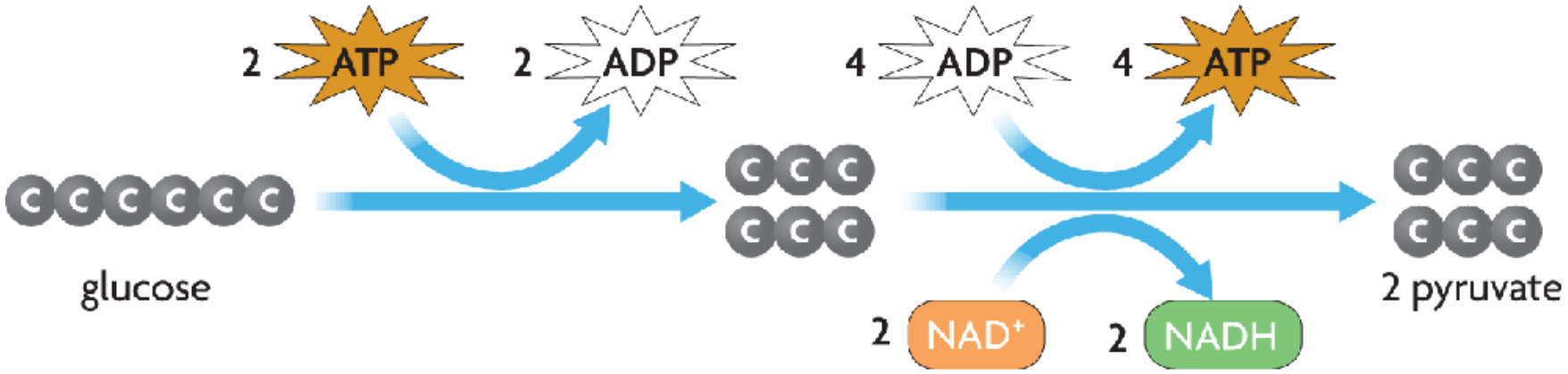
Chapter 4: Cellular Metabolism

KEY CONCEPT

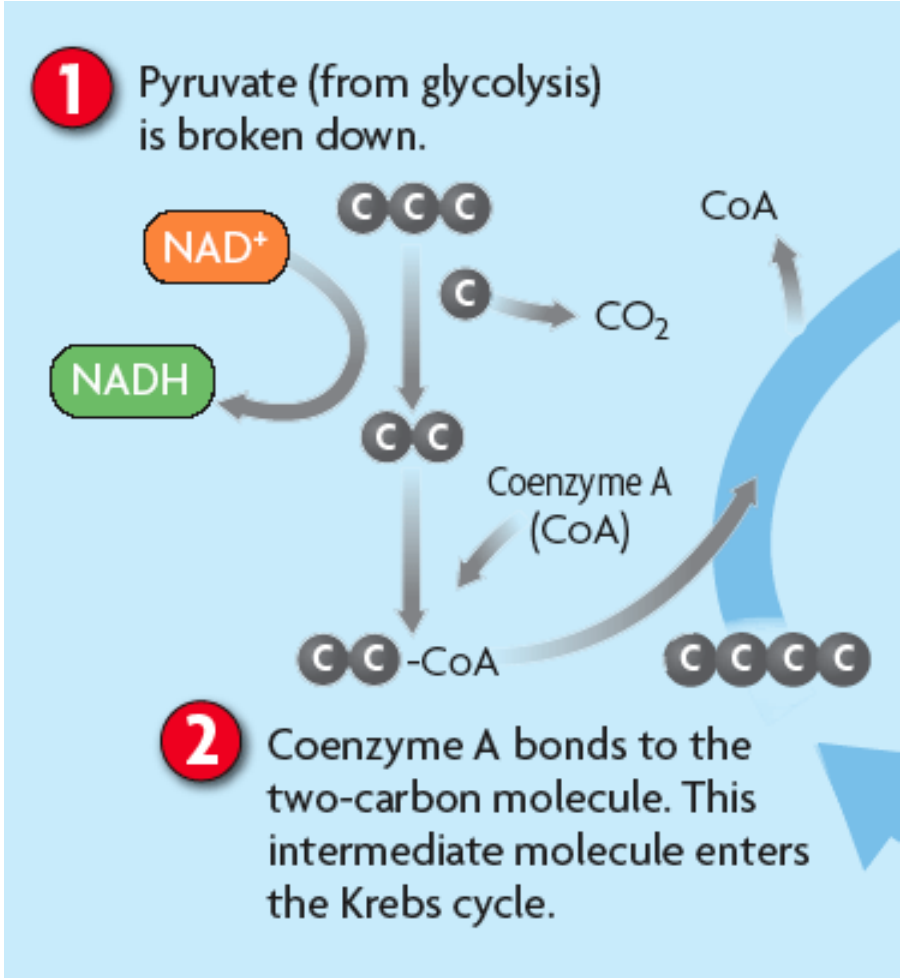
Cellular respiration is an aerobic process with two main stages.

