Cellular Respiration

Unit 5 Lesson 7

Students will be able to:

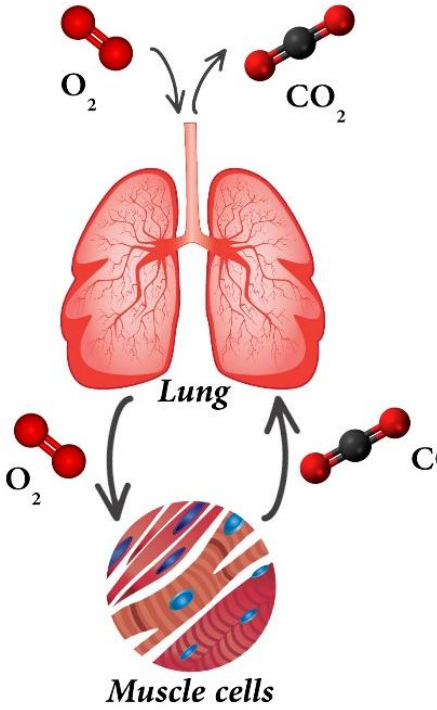
- Define cellular respiration.
- Understand the different stages of cellular respiration.
- Differentiate between the types of respiration.
- Describe the different forms of anaerobic respiration.

Key Vocabulary:

Respiration, glycolysis, citric acid cycle, electron transport chain, aerobic respiration, anaerobic respiration, mitochondria, acidic fermentation, alcoholic fermentation.

Cellular Respiration

- After you hear word 'respiration', you may now think about breathing.
- During breathing, the **oxygen** is entered with each inhale and **carbon dioxide** is released with each exhale.
- Cellular respiration is a chemical process by which energy is obtained within individual cells from biomolecules like **glucose**.



