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Section 9–2 The Krebs Cycle and Electron Transport (pages 226–232)

Key Concepts

- What happens during the Krebs cycle?
- How are high-energy electrons used by the electron transport chain?

Introduction (page 226)

1. At the end of glycolysis, how much of the chemical energy in glucose is still unused?
About 90 percent is still unused.

2. Because the final stages of cellular respiration require oxygen, they are said to be aerobic.

The Krebs Cycle (pages 226–227)

3. In the presence of oxygen, how is the pyruvic acid produced in glycolysis used?
It passes to the second stage of cellular respiration, the Krebs cycle.

4. What happens to pyruvic acid during the Krebs cycle? It is broken down into carbon dioxide in a series of energy-extracting reactions.

5. Why is the Krebs cycle also known as the citric acid cycle? Citric acid is the first compound formed in this series of reactions.

6. When does the Krebs cycle begin? It begins when pyruvic acid produced by glycolysis enters the mitochondrion.

7. What happens to each of the 3 carbon atoms in pyruvic acid when it is broken down?
One carbon atom becomes part of a molecule of carbon dioxide. Two of the carbon atoms are joined to a compound called coenzyme A to form acetyl-CoA.

8. What happens to the carbon dioxide produced in breaking down pyruvic acid?
It is released into the air.

9. How is citric acid produced? Acetyl-CoA adds the 2-carbon acetyl group to a 4-carbon molecule, producing a 6-carbon molecule called citric acid.

10. During the energy extraction part of the Krebs cycle, how many molecules of CO_2 are released? Two molecules are released.

11. What is the energy tally from 1 molecule of pyruvic acid during the Krebs cycle?
It is 4 NADH molecules, 1 $FADH_2$ molecule, and 1 ATP molecule.

12. When electrons join NAD^+ and FAD during the Krebs cycle, what do they form?
They form NADH and $FADH_2$.

13. Why is the 4-carbon compound generated in the breakdown of citric acid the only permanent compound in the Krebs cycle? It is regenerated at the end of each complete turn of the cycle.

Electron Transport (pages 228–229)

14. What is the electron transport chain? It is a series of proteins in the inner membrane of mitochondria.

15. What does the electron transport chain use the high-energy electrons from the Krebs cycle for? The chain uses the electrons to convert ADP into ATP.

16. How does the location of the electron transport chain differ in eukaryotes and prokaryotes? In eukaryotes, the chain is composed of a series of proteins located in the inner membrane of the mitochondrion. In prokaryotes, the chain is in the cell membrane.

17. Where does the electron transport chain get the high-energy electrons that are passed down the chain? It gets the electrons from NADH and $FADH_2$, which are produced in the Krebs cycle.

18. Is the following sentence true or false? Hydrogen serves as the final electron acceptor of the electron transport chain. false

19. What is the energy of the high-energy electrons used for every time 2 high-energy electrons move down the electron transport chain? Their energy is used to transport hydrogen ions across the membrane.

20. What causes the H^+ ions in the intermembrane space to move through the channels in the membrane and out into the matrix? During electron transport, H^+ ions build up in the intermembrane space, making it positively charged. The other side of the membrane, from which those H^+ ions have been taken, is now negatively charged. The charge differences that build up cause the ions to move.

21. On average, how many ATP molecules are produced as each pair of high-energy electrons moves down the electron transport chain? Three ATP molecules are produced.

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22. Complete the flowchart about electron transport. (Review Figure 9–7 on page 228 of your textbook.)

High-energy electrons from NADH and $FADH_2$ are passed into and along the electron transport chain.

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The energy from the electrons moving down the chain is used to move H^+ ions across the inner membrane.

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H^+ ions build up in the intermembrane space, making it positively charged and making the matrix negatively charged.

↓

H^+ ions move through channels of ATP synthase in the inner membrane.

↓

The ATP synthase uses the energy from the moving ions to combine ADP and phosphate, forming high-energy ATP.

The Totals (page 229)

23. How many ATP molecules are formed during cellular respiration? 36

24. Why is more ATP generated from glucose in the presence of oxygen?

When oxygen is not available, the Krebs cycle and electron transport cannot proceed, and glycolysis produces just 2 ATP molecules per glucose molecule. Under aerobic conditions, the Krebs cycle and electron transport enable the cell to produce 34 more ATP molecules per glucose molecule.

25. What happens to the energy of glucose that is not used to make ATP molecules?

It is released as heat.

26. What are the final waste products of cellular respiration? They are water and carbon dioxide.

Energy and Exercise (pages 230–231)

27. What are three sources of ATP a human body uses at the beginning of a race?

Three sources are ATP already in the muscles, new ATP made by lactic acid fermentation, and cellular respiration.

28. When a runner needs quick energy for a short race, what source can supply enough ATP for about 90 seconds? Lactic acid fermentation can supply the ATP.

29. Why does a sprinter have an oxygen debt to repay after the race is over? Lactic acid fermentation produces lactic acid as a byproduct. The only way to get rid of the lactic acid is in a chemical pathway that requires extra oxygen.

30. A runner needs more energy for a longer race. How does the body generate the necessary ATP? Cellular respiration is the only way to generate a continuing supply of ATP.

31. Why are aerobic forms of exercise so beneficial for weight control? Stores of glycogen used in cellular respiration usually last for 15 to 20 minutes. After that, the body begins to break down other stored molecules, including fats, for energy.

Comparing Photosynthesis and Cellular Respiration (page 232)

32. If photosynthesis is the process that "deposits" energy in a "savings account," then what is cellular respiration? It is the process that "withdraws" energy.

33. How are photosynthesis and cellular respiration opposite in terms of carbon dioxide? Photosynthesis removes carbon dioxide from the atmosphere, and cellular respiration puts it back.

34. How are photosynthesis and cellular respiration opposite in terms of oxygen? Photosynthesis releases oxygen into the atmosphere, and cellular respiration uses the oxygen to release energy from food.