Elements of Biology
Organization in Living Systems
Teacher's Guide

Grade Level: 9–12	**Curriculum Focus:** Life Science	**Lesson Duration:** Three class periods

Program Description

Students examine how matter and energy are organized in living systems, which allows adaptation to the environment.

Onscreen Questions

- What processes transport energy through cells?
- Why is photosynthesis necessary for every organism?
- What are some theories about the sauropod's diet?
- How did carnivorous dinosaurs evolve to become better hunters?

Lesson Plan

Student Objectives

- Explore recent research about dinosaurs.
- Compare newer findings with currently accepted ideas.
- Write a report showing how new findings have changed scientists' ideas about dinosaurs.

Materials

- *Elements of Biology: Organization in Living Systems* video
- Newsprint and markers
- Computer with Internet access
- Paper and pencils

Procedures

1. Begin the lesson with a discussion about dinosaurs. Ask students what they know about them. Write their responses on a sheet of newsprint. You can expect responses like those listed below:
   - Dinosaurs were reptiles.
   - Most dinosaurs were large and slow moving.
   - Some dinosaurs ate plants, and others ate meat.
   - Dinosaurs died out from an asteroid explosion about 65 million years ago.
2. Explain to students that paleontologists, or scientists who study fossil remains, continue to uncover new information about dinosaurs. Have students watch the segment "Dino Diet" in the program *Elements of Biology: Organization in Living Systems*; it explains how paleontologists learn what dinosaurs ate.
3. Tell students that other scientists have uncovered more information about dinosaurs by following the process similar to that in the segment. Students will read some of the new research and write a paper exploring how new discoveries have challenged some current ideas.
4. Have students use the Web sites listed below to learn about the new dinosaur research. For your information, a brief summary of the research covered at each site has been included.
   - http://www.sciencedaily.com/releases/2006/07/060713233840.htm**.** This article highlights the results of a study of skeletal remains of an *Albertosaurus* found in Alberta, Canada. Dr. Philip Currie discovered that the animal probably behaved more like a large mammal than a large reptile. He also noted that its survival pattern called into doubt the long-held theory that dinosaurs were wiped out by a catastrophic event. Also, it appears that if the dinosaur survived the first two years of life, it had a strong likelihood of living into young adulthood—about the age of 13.
   - http://www.sciencedaily.com/releases/2006/07/060712073816.htm**.** A new body of research based on studies of dinosaur fossils shows that dinosaurs had a very high body temperature—about 91° Fahrenheit (33° Celsius). This temperature appeared to change as the dinosaur grew larger. The research suggests that dinosaurs were probably cold-blooded, but they lost body heat very slowly. As a result, they could maintain their body temperatures more efficiently than many modern-day reptiles.
   - http://www.newscientist.com/popuparticle.ns?id=in33. Among the research findings highlighted in this article are the following:
     - Many new kinds of dinosaurs are being discovered all the time.
     - Some dinosaurs lived in social groups and nurtured their young.
     - Some dinosaurs could survive in polar regions.
     - Some dinosaurs had feathers, which probably evolved as a form of insulation. It appears that some dinosaurs had birdlike characteristics.
     - A debate continues over how the dinosaurs died out. While many scientists think an asteroid was responsible, others have different theories about the impact of this event on

dinosaurs. Some scientists think the initial impact of an asteroid may have caused a fire, which caused the dinosaurs to burn to death. Others think that climate change was responsible for a slower extinction.

- http://www.odysseymagazine.com/pages/ss/fossils.php. This article makes the case that a series of volcanic explosions raised Earth's temperature about 18° Fahrenheit. As a result, the plants that dinosaurs fed on died out, leading to their death. According to this theory, this was the first extinction that could be attributed to global warming.

- http://www.newscientist.com/channel/life/dinosaurs/dn7339--meateating-dinosaur-caught-turning-veggie.html. Scientists have discovered the teeth and gut of a dinosaur that was in the process of changing from a carnivore to an herbivore. The teeth became shaped for shredding plant material, and the gut became paunchy to digest the plant materials.

- http://www.blm.gov/ak/ak930/akdino.html. At one time, scientists thought that dinosaurs whose fossil remains were found in Alaska had migrated to southern climates, but now they think that those dinosaurs survived by eating vegetation that grew along the river. Other discoveries based on this study are that these dinosaurs may have been warm-blooded and their extinction was probably caused by multiple causes, including disease and climate change.

