

1. Glycolysis leads to the production of _____ and two molecules of ATP. In the absence of oxygen, fermentation leads to the production of _____. Glycolysis plus the citric acid cycle can convert the carbons of glucose to _____, storing the energy as ATP, _____ and _____.

- A. lactic acid, pyruvate, CO₂, NADH, FADH₂
- B. pyruvate, lactic acid, CO₂, NADH, FADH₂**
- C. CO₂, NADH, FADH₂, lactic acid, pyruvate
- D. O₂, lactic acid, pyruvate, FADH₂
- E. glucose, lactic acid, CO₂, NADH, FADH₂

2. At the end of glycolysis, each molecule of glucose has yielded 2 molecules of _____, 2 molecules of _____, and a net of 2 molecules of _____.

- A. FAD; NAD⁺; ADP
- B. CO₂; NAD⁺; ADP
- C. lactic acid; ethanol; CO₂
- D. pyruvate, NADH, ATP**
- E. H₂O; CO₂; ATP

3. Trematol is a metabolic poison derived from the white snake root. Cows eating this plant concentrate the poison in their milk. The poison inhibits liver enzymes that convert lactic acid to other compounds for metabolism. Why does physical exertion increase symptoms of poisoning by trematol? Why does the pH of the blood decrease in a person who has digested trematol?

- A. Physical exertion would increase the production of lactic acid by fermentation, and the build up of lactic acid decreases blood pH when liver enzymes are blocked.**
- B. Physical exertion increases metabolism, and the electron transport chain pumping H⁺ out of mitochondria increases blood pH.

4. Dinitrophenol (DNP) is an uncoupler, or has the ability to separate the flow of electrons and the pumping of H⁺ ions for ATP synthesis. This means that the energy from electron transfer cannot be used for ATP synthesis. Fifty years ago, DNP was given as a drug to help patients lose weight. Why does this work? Why would this be dangerous?

- A. Uncoupling the electron transport chain would inhibit fermentation and decrease ATP production, a potentially dangerous situation.
- B. If electron transport doesn't produce ATP, then much more sugar must be metabolized for energy needs. Very low production of ATP would be lethal.**

5. If you isolate mitochondria and place them in buffer with a low pH they begin to manufacture ATP. Why?

- A. Low pH increases the concentration of base causing mitochondria to pump out H⁺ to the inter membrane space leading to ATP production.
- B. The high external acid concentration causes an increase in H⁺ in the inter membrane space leading to increased ATP production by ATP synthetase.**
- C. Low pH increases the acid concentration in the mitochondrial matrix, a condition that normally causes ATP production.
- D. Low pH increases the OH⁻ concentration in the matrix resulting in ATP production by ATP synthetase.

6. A new drug was found to decrease Hepatitis B virus. The drug is an analogue of one of the nucleic acid bases of DNA and probably works by being incorporated into the virus and disrupting viral genes during viral DNA replication. However, patients in a clinical trial of the drug began to experience drastic overproduction of lactic acid and liver failure leading to death. The most likely explanation for the problem:

- A. **Incorporation of the drug into mitochondrial DNA disrupts the ability of mitochondria to make ATP.**
- B. The virus with mutations must overproduce lactic acid.

7. Explain why in anaerobic cells the ratio of pyruvate/ lactate is much less than 1 while under aerobic conditions the ratio of pyruvate/ lactate is much greater than 1.

- A. **lactate is produced from pyruvate only under anaerobic conditions**
- B. under anaerobic conditions pyruvate is converted to carbon dioxide
- C. in anaerobic conditions, pyruvate is converted to glucose using the energy of light
- D. lactate is the terminal electron acceptor under aerobic conditions
- E. pyruvate is transported into mitochondria under anaerobic conditions

8. Which of the following statements about mitochondria is false?

- A. They contain an inner and an outer membrane.
- B. The region enclosed by the inner membrane is termed the matrix.
- C. They contain DNA and ribosomes.
- D. They are an important site for energy production in cells.
- E. **They contain stacked internal thylakoid membranes.**

9. The electron transport chain is located predominantly in the:

- A. Outer membrane of the mitochondria
- B. Intermembrane space of the mitochondria
- C. **Inner membrane of the mitochondria**
- D. Matrix of the mitochondria
- E. Cytoplasm of the cell

10. What cellular compartment becomes acidic (high concentration of hydrogen ions) during mitochondrial electron transport?