Glycolysis is needed for cellular respiration.

- The products of glycolysis enter cellular respiration when oxygen is available.
  - two ATP molecules are used to split glucose
  - four ATP molecules are produced
  - two molecules of NADH produced
  - two molecules of pyruvate produced



- **The Krebs cycle is the first main part of cellular respiration.**
  - Pyruvate is broken down before the Krebs cycle.
    - carbon dioxide released
    - NADH produced
    - coenzyme A (CoA) bonds to two-carbon molecule



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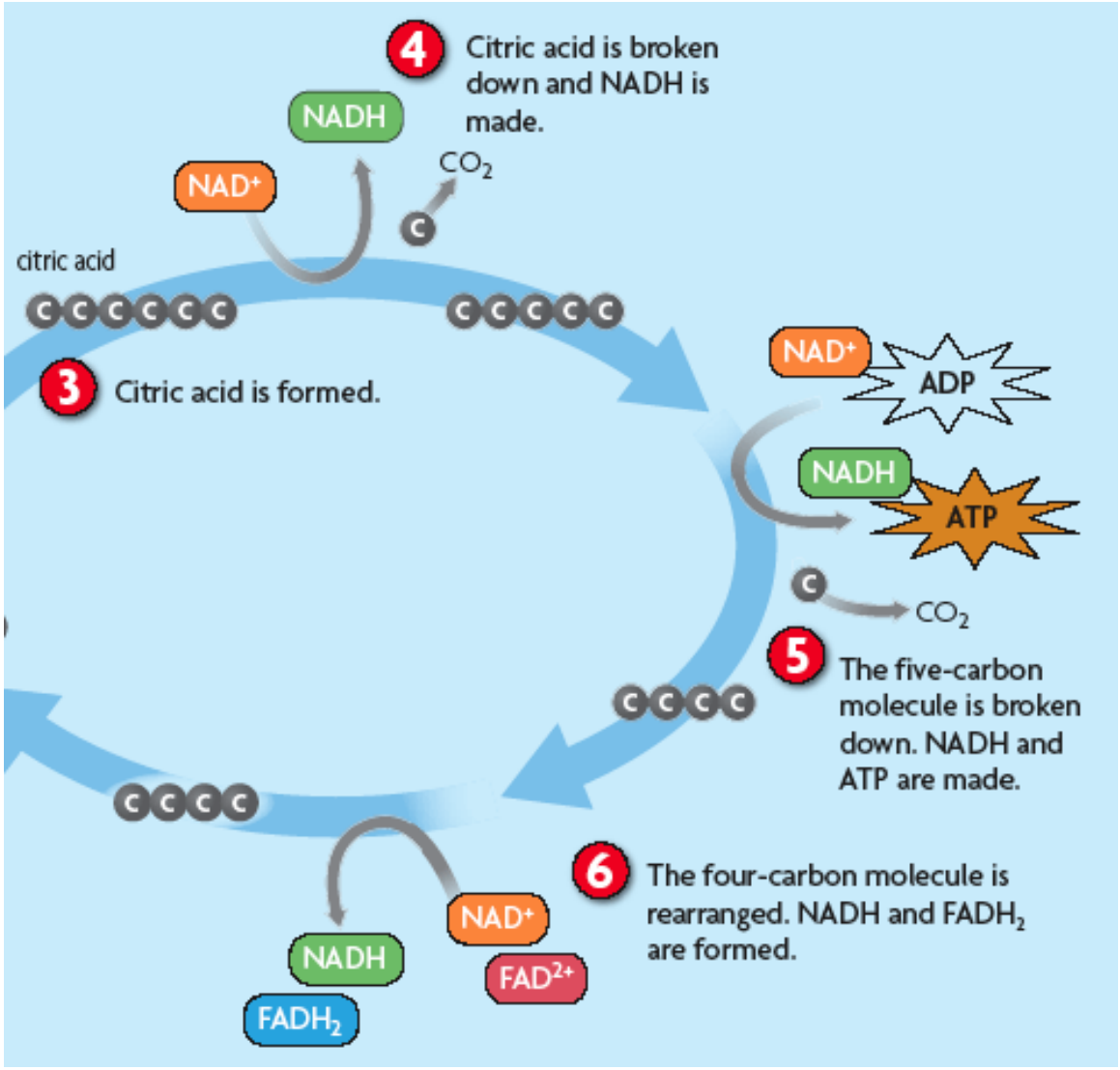
- The Krebs cycle produces energy-carrying molecules.