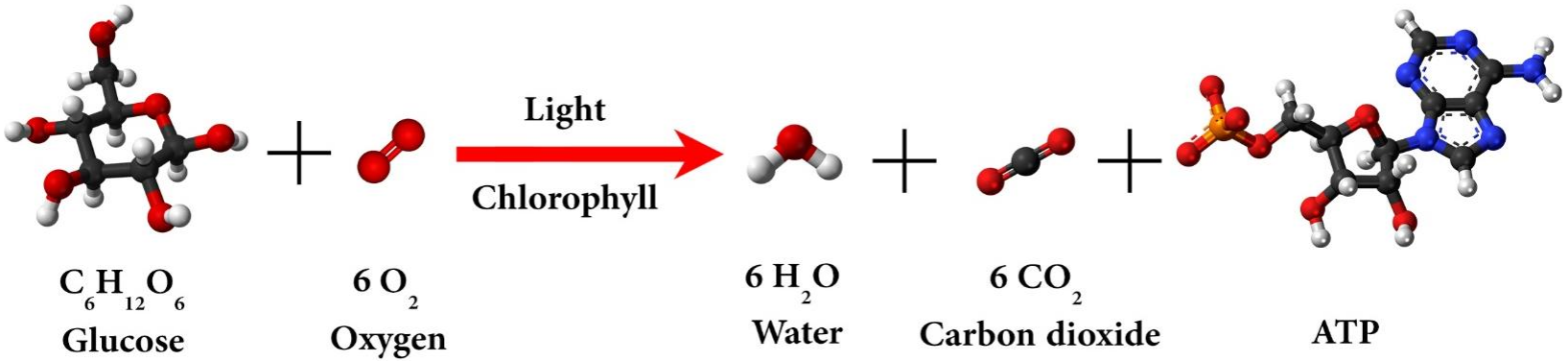
Breathing

Cellular Respiration

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 25ATP$$

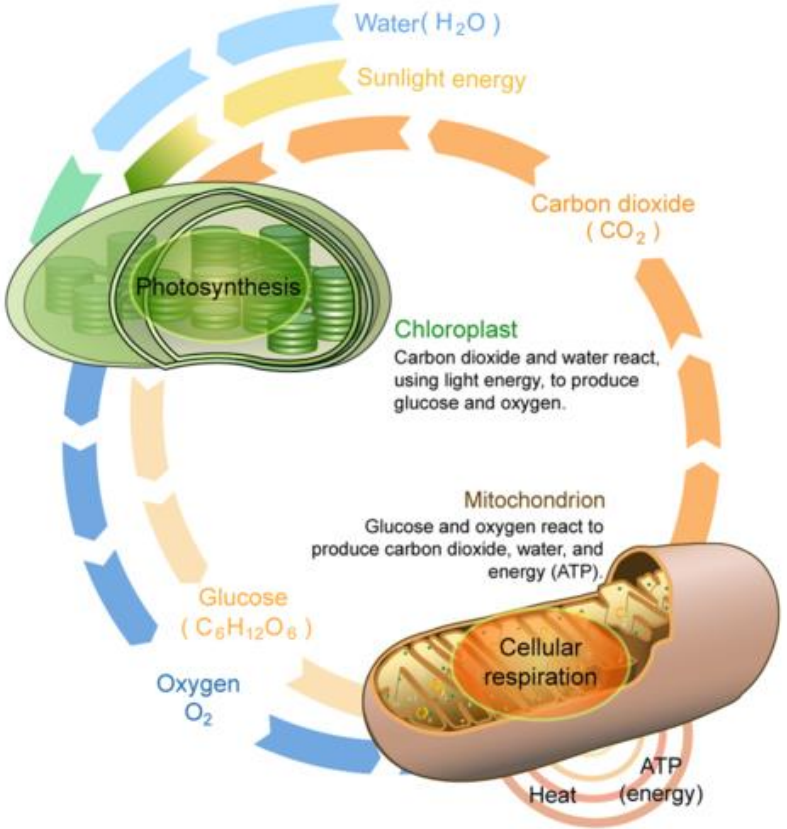
Cellular Respiration

- During cellular respiration, the glucose is broken down into **carbon dioxide**, **water** and some **ATP** molecules are produced.
- The equation of cellular respiration is composed of reactants that include glucose and oxygen (for aerobic respiration), and the products that contain carbon dioxide, water, and ATP.



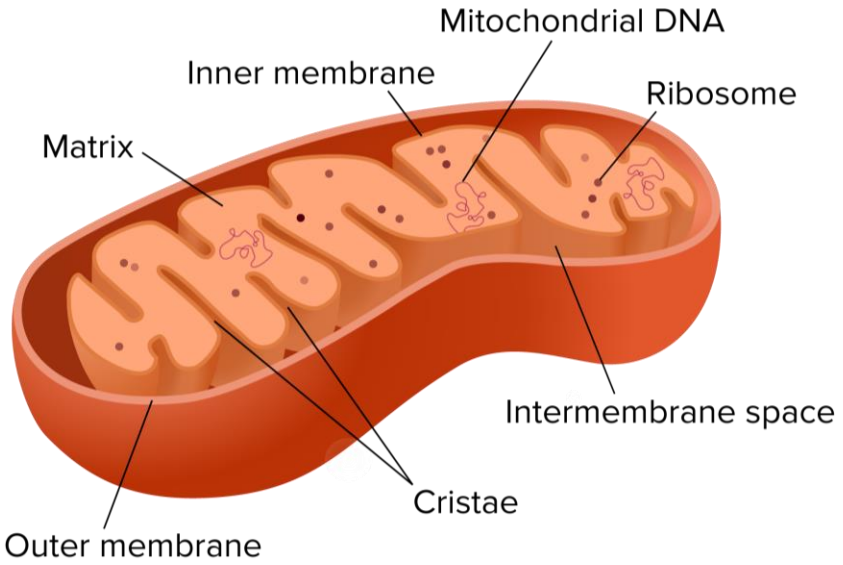
Balance with Photosynthesis

- The respiration is the contrast of the photosynthesis.
- In Respiration, glucose and oxygen which are the products of photosynthesis are taken by heterotrophs who cannot make their own energy.
- The carbon dioxide and water which are the byproducts of respiration are then used in photosynthesis.