- A. Mitochondrial stroma
- B. Cytoplasm
- C. Endoplasmic reticulum
- D. **Space between inner and outer mitochondrial membranes**
- E. Thylakoid membranes

11. In the absence of oxygen, the primary purpose of fermentation is to:

- A. produce amino acids for protein synthesis
- B. generate a proton gradient for ATP synthesis
- C. oxidize glucose to generate reduce electron carriers
- D. generate alcohol for beverages
- E. **regenerate NAD⁺ from NADH allowing glycolysis to continue**

12. In the first step of glycolysis, the enzyme hexokinase uses ATP to transfer a phosphate to glucose to form glucose-6-phosphate. The product continues to be oxidized forming pyruvate in glycolysis and is a precursor to acetyl-CoA for the citric acid cycle. Suppose that a cell has only glucose available for energy and that the activity of hexokinase is suddenly stopped in this cell. Which of the following conditions will occur?

- A. The cell will continue to produce energy from mitochondrial electron transport.
- B. The cell will continue to produce ATP using the citric acid cycle.
- C. The cell will ultimately be unable to produce ATP.**
- D. The cell will be forced to switch to fermentation to produce ATP.
- E. The use of oxygen by the cell will increase.

13. As a result of glycolysis, pyruvate oxidation and the citric acid cycle, only a small portion of the energy of glucose has been converted to ATP. At this point, the majority of the usable energy is contained in:

- A. oxidized electron carriers NAD⁺ and FAD
- B. carbon dioxide
- C. pyruvate
- D. acetyl coenzyme A
- E. reduced electron carriers NADH and FADH**

14. The terminal electron acceptor during mitochondrial respiration:

- A. H₂O
- B. NAD⁺
- C. FAD
- D. ATP
- E. O₂**

15. During a heart attack, blood flowing to the heart muscle is interrupted by blockage of a coronary artery. How would you expect the metabolism in the heart to change?

- A. oxidative phosphorylation would slow down in the mitochondria
- B. the rate of production of lactic acid would be stimulated
- C. the use of glucose by the muscle tissue would increase
- D. the production of water by mitochondria would be inhibited
- E. all are expected metabolic changes**

16. The major production of ATP during aerobic metabolism occurs when electrons from _____ and _____ are transferred to _____.

- A. FADH₂, NADH, H₂O
- B. O₂, FADH₂, NADH
- C. FADH₂, O₂, NADH
- D. NADH, O₂, FADH₂
- E. FADH₂, NADH, O₂**

17. ATP synthase can produce ATP using as a direct energy source:

- A. energy from the conversion of glucose to pyruvate
- B. energy from the oxidation of pyruvate producing CO₂ and H₂O
- C. energy from a proton gradient established in mitochondria**
- D. energy derived from the breakdown of NADH and FADH₂
- E. energy from the metabolism of amino acids

18. Which of the following is true about enzymes?
- A. Enzymes are catalysts and, therefore, increase the rate of a reaction while not being permanently altered by the reaction.
 - B. Enzymes are proteins that can be denatured by changes in pH or temperature.
 - C. Enzymes are highly specific for the substrates they react with and catalyze only one or a limited set of possible reactions with those substrates.
 - D. All of these are true about enzymes**
 - E. None of these are true about enzymes
19. Enzymes catalyze a reaction by _____.
- A. decreasing the amount of energy released by the reaction.
 - B. increasing the amount of energy released by the reaction.
 - C. decreasing the amount of activation energy needed to drive the reaction.**
 - D. increasing the amount of activation energy needed to drive the reaction
20. The _____ law of thermodynamics states that energy can be neither created nor destroyed.
- A. first**
 - B. second
 - C. third
 - D. fourth
 - E. fifth
21. _____ is the exergonic breakdown of substrates.
- A. metabolism
 - B. anabolism
 - C. catabolism**
 - D. exernism
22. _____ is the endergonic synthesis of molecules.
- A. metabolism
 - B. anabolism**
 - C. catabolism
 - D. exernism
23. An unfavorable reaction that requires an input of energy in order to proceed is _____.
- A. exergonic
 - B. endergonic**
 - C. impossible
 - D. none of these
24. _____ includes all chemical reactions occurring within a cell.
- A. metabolism**
 - B. anabolism
 - C. catabolism
 - D. exernism

