Cellular Respiration - Advanced

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CHAPTER 1

Cellular Respiration - Advanced

- Clarify the relationship between breathing and cellular respiration.

In the presence of oxygen. Why?

Oxygen is made by trees and other plants during photosynthesis. We know that we need oxygen to live. But why? This oxygen is an essential component for the optimal production of usable energy - which occurs through cellular respiration.

Cellular Respiration

You know that humans deprived of oxygen for more than a few minutes will quickly become unconscious and die. Breathing, also known as **respiration**, is essential for human life, because the body cannot store oxygen for later use as it does food. The mammalian respiratory system, shown in **Figure** 1.1 features a diaphragm, trachea, and a thin membrane whose surface area is equivalent to the size of a handball court - all for efficient oxygen intake. Other forms of life employ different types of respiratory organs: fish and aquatic amphibians and insects flaunt gills, spiders and scorpions develop "book lungs," and terrestrial insects use an elaborate network of tubes called tracheae, which open via spiracles, as shown in **Figure** 1.1. A constant supply of oxygen gas is clearly important to life. However, do you know why you need oxygen?

Many people would answer that oxygen is needed to make carbon dioxide, the gas exhaled or released by each of the respiratory systems listed above. However, CO_2 is a waste product. But a waste product of what?

There must be more to this story than just gas exchange with the environment. To begin to appreciate the role of oxygen inside your body, think about when your breathing rate increases: climbing a steep slope, running a race, or skating a shift in a hockey game. **Respiration rate** correlates with energy use, and that correlation reflects the link between oxygen and energy metabolism. For this reason, the chemical process inside your cells that consume oxygen to produce usable energy is known as **cellular respiration**. During this process, energy is converted from

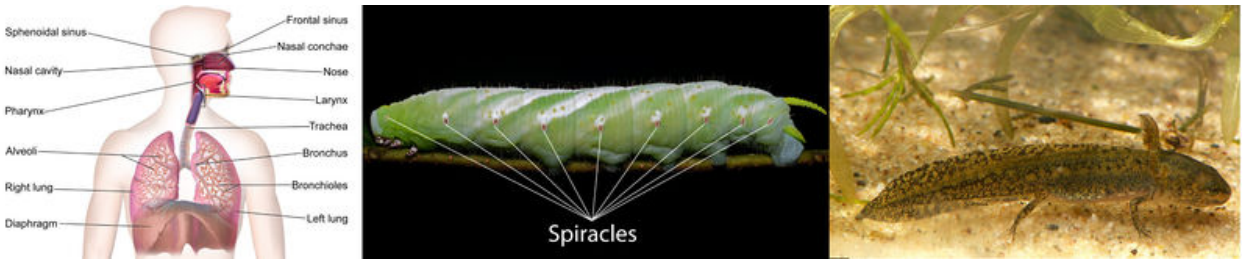


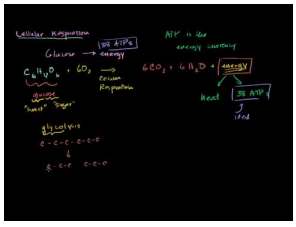
FIGURE 1.1

(left) The human respiratory system is only part of the story of respiration. Diaphragm, lungs, and trachea take air deep into the body and provide oxygen gas to the bloodstream. The fate of that oxygen is the story of cellular respiration. (center) Spiracles in this Cluentius Sphinx (*Neococytius cluentius*) caterpillar connect to a system of internal tubes (tracheae), which carry oxygen throughout the animal's body. (right) Gills in this alpine newt larva, *Ichthyosaura alpestris*, bring blood close to an extensive surface area so that the newt can absorb dissolved oxygen gas from its watery habitat.

glucose, in the presence of oxygen, into numerous **ATP** molecules. The glucose, of course, comes from the food you eat. In biological terms, you do not eat because you are hungry, you eat to get energy. Other **heterotrophic** organisms also acquire glucose from other organisms, whereas **autotrophic** organisms make their own glucose, mostly through photosynthesis.

Though cellular respiration can occur **anaerobically** without oxygen, the process is much more efficient under **aerobic** conditions, in the presence of oxygen. And what exactly is the role of oxygen? Oxygen is the final electron acceptor of the electron transport chain in the final step of cellular respiration. Oxygen combines with electrons and hydrogen ions to produce water.

An introduction to cellular respiration can be viewed at http://www.youtube.com/watch?v=2f7YwCtHcgk (14:19).



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Vocabulary

- **aerobic**: With oxygen, or living or occurring only in the presence of oxygen.
- **anaerobic**: Without oxygen; living or occurring in the absence of oxygen.
- **ATP** (**adenosine triphosphate**): Energy-carrying molecule that cells use to power their metabolic processes; energy-currency of the cell.
- **autotroph**: Organism that produces organic compounds from energy and simple inorganic molecules; also known as a producer.

- **cellular respiration**: Metabolic process which transfers chemical energy from glucose (a deliverable fuel molecule) to ATP (a usable energy-rich molecule); most efficient in the presence of oxygen (aerobic).
- **glucose**: The carbohydrate product of photosynthesis; serves as the universal fuel for life; $C_6H_{12}O_6$.
- **heterotroph**: Organisms which must consume organic molecules; also known as a consumer.
- **respiration**: Exchange of gases between the body and the outside air.
- **respiration rate**: The rate of respiration; the rate of gas exchange between the body and the outside air.

Summary

- Respiration is the exchange of gases between the body and the outside air.
- Cellular respiration is the cellular process which transfers chemical energy from glucose to ATP.
- Oxygen is essential to have efficient cellular respiration; most organisms need oxygen for a single purpose: to release energy from food for use by cells.

Explore More

Use this resource to answer the questions that follow.

- **Cellular Respiration** at http://hyperphysics.phy-astr.gsu.edu/hbase/biology/celres.html

1. Define the term cellular respiration.
2. What is a main difference between cellular respiration in prokaryotes and eukaryotes?
3. What is ATP?
4. Give an overview of aerobic cellular respiration.

Review

1. Why do nearly all organisms die without a constant supply of oxygen?
2. Describe the difference between respiration and cellular respiration.
3. What is the role of oxygen in cellular respiration?
4. Which is most efficient, aerobic respiration or anaerobic respiration?

References

1. Left: User:BruceBlaus/Wikimedia Commons; Center: Geoff Gallice; Right: Piet Spaans. Left: http://commons.wikimedia.org/wiki/File:Blausen_0770_RespiratorySystem_02.png; Center: http://www.flickr.com/photos/dejeuxx/6407247699/; Right: http://commons.wikimedia.org/wiki/File:MesotritonAlpestrisLarva1.JPG . Left: CC BY 3.0; Center: CC BY 2.0; Right: CC BY 2.5