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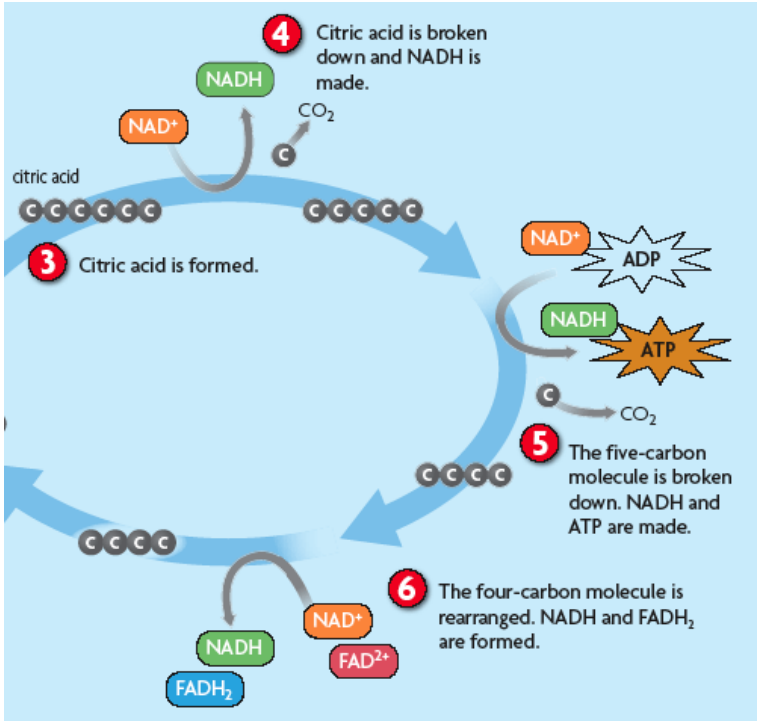
- The Krebs cycle produces energy-carrying molecules.
  - NADH and $FADH_2$ are made
  - intermediate molecule with CoA enters Krebs cycle
  - citric acid (six-carbon molecule) is formed
  - citric acid is broken down, carbon dioxide is released, and NADH is made



  - five-carbon molecule is broken down, carbon dioxide is released, NADH and ATP are made
  - four-carbon molecule is rearranged

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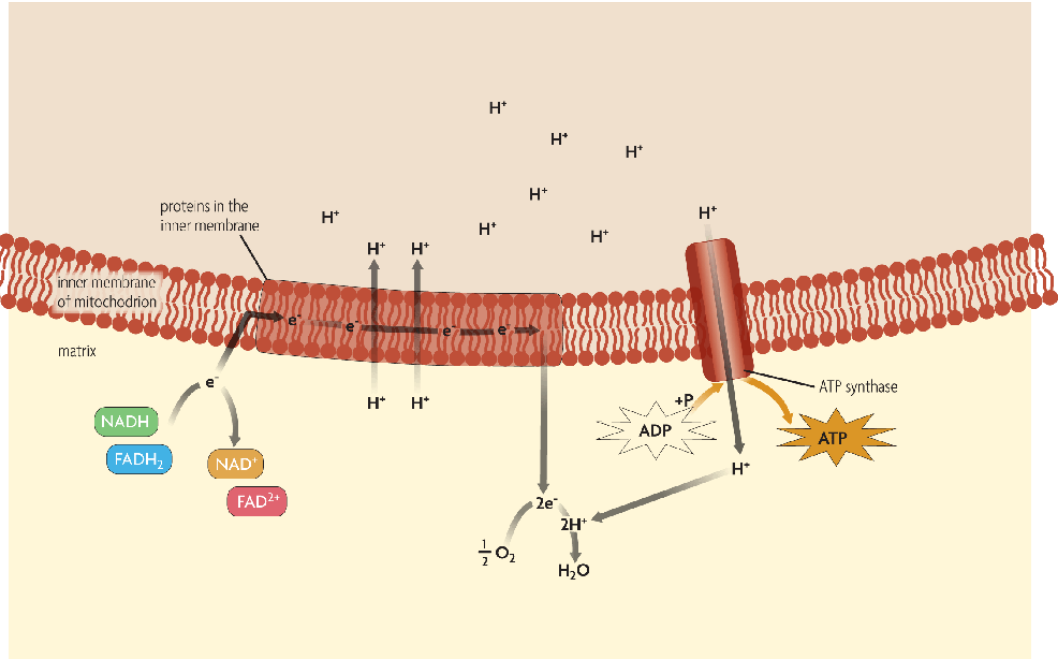
- **The electron transport chain is the second main part of cellular respiration.**
  - The electron transport chain uses NADH and $FADH_2$ to make ATP.
    - high-energy electrons enter electron transport chain
    - energy is used to transport hydrogen ions across the inner membrane
    - hydrogen ions flow through a channel in the membrane