5. Give students time in class to work on their papers. Have them share their first drafts with a partner for peer editing. Ask students to discuss the changes their classmates suggest and make them if appropriate.
6. Hold a class discussion about recent dinosaur research. Ask students to summarize the key findings. Then take a quick look at the sheet of newsprint with the ideas that students suggested at the beginning of the lesson. How many of their ideas have changed? What have students learned about the way scientists gain new information?

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- **3 points:** Students carefully and thoughtfully read all the new research; made insightful comparisons between the old and new findings; and wrote an accurate report describing how scientists' ideas about dinosaurs have changed.
- **2 points:** Students adequately read most of the new research; made some comparisons between the old and new findings; and wrote a satisfactory report describing how scientists' ideas about dinosaurs have changed.
- **1 point:** Students did not finish reading the new research; had difficulty making comparisons between the old and new findings; and wrote an unsatisfactory report describing how scientists' ideas about dinosaurs have changed.

Vocabulary

carnivore

Definition: An animal that hunts for its food and eats mostly meat

Context: Tyrannosaurus rex was a voracious carnivore, killing other dinosaurs for food.

cold-blooded

Definition: Animals whose body temperature varies with that of their environment

Context: New evidence about dinosaurs is casting doubt on the idea that they were cold-blooded creatures.

dinosaur

Definition: Vertebrate land animals that roamed Earth for 160 million years and died out 65 million years ago

Context: Dinosaurs came in many shapes and sizes, and some were herbivores and others were carnivores.

fossils

Definition: Remains such as bones and teeth or an imprint in a rock of an organism that lived long ago

Context: The discovery of dinosaur fossils has led to the development of new theories about them.

herbivore

Definition: An animal that eats plants

Context: One type of dinosaur changed from being a carnivore to an herbivore, a discovery based on an analysis of its teeth.

paleontologist

Definition: A scientist who specializes in studying fossil remains

Context: After studying the bones and other fossils found in Alberta, paleontologist Phil Currie concluded that large dinosaurs behaved more like mammals than like reptiles.

warm-blooded

Definition: An animal that produces heat so that its body temperature remains constant

Context: Most scientists agree that dinosaurs were probably cold-blooded and that they lost body heat very slowly, a characteristic usually seen in warm-blooded animals.

Academic Standards

National Academy of Sciences

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K–12. To view the standards, visit this Web site:

http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following national standards:

- Life Science: Structure and function in living systems; Regulation and behavior
- History and Nature of Science: Science as a human endeavor

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K–12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science: Life Sciences—Understands relationships among organisms and their physical environment
- Nature of Science—Understands the scientific enterprise
- Language Arts: Viewing—Uses viewing skills and strategies to understand and interpret visual media; Writing: Uses the general skills and strategies of the writing process, Gathers and uses information for research purposes; Reading: Uses reading skills and strategies to understand and interpret a variety of informational texts

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DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How to Use the DVD

The DVD starting screen has the following options:

Play Video—This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

Video Index—Here the video is divided into sections indicated by video thumbnail icons; brief descriptions are noted for each one. Watching all parts in sequence is similar to watching the video

from start to finish. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

***Curriculum Units*—**These are specially edited video segments pulled from different sections of the video (see below). These nonlinear segments align with key ideas in the unit of instruction. They include onscreen pre- and post-viewing questions, reproduced below in this Teacher's Guide. Total running times for these segments are noted. To play a particular segment, press Enter on the TV remote or click once on the Curriculum Unit title on a computer.

***Standards Link*—**Selecting this option displays a single screen that lists the national academic standards the video addresses.

***Teacher Resources*—**This screen gives the technical support number and Web site address.

Video Index

I. The Flow of Energy (6 min.)

Like microscopic power plants, cells provide the energy needed to sustain life. Explore the chemical processes that occur within organisms to create the energy needed for life.

II. Alive with Energy (6 min.)

All life depends on a steady supply of energy. Learn about photosynthesis and cellular respiration, the processes responsible for breaking down sunlight and molecules of food to create energy.

III. Food and the Limits of Life (4 min.)

Discover how the digestive processes in a heterotroph break down complex molecules to release their energy. Explore metabolism and metabolic pathways in different organisms.

IV. Breaking Down Digestion (4 min.)

When we take a bite of food, a complex process called digestion begins. Discuss what happens to food as it travels through the digestive system.

V. Dino Diet (29 min.)

What dinosaurs ate and why tells us a lot about their daily routines. Examine the digestive processes and food choices of different kinds of dinosaurs.