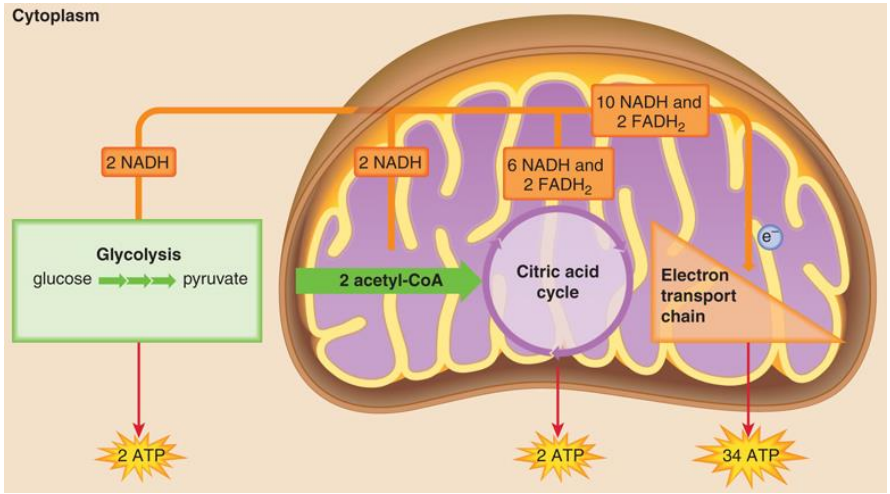
Phases of cellular respiration

- Cellular respiration involves three phases: **glycolysis**, **the citric acid cycle**, and **the electron transport chain**.
- Respiration takes place in the cytosol and in the mitochondria. Mitochondria are considered the powerhouses of eukaryotic cells, and typically contain high surface areas of membrane folds where respiration process can be maximized.



Phases of cellular respiration

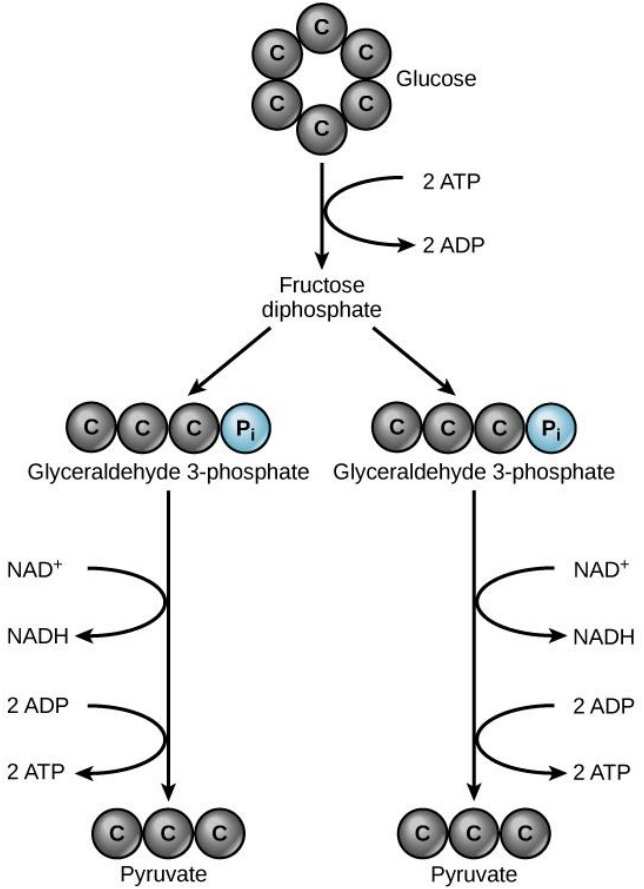
- Glycolysis takes place outside the mitochondria and does not require the presence of oxygen so, glycolysis is considered as **anaerobic** process.
- The other two phases occur inside the mitochondria, where oxygen is the final acceptor of electrons.
- Therefore, the citric acid cycle and electron transport chain is considered as **aerobic** processes.



