

Key Concept 1: Chemistry of Life

Learning Objectives

Students will be able to ...

Essential Knowledge

Students need to know that ...

Biomolecules

CELLS 1.1(a) Differentiate between the major macromolecules based on their structure and/or function.

CELLS 1.2(a) Explain the role macromolecules play in supporting cellular function.

CELLS 1.1.1 The four classes of organic macromolecules are proteins, carbohydrates, lipids, and nucleic acids, and each have unique chemical structures.

- These organic macromolecules are primarily made up of just a few elements—carbon, hydrogen, nitrogen, oxygen, sulfur, and phosphorus.
- Most macromolecules are polymers that are made up of specific, smaller subunits called monomers.

CELLS 1.2.1 Each class of macromolecule carries out specific functions in biological systems.

- Carbohydrates serve as the primary source of energy for organisms in the forms of glycogen and starch and as structural support in plant cell walls in the form of cellulose.
- Lipids are used as a source of energy and building blocks of biological membranes.
- Proteins are responsible for numerous cellular functions, such as catalyzing reactions, providing structure, and aiding in cell transport and signaling.
- Nucleic acids are responsible for storing and transferring genetic information in the form of DNA and RNA.

Enzymes

CELLS 1.3(a) Describe the effect of enzymes on the rate of chemical reactions in biological systems.

CELLS 1.3(b) Predict how a change in pH and/or temperature will affect the function of an enzyme.

CELLS 1.3.1 Enzymes are proteins that are catalysts in biochemical reactions and essential for maintaining life processes.

- The rate of a chemical reaction is affected by the concentration of substrates and enzymes.
- Enzymes have specific shapes that bind to specific substrates in a precise location called the active site.
- Enzymes function optimally in a specific pH and temperature range.

Learning Objectives*Students will be able to ...***Essential Knowledge***Students need to know that ...***Cellular Energy Needs**

CELLS 1.4(a) Explain the role of ATP in supporting processes in biological systems.

CELLS 1.4(b) Explain why different species demonstrate diverse energy and nutrient requirements.

CELLS 1.4(c) Use data to predict the energy needs of diverse species.

CELLS 1.4.1 Energy in biological systems is stored and released as chemical bonds are formed and broken.

- a. ATP serves as the major energy currency of the cell.
- b. The amount of energy available to organisms from the breakdown of macromolecules varies based on their chemical composition.

CELLS 1.4.2 Because organisms have diverse ecological roles, they also have diverse energy needs.

Content Boundary: While students should recognize that sulfur is one of the most common elements in living systems, a deeper understanding of the role sulfur plays in biological systems is *beyond the scope* of this course.

Cross Connections: Students should *connect key concepts* to Unit 1: Ecological Systems. The cycling of matter in the biosphere provides the building blocks for development of the macromolecules. Students should make connections between the role of enzymes in biological systems and the how those systems can be affected by mutations during replication—specifically, when these mutations result in changes to enzymes produced during protein synthesis. (Unit 4: Genetics). Students should expand on that understanding to see how changes in proteins (enzymes) influence an organism's fitness, *connecting to key concepts* in Unit 2: Evolution.

Key Concept 2: Cell Structure and Function**Learning Objectives***Students will be able to ...***Essential Knowledge***Students need to know that ...***Cellular Structure and Function**

CELLS 2.1(a) Provide evidence to support the claim that all biological systems demonstrate some shared characteristics.

CELLS 2.2(a) Develop and/or use models to compare and contrast cellular structures of different cells.

CELLS 2.1.1 The cell is the basic unit of biological systems, and there are some shared characteristics among all cells.

- a. All cells possess a plasma membrane, ribosomes, genetic material, and cytoplasm.
- b. All cells result from the division of preexisting cells.

CELLS 2.2.1 Cells have specialized structures that perform specific functions.

- a. Some cells (eukaryotes) have a nucleus that houses their DNA.
- b. Cellular structures can be organized based on four primary functions:
 1. Energy production (e.g., chloroplasts, mitochondria).
 2. Production of proteins (e.g., ribosomes, ER, Golgi apparatus).
 3. Storage and recycling of materials (e.g., lysosome, vacuoles, vesicles).
 4. Support and movement (e.g., cell wall, cytoskeleton, flagella).