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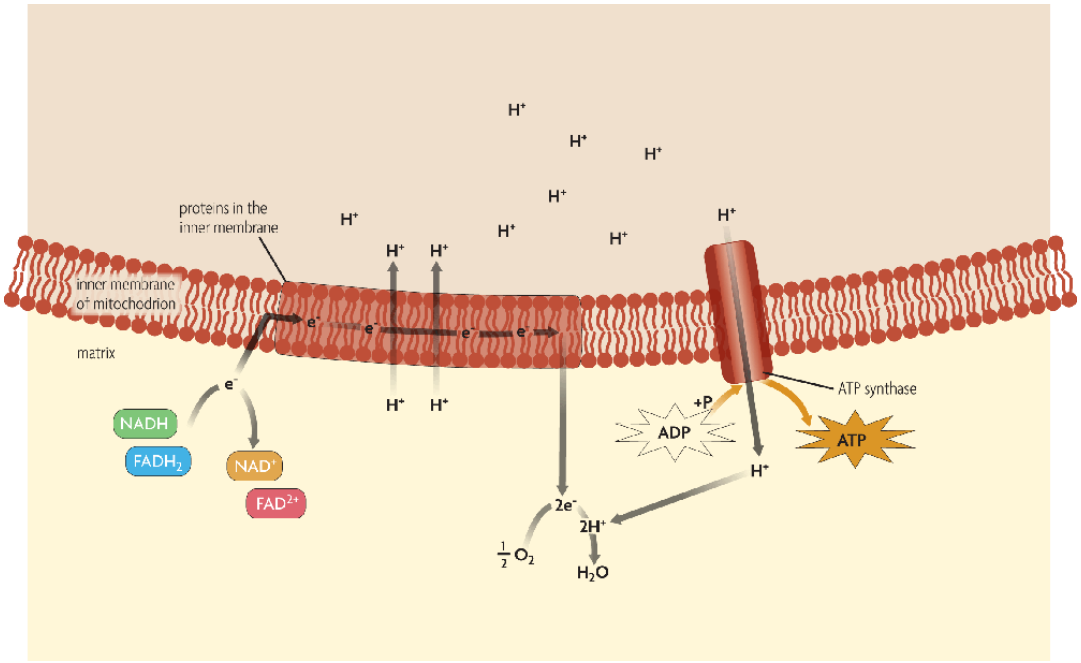
- **The electron transport chain is the second main part of cellular respiration.**
  - The electron transport chain uses NADH and $FADH_2$ to make ATP.
  - The breakdown of one glucose molecule produces up to 38 molecules of ATP.
    - ATP synthase produces ATP
    - oxygen picks up electrons and hydrogen ions
    - water is released as a waste product



Chapter 4: Cellular Metabolism

KEY CONCEPT

Fermentation allows the production of a small amount of ATP without oxygen.

Chapter 4: Cellular Metabolism

- If no oxygen is available, cells can obtain energy through the process of *anaerobic respiration*.
- A common anaerobic process is *fermentation*.
- Fermentation is not an efficient process and results in the formation of far fewer ATP molecules than aerobic respiration.