the three stages of the cellular respiration

1. **Glycolysis**

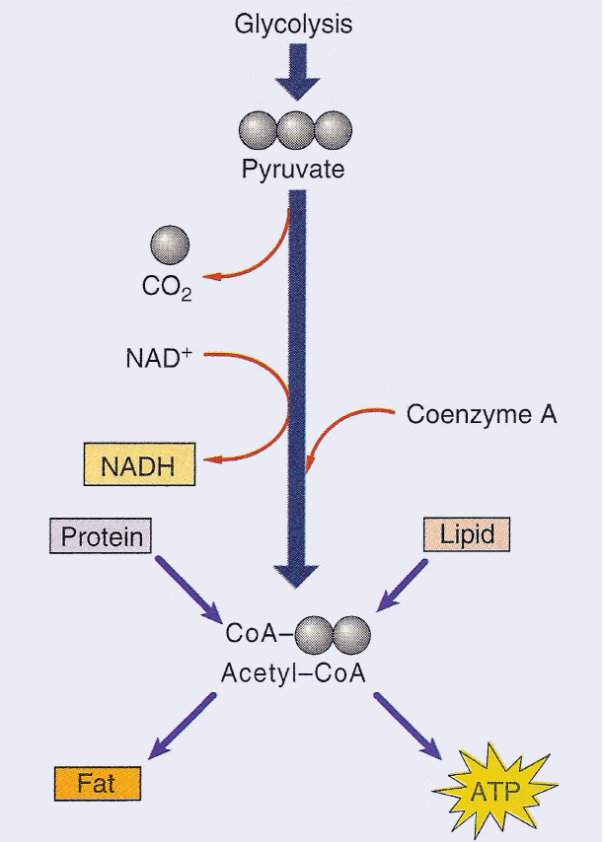
- Glycolysis [glycos = sugar, and lysis = splitting] is the breakdown of **glucose**. The glucose molecule (**six** carbon molecule) undergoes a series of chemical reactions to produce two pyruvate molecules (**three** carbon molecule) in the **cytosol**.



the three stages of the cellular respiration

1. **Glycolysis**

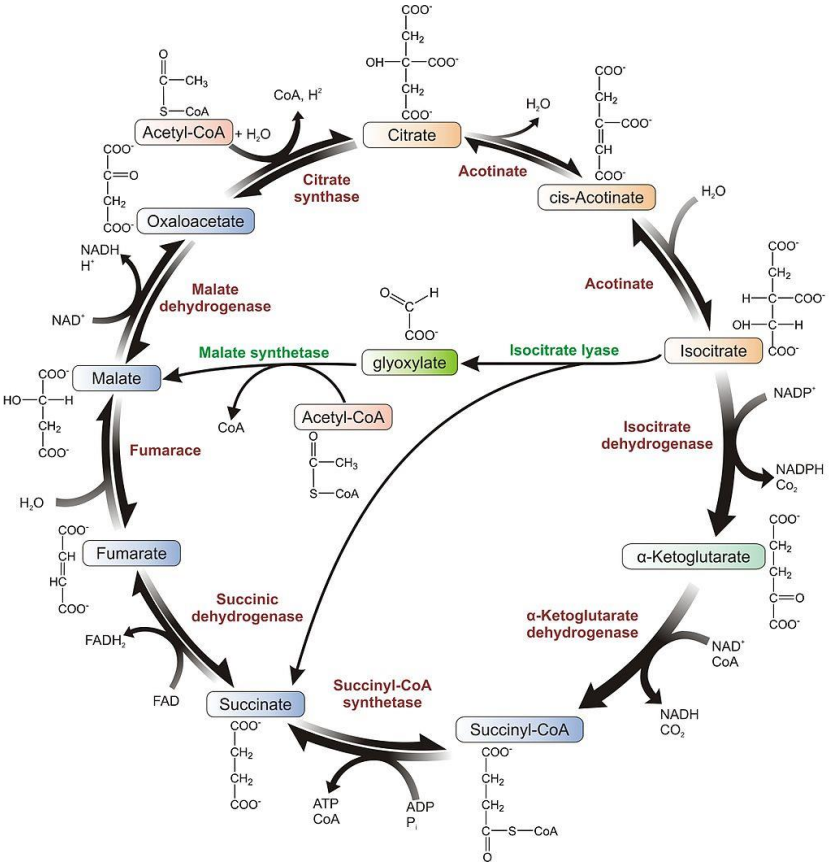
- In these reactions the NAD^+ molecules is converted to NADH and ATP is produced.
- The pyruvic acid is finally oxidized into CO_2 and water, leaving a **<u>two-carbon</u>** molecule that called acetyl-CoA.



the three stages of the cellular respiration

2. **Citric acid cycle**

- It occurs in the mitochondrial matrix. Each acetyl CoA molecules react with a 4-carbon molecule, forming two **6-carbon** citrate molecules.
- As citrate molecules goes through a cycle of biochemical reactions, NADH and FADH2 molecules are produced, and two CO_2 per citrate are released.



