATP directly from
   a. sunlight.
   b. flow of H^+ through a membrane.
   c. oxidation of glucose.
   d. movement of electrons through a series of carriers.
   e. reduction of oxygen.

10. Which of the following describes glycolysis?
    a. It begins the oxidation of glucose.
    b. It produces a small amount of ATP.
    c. It generates NADH.
    d. It splits glucose to form two molecules of pyruvic acid.
    e. All of the above.

11. Most of the NADH that delivers high-energy electrons to the electron transport chain comes from
    a. chemiosmosis.
    b. the cytoplasm.
    c. glycolysis.
    d. biosynthesis.
    e. the Krebs cycle.

12. When protein molecules are used as fuel for cellular respiration, _____ are produced as waste.
    a. amino groups
    b. fatty acids
    c. sugar molecules
    d. molecules of lactic acid
    e. ethanol and CO_2

Essay

1. Describe the relationship between breathing and cellular respiration.
2. Compare the advantages and disadvantages of aerobic cellular respiration with the advantages and disadvantages of fermentation as methods of making ATP for cellular activities.
3. Compare the two mechanisms that generate ATP in cellular respiration—chemiosmotic phosphorylation and substrate-level phosphorylation. In what stage(s) of cellular respiration does each occur? Where does each get the energy for making ATP? Which produces the most ATP under aerobic conditions? Under anaerobic conditions?
4. Describe three ways in which poisons can interfere with cellular respiration.
5. Explain the roles of glycolysis and the Krebs cycle in the biosynthesis of organic molecules.

Applying Your Knowledge

Multiple Choice

1. Which of the following illustrates oxidation?
   a. $CO_2 + H_2O \longrightarrow C_6H_{12}O_6$
   b. $C_6H_{12}O_6 \longrightarrow CO_2 + H_2O$
   c. $ADP + P \longrightarrow ATP$
   d. $ATP \longrightarrow ADP + P$
   e. $H_2O \longrightarrow O_2 + H$
2. In an experiment, mice were fed glucose ($C_6H_{12}O_6$) containing a small amount of radioactive oxygen. The mice were closely monitored, and in a few minutes radioactive oxygen atoms showed up in
   a. CO_2.
   b. NADH.
   c. H_2O.
   d. ATP.
   e. O_2.
3. In a second experiment, mice were allowed to breathe oxygen gas (O_2) laced with radioactive oxygen. In this experiment, the radioactive oxygen atoms quickly showed up in
   a. CO_2.
   b. NADH.
   c. H_2O.
   d. ATP.
   e. glucose, $C_6H_{12}O_6$.
4. A chemist has discovered a drug that blocks glucose phosphate isomerase, an enzyme that catalyzes the second reaction in glycolysis. He wants to use the drug to kill bacteria in people with infections. But he can't do this because
   a. bacteria are facultative anaerobes; they usually don't need to do glycolysis.
   b. glycolysis produces so little ATP that the drug will have little effect.
   c. human cells also do glycolysis; the drug might also poison them.
   d. bacteria do not perform glycolysis.
   e. glycolysis can occur without the action of enzymes.
5. A glucose molecule is completely broken down in glycolysis and the Krebs cycle, but these two processes yield only a few ATPs. Where is the rest of the energy the cell obtains from the glucose molecule?
   a. in FAD and NAD^+
   b. in the oxygen used in the electron transport chain
   c. lost as heat
   d. in NADH and $FADH_2$
   e. in the CO_2 molecules released by the processes
6. Which of the following contains energy that a cell could use to make ATP?
   a. O_2
   b. CO_2
   c. NAD^+
   d. NADH
   e. H_2O
7. NADH is sometimes used by the cell in biosynthesis of needed organic molecules. Based on what you know about NADH, which of the following might be its function in biosynthesis?
   a. oxidizing organic molecules
   b. aiding in direct phosphorylation
   c. reducing organic molecules
   d. producing NAD^+
   e. breaking down ATP

8. Gram for gram, sugars are not as good as fats as a source of energy for cellular respiration, because sugars
   a. produce toxic amino groups when broken down.
   b. contain more hydrogen.
   c. usually bypass glycolysis and the Krebs cycle.
   d. contain fewer hydrogen atoms and electrons.
   e. are not as easily reduced.

9. A microbiologist discovered a new antibiotic that slowed the growth of bacteria by interfering with cellular respiration. She found that bacteria treated with the antibiotic produced about 15 ATP molecules for every glucose molecule they consumed. Which of the following hypotheses could explain the antibiotic's effect? The treated bacteria
   a. cannot perform glycolysis.
   b. have partially crippled electron transport chains.
   c. cannot produce NADH.
   d. have to rely at least partially on biosynthesis for their ATP.
   e. are forced to rely on fermentation for ATP.

10. A drug that blocks dehydrogenase enzymes would cause cells to
    a. run out of NADH.
    b. suffocate.
    c. deplete their supply of ADP.
    d. rely totally on electron transport and chemiosmosis for energy.
    e. be poisoned by lactic acid.

Essay

1. Fermentation is a much less efficient way to make ATP than aerobic cellular respiration. This being the case, why do you think the fermenters have not been driven to extinction by competition with aerobes?

2. Without oxygen, cellular respiration grinds to a standstill, although glycolysis can continue to make some ATP anaerobically for a short time. When oxygen runs out, why does electron transport stop? Why do you think the Krebs cycle stops?

3. FAD and NAD^+ are made from the B vitamins riboflavin and niacin. Why do you think these substances are required in such tiny amounts in your diet? How would a deficiency in one of these vitamins interfere with cell function?

4. After a biochemical analysis of the victim's tissues, brilliant biologist/criminal investigator J. C. Mickleberry announced his findings: "Contrary to the conclusions of the police, the victim did not suffocate. The electron carriers in his mitochondria were all in the oxidized state. We will need to perform a second autopsy to determine the actual cause of death." Explain how the data led Mickleberry to his conclusion.

5. A microbiologist poured a test tube full of yeast into a flask of sugar water and periodically took samples from the flask. At first, the amount of sugar in the flask decreased gradually. Then there was a sharp drop in sugar, accompanied by the appearance of ethanol in the flask. Explain these results.

Extending Your Knowledge

1. Look around your home and find as many products as possible that either contain yeast or were made by yeast. Why were yeasts used to make these products?

2. Health and fitness experts recommend 20 minutes of aerobic exercise at least three times a week for peak cardiovascular conditioning and weight control. What kinds of exercise do you do? Do you exercise enough?