

Life Science Standard **LS1B****Content Standard:**

The gradual combustion of carbon-containing compounds within cells, called cellular respiration, provides the primary energy source of living organisms: the combustion of carbon by burning of fossil fuels provides the primary energy source for most of modern society.

**Performance Indicators:**

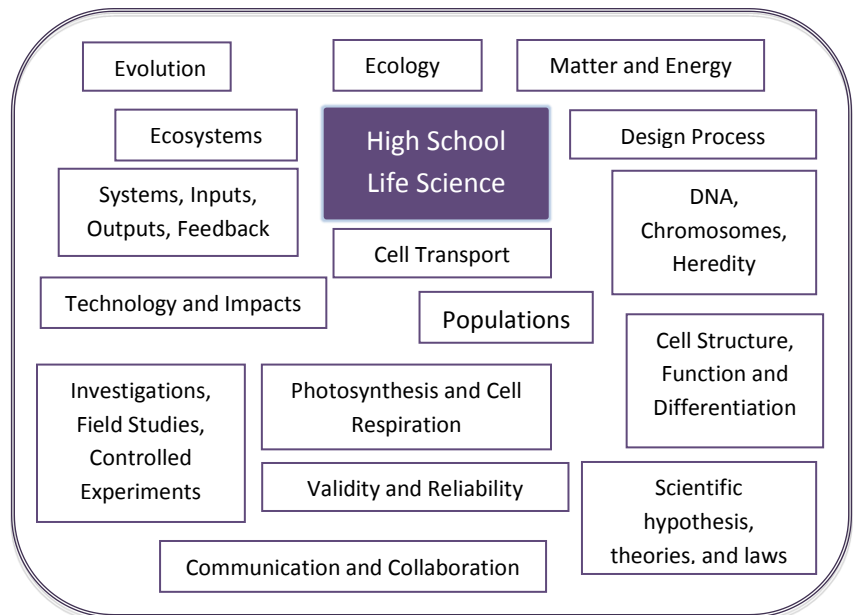
**Explain** how the process of cellular respiration is similar to the burning of fossil fuels (e.g., both processes involve combustion of carbon-containing compounds to transform chemical energy to a different form of energy).

**Item Specifications:**

**Describe** cellular respiration as the process cells use to change the energy of glucose into energy in the form of ATP and/or the process that provides the energy source for most living organisms.

**Compare** cellular respiration to the burning of fossil fuels (e.g., large carbon-containing compounds are broken into smaller carbon compounds as chemical energy is transformed to different forms of energy in both cellular respiration and combustion of fossil fuels).

**Describe** the inputs and/or outputs of matter and/or energy in cellular respiration and/or in combustion (i.e., inputs include glucose or large carbohydrates and oxygen, outputs include carbon dioxide, water, and energy/ATP).

**Reflective Questions for Students:**

**How** is it that carbon is an atom that allows organisms to both store and release energy?

**What examples** of energy storage and release can you describe in your everyday life?

**If you diagram** a model of cellular respiration, what inputs and outputs of matter and energy can you identify?

**How** is a forest fire an analogy for cellular respiration?

**Assessment Information**

<http://www.k12.wa.us/Science/Assessments.aspx>

**Quick Links for Students:**

The following links will help you visualize the process of photosynthesis:

- Carbon Cycle:  
<http://earthobservatory.nasa.gov/Features/CarbonCycle/page3.php>
- Cellular Respiration Application:  
<http://www.teachersdomain.org/resource/oer08.sci.life.reg.exercise/>  
[http://www.teachersdomain.org/asset/oer08\\_vid\\_exercise/](http://www.teachersdomain.org/asset/oer08_vid_exercise/)
- Cellular Respiration Simulation:  
[http://www.teachersdomain.org/asset/lps07\\_int\\_cellenergy/](http://www.teachersdomain.org/asset/lps07_int_cellenergy/)

# Teacher Center

## Elements of Effective Science Instruction

### Disciplinary Core Ideas

**Photosynthesis & respiration:** Students should be able to identify the reactants, products, and basic purposes of photosynthesis and cellular respiration. They should be able to explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms. Students should be able to identify where cellular respiration and photosynthesis occur at the sub-cellular level.

### Essential teaching components leading to the big ideas:

Student acquisition of the content of science involves opportunities to meet state crosscutting and domain standards and recognize how the big ideas fit within a large conceptual framework. Learning is best achieved through sequencing learning targets into learning progressions that inform teacher's instructional decision making.

- Process by which the chemical energy of "food" molecules is released and partially captured in the form of **ATP**. Carbohydrates, fats, and proteins can all be used as fuels in cellular respiration, but **glucose** is most commonly used as an example to examine the reactions and pathways involved.
- Glucose needed for cellular respiration is produced by plants.
- The Krebs (or Citric Acid) cycle occurs in the mitochondria matrix and generates a pool of chemical energy (ATP, NADH, and FADH<sub>2</sub>) from the oxidation of pyruvate, the end product of glycolysis.