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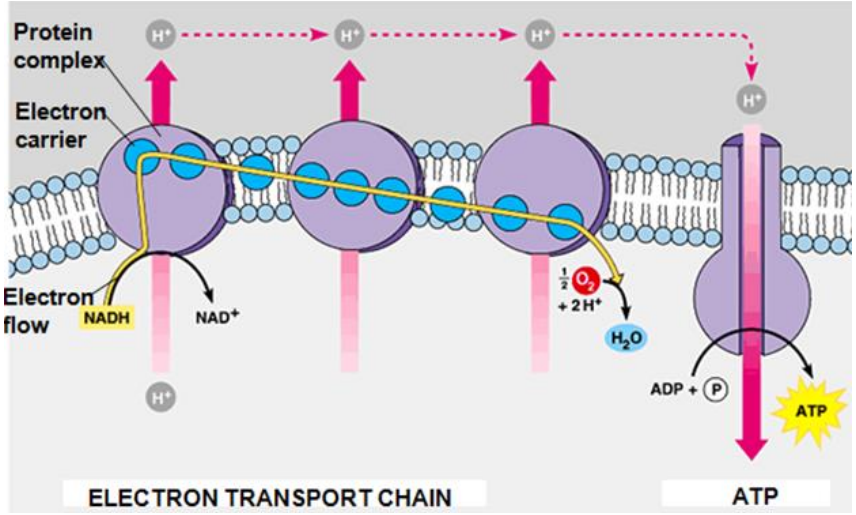
the three stages of the cellular respiration

3. **Electron transport chain**

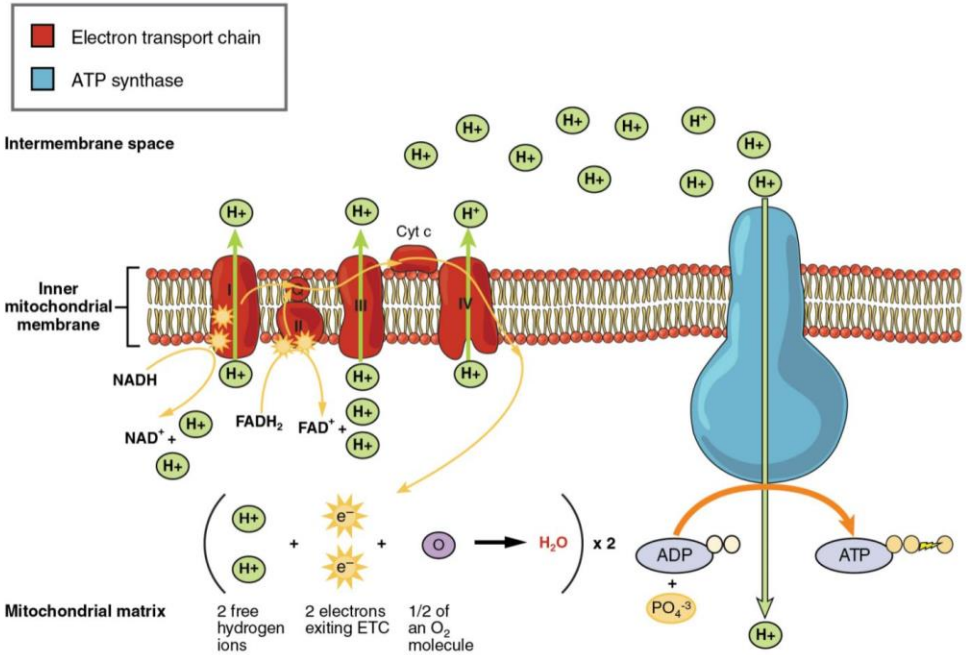
- The electron acceptor molecules (NADH and FADH2) deposit their electrons into the electron transport chain and return into the empty forms. The energy is released as the electrons move down and used to pump H+ ions in high concentration from the matrix to one side of the plasma membrane.



the three stages of the cellular respiration

3. **Electron transport chain**

- The hydrogen ions (protons) flow back to the matrix through the ATP synthase enzyme, generating about 32 ATP.
- The remaining electrons are taken by oxygen that also combines with free hydrogen to form water.