25. If the nonprotein component of an enzyme is firmly attached to the protein it is called a(n)

- _____.
- A. apoenzyme
 - B. coenzyme
 - C. holoenzyme
 - D. prosthetic group**

26. The standard reduction potential of a redox reaction is a measure of the tendency of the _____ to _____ electrons.

- A. reductant; gain
- B. reductant; lose
- C. oxidant; gain**
- D. oxidant; lose

27. Which of the following represents work normally done by cells?

- A. synthesis of complex molecules
- B. nutrient uptake and waste elimination
- C. internal and external movement
- D. All of these**

28. You grow a FACULTATIVE anaerobe under AEROBIC conditions in a medium containing glucose as the sole carbon and energy source. Then, you suddenly SHIFT this culture to ANAEROBIC conditions. [No other suitable inorganic terminal-electron acceptors are available to substitute for oxygen.] During this shift in metabolism, the cells will do all except one of the following will take place. Which one will they NOT do?

- A. Quit producing ATP by substrate-level phosphorylation.**
- B. Quit the complete oxidation of glucose to carbon dioxide.
- C. Quit using the electron-transport system as a major route of hydrogen carrier reoxidation.
- D. Quit using the tricarboxylic acid cycle.
- E. Quit making a large quantity of ATP per molecule of glucose.

29. Let us assume that all of the glucose consumed by the yeast is converted to these two compounds. How many molecules of CARBON DIOXIDE and how many molecules of ETHANOL will be formed from each molecule of glucose?

- A. Two of carbon dioxide and two of ethanol.**
- B. One of carbon dioxide and two of ethanol.
- C. Three of carbon dioxide and one of ethanol.
- D. One of carbon dioxide and three of ethanol.
- E. Two of carbon dioxide and one of ethanol.

30. The Krebs's tricarboxylic acid cycle performs many important functions for cells. Which of the following IS NOT a function of the TCA cycle?

- A. To produce lactic acid or ethanol and thereby recycle reduced electron carriers.**
- B. To produce intermediates for amino acid synthesis.
- C. To reduce hydrogen carriers that feed their hydrogens into the electron-transport chain and promote oxidative phosphorylation.
- D. To provide for continued oxidation of pyruvate (acetyl-Co A).
- E. To yield carbon dioxide from glucose.

31. Which of the following descriptions most accurately describes the citric acid cycle? A cyclic sequence of biochemical reactions by which _____.

- A. ATP is produced
- B. pyruvic acid is reduced
- C. glucose is broken down to pyruvic acid
- D. ATP is produced from the oxidation of pyruvic acid
- E. NADH₂ is produced from the oxidation of pyruvic acid**

32. Inorganic phosphate can be assimilated by _____.

- A. oxidative phosphorylation
- B. photophosphorylation
- C. substrate level phosphorylation
- D. all of the above**
- E. none of the above

33. Which of the following is the correct sequence of reactions found in the citric acid cycle?

- A. pyruvic acid -> citric acid -> oxaloacetic acid
- B. citric acid -> alpha-ketoglutaric acid -> isocitric acid
- C. alpha-ketoglutaric acid -> succinic acid -> succinyl-CoA
- D. succinic acid -> fumaric acid -> malic acid**
- E. fumaric acid -> oxaloacetic acid -> citric acid