A resource for teaching about cellular respiration:

<http://www.emc.maricopa.edu/faculty/farabee/biobk/BioBookGlyc.html>

Another helpful resource can be found at Cellular Respiration from NSTA.

<http://learningcenter.nsta.org/default.aspx>

Search the site for **Cells and Chemical Reactions: Cellular Respiration**

This website provides different activities for biology teachers.

[http://serendip.brynmawr.edu/sci\\_edu/waldron/#yeast](http://serendip.brynmawr.edu/sci_edu/waldron/#yeast)

### Cross Cutting Ideas: *Designing for Learning*

### Strategies to reveal student understanding include:

- Paige Keeley's Formative assessment probes available through [nsta.org](http://nsta.org)
- Teacher's Toolkit: Misconceptions in the science classroom, Science Scope at [www.nsta.org](http://www.nsta.org)  
This article in Science Scope offers suggestions for identifying science misconceptions in general.
- Private Universe Project in Science at <http://www.learner.org/resources/series29.html> is a collection of videos probing misconceptions of several important science concepts and offers insight into how these misconceptions interfere with learning.
- <http://www.doe.mass.edu/omste/ste/default.html>: Go to the life science file on this page for extensive descriptions of common student misconceptions about concepts in biology.

**Prerequisite knowledge required:**

Middle school students recognize that living cells and the subcomponents are comprised of molecules. Students realize proteins are molecules that have specific shapes and identify the importance of proteins in carrying out the work of cells. Students can explain that individual cells carry out all the basic functions of any living thing. Students often confuse the relationship between a cell, a nucleus and biological molecule like proteins and DNA. Students realize that includes only proteins, carbohydrates, and fats and can explain that food is used as both a source of energy and building materials in organisms. They realize that plants produce their own food and animals must take it in by eating other organisms. Students can describe the mitochondrion as a cell structure where energy is released and transformed into chemical energy that the cell can use later. They understand that plants undertake photosynthesis to produce food (glucose), but sometimes confuse the process of photosynthesis and respiration, particularly in plants. Students can explain that all organisms need to reproduce (replicate), including single-celled organisms like bacteria.

(From: <http://www.doe.mass.edu/omste/ste/default.html>)

**Learning progressions may include:**

High school students can draw sub-cellular organelles found inside a plant and animal cell, and relate those organelles to their functions. Students can predict what would happen if one of these structures was removed or ablated. They can compare and contrast, at the cellular level, the general structures and degrees of complexity of prokaryotes and eukaryotes and predict what structures one would find if looked at under the microscope. Students can compare and contrast a virus and a cell. They can identify the reactants, products, and basic purposes of photosynthesis and cellular respiration and explain the interrelated nature of these in the cells of photosynthetic organisms.

(From: <http://www.doe.mass.edu/omste/ste/default.html>)

**Scientifically oriented questions focused on clarifying and extending student understanding include:**

What is the big picture of cellular respiration? Can I describe inputs and outputs when thinking about cellular respiration?

What factors might the process of cellular respiration?

What are the characteristics organisms that undergo anaerobic respiration?

**Activities supporting opportunities for students to make claims, use evidence and communicate reasonings include:**

Is it possible to improve a person's cellular respiration in order to compete in an athletic event?

**Cross Cutting Ideas:**  
*Sense Making*

**Planning time in the lessons to support time for students to make sense of what they are learning include:**

- This website offers a variety of professional development lessons and videos for strategies to teach specific concepts within science.  
[http://www.teachersdomain.org/search/?q=strategies+for+effective+teaching&fq\\_grade=PK&fq\\_grade=PS](http://www.teachersdomain.org/search/?q=strategies+for+effective+teaching&fq_grade=PK&fq_grade=PS).

**Cross Cutting Ideas:**  
*Classroom Culture and Environment*

**Activities that show how cellular respiration relates to students' everyday lives include:**

- This site has a teacher lesson on respiration.  
<http://www.learner.org/courses/essential/life/session7/closer4.html>
- This site has a 35 minute lecture on the functions of blood.  
<http://blossoms.mit.edu/video/anahtar/anahtar-watch.html>

<p><b>Strategies to focus on student conversations, interactive notebook prompts, model-building include:</b></p> <p>This site models cellular respiration in a tutorial. <a href="http://www.sp.uconn.edu/~terry/Common/respiration.html">http://www.sp.uconn.edu/~terry/Common/respiration.html</a></p>	<p><b>Activities that show how scientists think and do science in relationship to this content standards include:</b></p>