Anaerobic Respiration

- The cell undergoes the previously described stages if there is sufficient amount of oxygen but, when oxygen is missing, cells of living organisms respire by **anaerobic** respiration (fermentation) that takes place in the presence of some special enzymes.

Anaerobic Respiration

- Anaerobic respiration begins with the same beginning of the aerobic respiration. The Glucose molecule is decomposed into two molecules of **pyruvic acid**, with the formation of two molecules of NADH + H^+ and a small quantity of energy (**two** ATP molecules).
- The next step depends on the type of cell doing this respiration.

Anaerobic Respiration

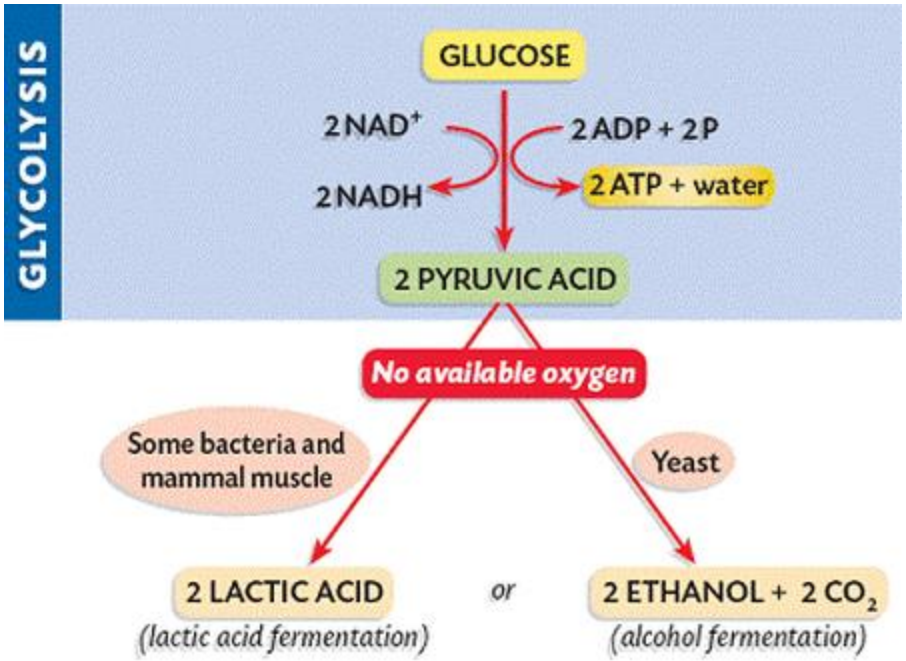
In case of animal cells, especially muscle fibers and Bacteria

- When the muscles exert vigorous efforts or exercises, they consume most of the oxygen. The cells tend to convert pyruvic acid into lactic acid after its reduction by combining with hydrogen on NADH. This is known as muscular fatigue or acidic fermentation. If oxygen becomes available, lactic acid is converted into **pyruvic acid** again and then into **acetyl co-A**.

Anaerobic Respiration

In case of Yeast fungus, or in some plant cells

- Pyruvic acid is reduced into ethyl alcohol and carbon dioxide.
- This process is called **alcoholic** Fermentation and is used in the industry of some products like alcohol and beverages.



Summary

- Cellular respiration is a chemical process by which energy is obtained within individual cells from biomolecules like **glucose**.
- The respiration is the contrast of the photosynthesis.
- Respiration takes place in the cytosol and in the mitochondria.
- Cellular respiration may be aerobic or anaerobic.
- The Aerobic cellular respiration involves three phases: **glycolysis**, **the citric acid cycle**, and **the electron transport chain**.
- There are two types of anaerobic respiration:

1. Acid fermentation
2. Alcoholic fermentation