There are two primary fermentation processes:

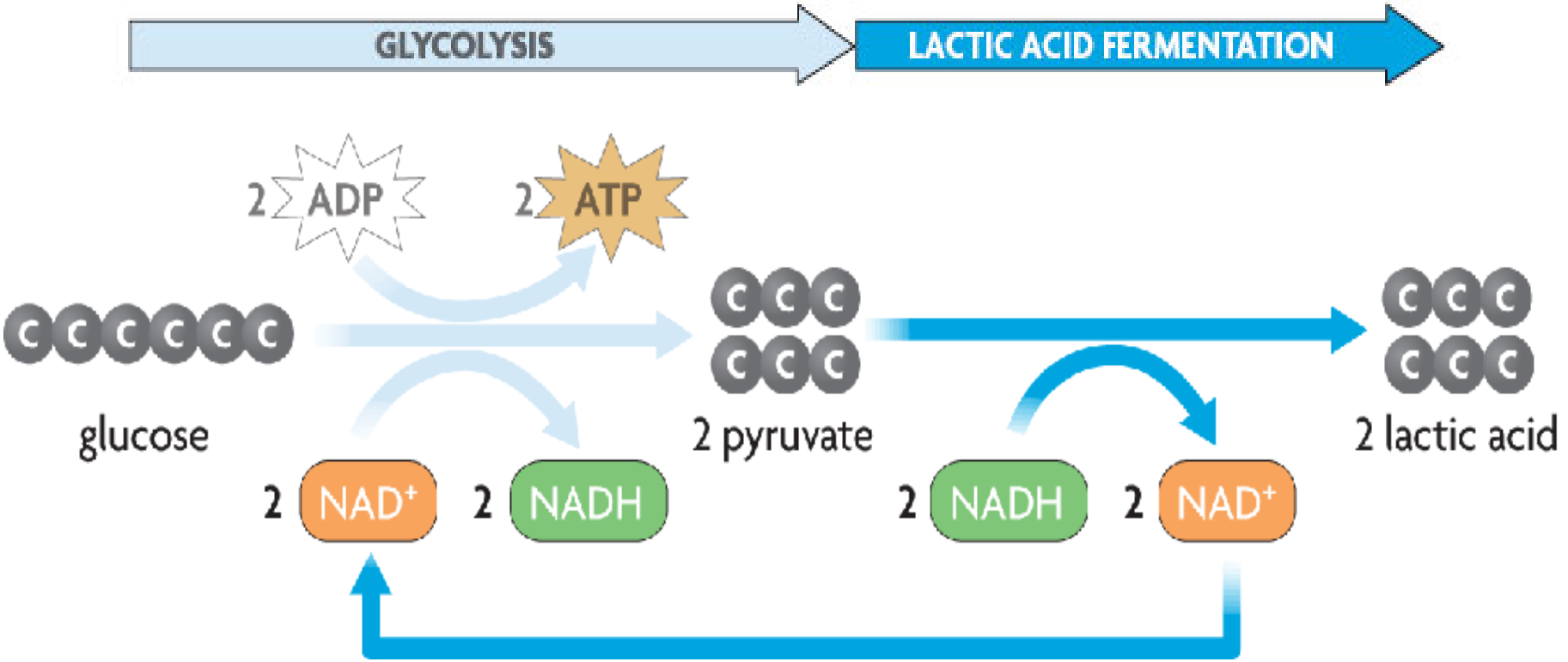
1. Lactic Acid Fermentation
2. Alcohol Fermentation

Lactic acid fermentation occurs when oxygen is not available.

For example, in muscle tissues during rapid and vigorous exercise, muscle cells may be depleted of oxygen. They then switch from respiration to fermentation.

The pyruvic acid formed during glycolysis is broken down to lactic acid and energy is released (which is used to form ATP).