Curriculum Units

1. Transferring Energy between Molecules

Pre-viewing question
Q: What are some examples of chemical reactions that occur in nature?
A: Answers will vary.

Post-viewing question
Q: What is the difference between exergonic and endergonic chemical reactions?
A: Every chemical reaction transfers energy between molecules. Exergonic chemical reactions release energy by breaking down the chemical bonds of complex molecules. Endergonic reactions consume energy to build complex molecules from simpler ones. Exergonic reactions take place in our muscles whenever we move. Endergonic reactions form the molecules that build up to comprise an organism. All the tissues and organs in our bodies are formed by endergonic reactions.

2. Photosynthesis and Cellular Respiration

Pre-viewing question
Q: How does your body use energy?
A: Answers will vary.

Post-viewing question
Q: What is cellular respiration?
A: Cellular respiration is the process that releases the energy stored in food. Cellular respiration starts with glycolysis, which breaks down a molecule of glucose. Glycolysis yields one pair of three carbon molecules, called pyruvate, as well as two molecules of ATP. The next three stages in cellular respiration are pyruvate oxidation, the Krebs cycle, and electron transport chain. During these cycles, the pyruvate molecules are broken down into acetyl-COA; the acetyl-COA is then broken down during the Krebs cycle to produce one molecule of ATP for many electrons. On the electron transport chain, the electrons are further broken down to produce more ATP. The energy contained in ATP is eventually distributed to every cell in the organism, where it powers the reactions necessary for life.

3. Metabolism and Metabolic Pathways

Pre-viewing question
Q: What do you know about metabolism?
A: Answers will vary.

Post-viewing question
Q: What does the term "metabolism" mean?
A: The chemical reactions in cells that change energy from one form to another also transform matter. The processes that alter matter and energy in an organism are referred to as metabolism.

4. The Human Digestive System

Pre-viewing question
Q: What do you know about the human digestive system?
A: Answers will vary.

Post-viewing question
Q: Describe what happens to food in your stomach.
A: Once food is in your stomach, layers of muscle expand and contract, mixing your food with digestive fluids. This is called chemical digestion. The digestive fluids are produced in the stomach's lining. They begin the process of breaking down proteins in our food to even smaller particles that can be absorbed into the bloodstream. When everything has been churned to a consistency of soft cottage cheese called chyme, the stomach starts expanding and contracting again, pushing tiny particles of partially digested food out of the stomach.

5. Eating Habits of the Sauropod

Pre-viewing question
Q: Name some cold-blooded animals. What do they eat?
A: Answers will vary.

Post-viewing question
Q: Why do scientists think that sauropods were cold-blooded?
A: If sauropods had been warm-blooded, they would have spent 22 hours a day eating and would have consumed at least the equivalent of 17 bales of hay. Because this kind of schedule would have left no time for sleeping or other activities, scientists believe that sauropods were most likely cold-blooded. As cold-blooded animals, sauropods would have spent much less time eating and would have consumed a quantity of food equal to about six bales of hay.

6. Herbivores and Meat-Eating Dinosaurs

Pre-viewing question
Q: Name some small but dangerous predators.
A: Answers will vary.

Post-viewing question
Q: Why were there fewer carnivorous dinosaurs than herbivores?
A: Scientists think there were fewer carnivorous dinosaurs than herbivores because high-energy food was much harder to find.

7. Examining the Tooth Strength of a T-Rex

Pre-viewing question
Q: Which animals do you think have the strongest jaws?
A: Answers will vary.

Post-viewing question
Q: What did Dr. Erikson's study prove?
A: Dr. Erikson was able to effectively simulate the bite force of a T-Rex. He calculated the bite force at 3,000 pounds per square inch, meaning that a T-Rex had the bite strength to devour creatures its own size. His study proved that the teeth of a T-Rex could withstand the pressures of biting into struggling prey. Erikson feels that this sheds light on a longstanding mystery—T-Rex may have been an agile and fast predator, and not just a scavenger.

8. Digestive Aids for Dinosaurs

Pre-viewing question
Q: What are some foods or other items that aid human digestion?
A: Answers will vary.

Post-viewing question
Q: How did eating stones help dinosaurs digest food?
A: Dinosaurs like sauropods swallowed stones to aid digestion. They ate whole, fibrous leaf material that was hard to digest. As the stomach digested the leaves, the stones rubbed against the leaves, breaking them down into small fragments that were more easily digestible.