

9.3 Fermentation

Lesson Objectives

- ☑ Explain how organisms get energy in the absence of oxygen.
- ☑ Identify the pathways the body uses to release energy during exercise.

Lesson Summary

Fermentation Fermentation releases energy from food molecules by producing ATP without oxygen. Cells convert NADH to the electron carrier NAD⁺. This allows glycolysis to produce a steady stream of ATP. There are two forms of fermentation. Both start with the reactants pyruvic acid and NADH.

- ▶ alcoholic fermentation produces ethyl alcohol and carbon dioxide
 - occurs in yeast and a few other microorganisms
 - produces alcoholic beverages and causes bread dough to rise
- ▶ lactic acid fermentation produces lactic acid
 - occurs in most organisms, including humans
 - used to produce beverages such as buttermilk and foods such as cheese, yogurt, and pickles

Energy and Exercise The body uses different pathways to release energy.

- ▶ For short, quick bursts of energy, the body uses ATP already in muscles as well as ATP made by lactic acid fermentation.
- ▶ For exercise longer than about 90 seconds, cellular respiration is the only way to continue generating a supply of ATP.

Fermentation

For Questions 1–6, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

- T 1. Glycolysis provides the pyruvic acid molecules used in fermentation.
- F NAD⁺ 2. Fermentation allows glycolysis to continue by providing the NADPH needed to accept high-energy electrons.
- F Anaerobic 3. Fermentation is an aerobic process.
- F Cytoplasm 4. Fermentation occurs in the mitochondria of cells.
- T 5. Alcoholic fermentation gives off carbon dioxide and is used in making bread.
- T 6. Most organisms perform fermentation using a chemical reaction that converts pyruvic acid to lactic acid.

7. Compare and contrast fermentation and cellular respiration by completing the compare/contrast table. Write your answers in the empty table cells.

Aspect	Fermentation	Cellular Respiration
Function	MAKE ATP w/o O ₂	MAKE ATP w/ O ₂
Reactants	Pyruvic Acid + NADH	Glucose + O ₂ (C ₆ H ₁₂ O ₆)
Products	L.A. ATP Lactic Acid A.F. Alcohol + CO ₂	CO ₂ + H ₂ O + ATP

8. Compare and contrast alcoholic fermentation and lactic acid fermentation by completing the compare/contrast table. Write your answers in the empty table cells.

Type of Fermentation	Summary Equation	Use in Industry
Alcoholic	Pyruvic Acid + NADH → Alcohol + CO ₂ + NAD ⁺	make Alcoholic Bev. + Bread
Lactic acid	Pyruvic Acid + NADH → Lactic Acid + NAD ⁺	Yogurt, Sour Cream, Cheese

9. What causes humans to become lactic acid fermenters?
LACK OF O₂ & high demand for energy

Energy and Exercise

10. What are three main sources of ATP available for human muscle cells?
ATP From Lactic Acid Fermentation
ATP From cell respiration
✓ ATP stored in muscle cells
11. During a race, how do your muscle cells produce ATP after the store of ATP in muscles is used?
Lactic Acid Fermentation
12. Why does a sprinter have an oxygen debt to repay after the race is over?
Extra O_2 is needed to remove the buildup of Lactic Acid.
13. A runner needs more energy for a longer race. How does the body generate the necessary ATP?
Cellular respiration
14. Why are aerobic forms of exercise so beneficial for weight control?
After 15-20 min the body will use stored fat for energy

Apply the Big idea

15. Compare and contrast the role of fermentation and cellular respiration in the actual production of ATP. In your response, consider which process produces ATP and which process contributes to its production.
- _____
- _____
- _____
- _____