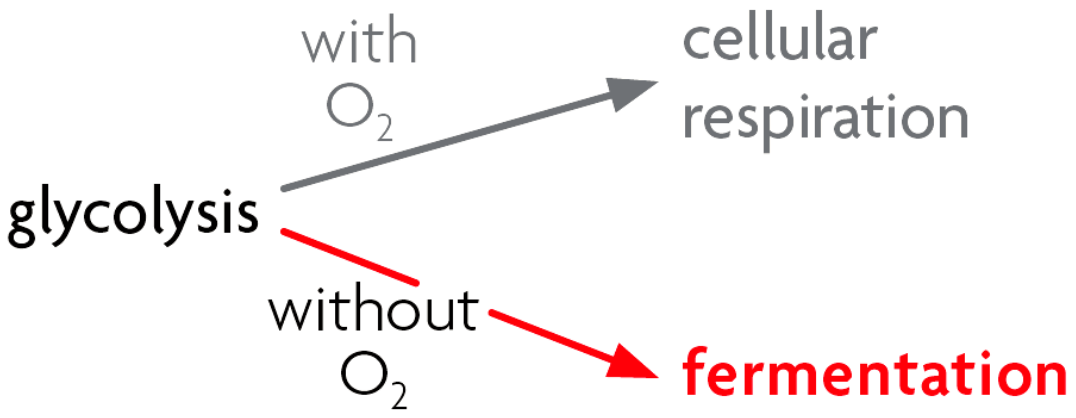
Glucose → Pyruvic acid → Lactic acid + energy



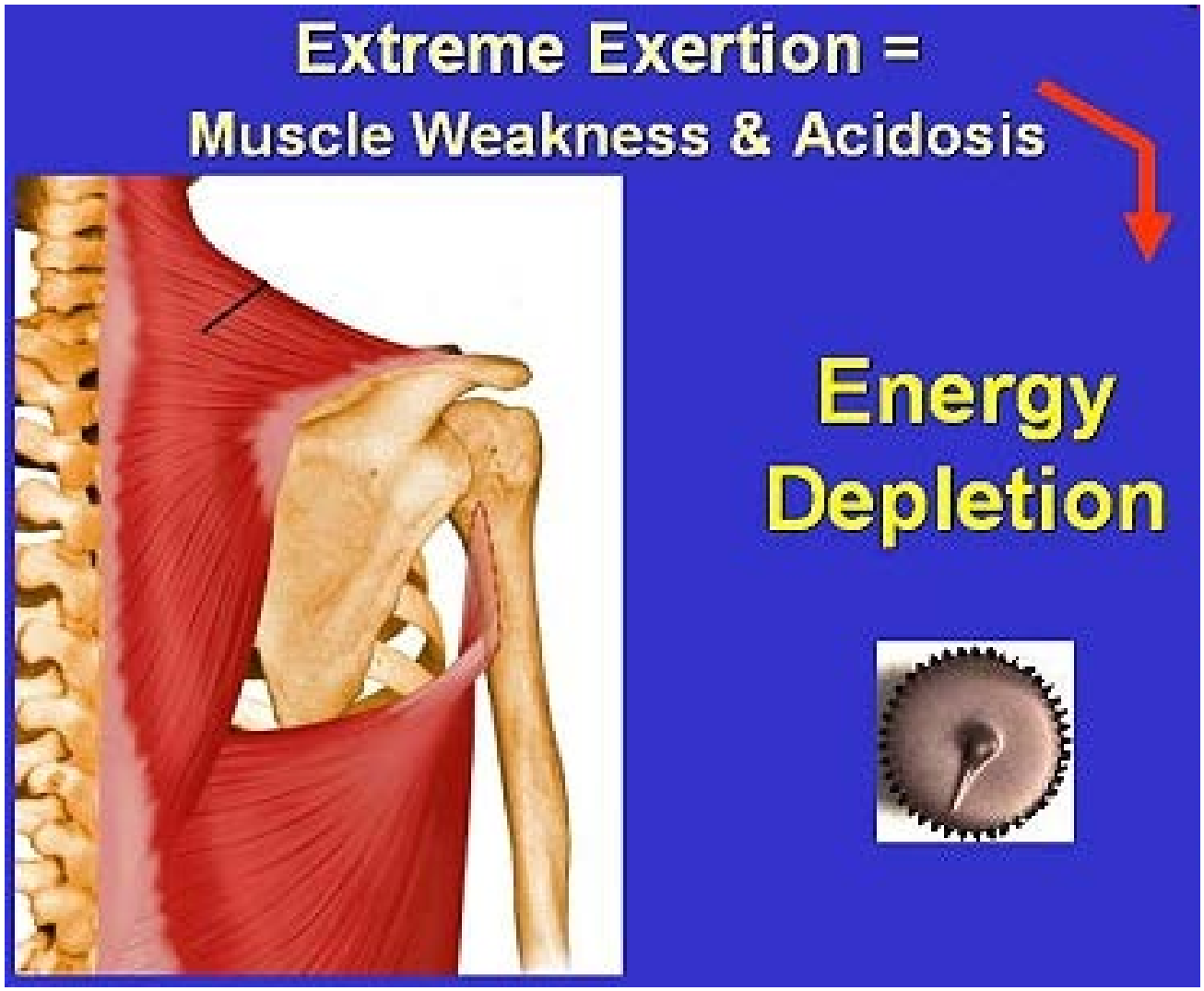
•The process of **lactic acid fermentation** replaces the process of aerobic respiration so that the cell can have a continual source of energy, even in the absence of oxygen.

•However this shift is only temporary and cells need oxygen for sustained activity.

Fermentation is an anaerobic process that allows glycolysis to continue.

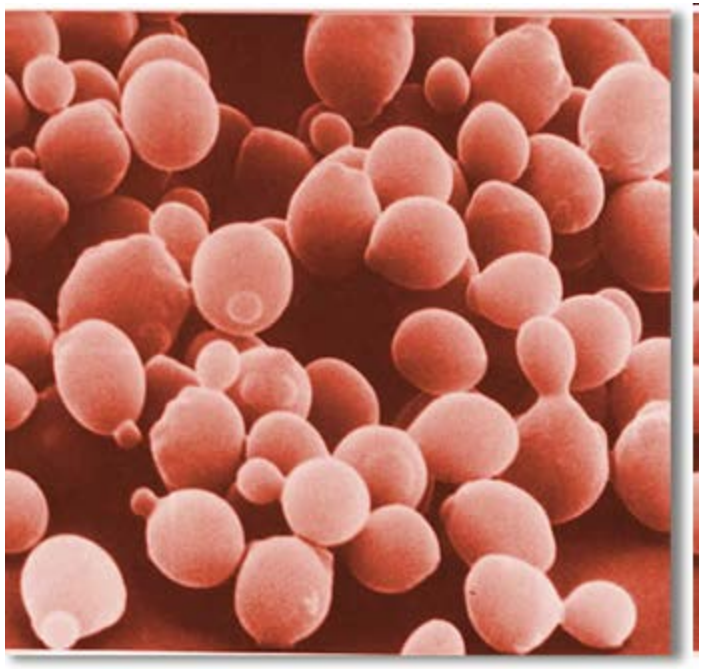


•Lactic acid that builds up in the tissue causes a burning, painful sensation.



Alcohol fermentation occurs in yeasts and some bacteria.

Pyruvic acid formed during glycolysis is broken down to produce alcohol and carbon dioxide and is released (which is used to form ATP).



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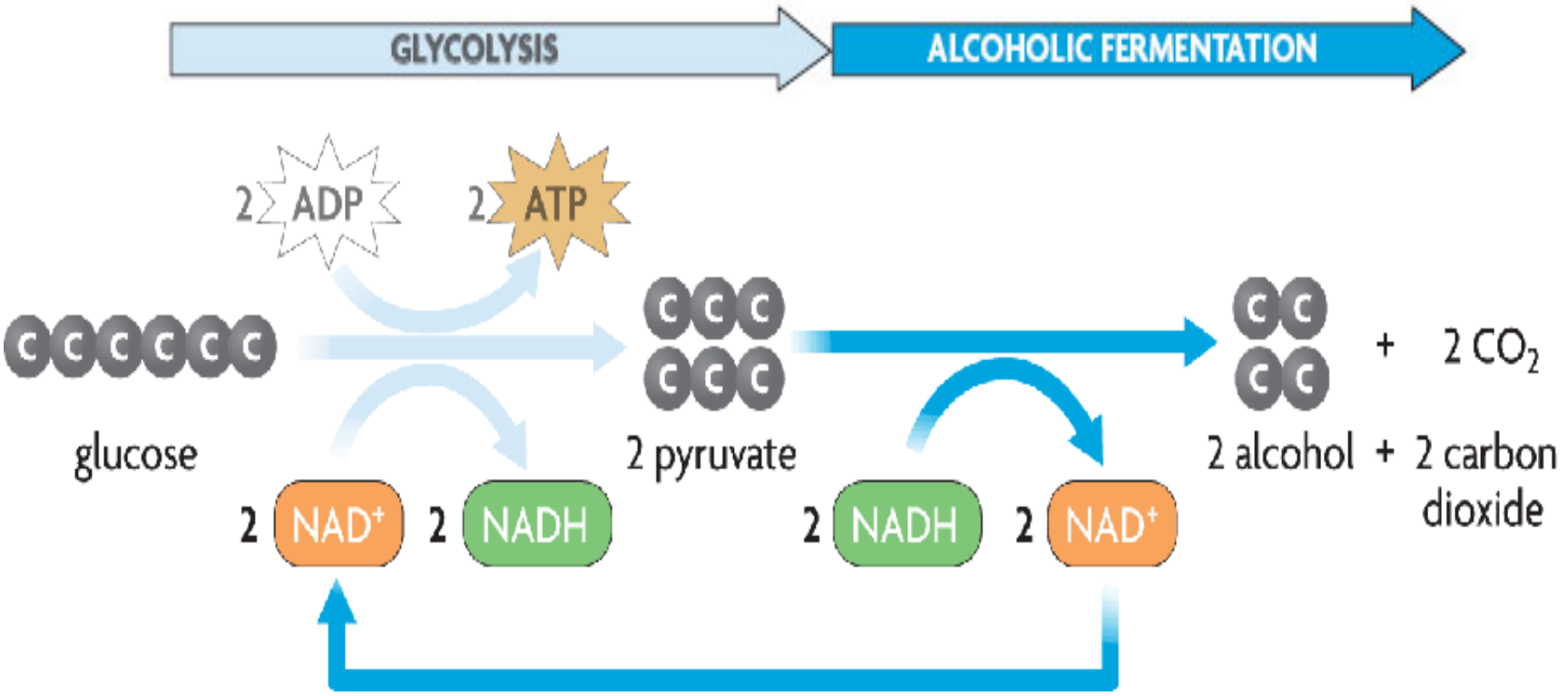
Glucose → Pyruvic acid → alcohol + carbon dioxide + energy



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- Fermentation is used in food production.
  - Yogurt
  - Cheese
  - Bread
  - Beer/ Meade
  - Sauerkraut
  - Soy Sauce
  - Vinegar
  - Olives/Pickles
  - Wine/ Ale
  - Malt

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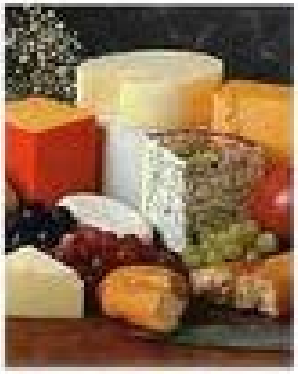

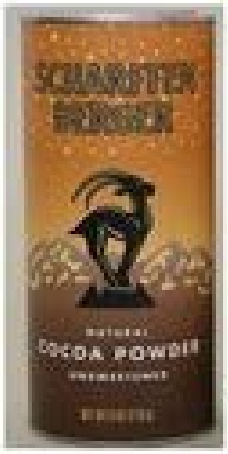

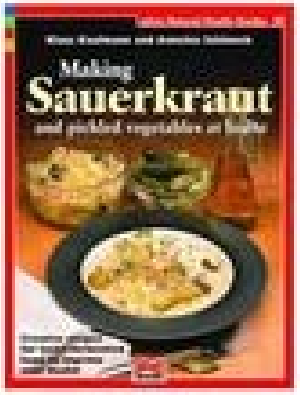

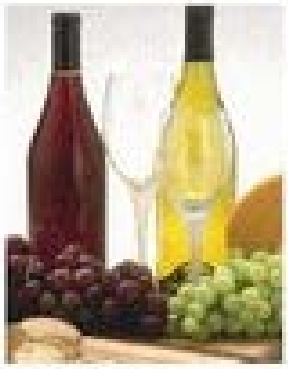

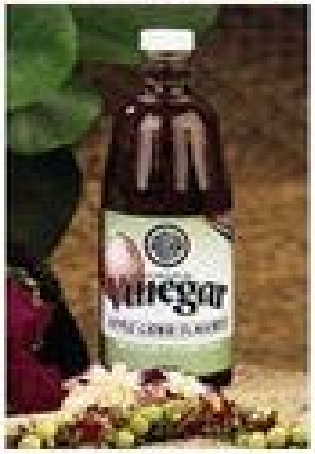

Chapter 4: Cellular Metabolism

HW

- Complete Section 4.6 in the Study Guide workbook (p. 41-42)

- Study for Cellular Respiration **Quiz** on Friday!!