

Biology, Quarter 1, Unit 1.1

Introduction to Biology

Overview

Number of instructional days: 5 (1 day = 53 minutes)

Content to be learned

- Understand that all living organisms have organized structures and characteristics that allow them to survive.
- Understand that matter cycles and energy flows through ecosystems.
- Understand that living things show evidence of change over time.
- Understand that humans are similar to other species in many ways, but are unique among earth's life forms.

Essential questions

- What are the connections between the big scientific ideas of 'form and function' and 'change over time'?
- What is the relationship between chemical changes in matter and the flow of energy in living systems?

Processes to be used

- Use data and observations to make connections.
- Analyze structure and function.
- Analyze case studies.

- What are the connections between homeostasis in the human body and humans' responses to different environmental stimuli?
- How does research into humans' impact on the environment add to our knowledge of ecological interactions?
- How would you determine whether a newly discovered specimen should be classified as living or nonliving?

Written Curriculum

Grade Span Expectations

LS1 - All living organisms have identifiable structures and characteristics that allow for survival (organisms, populations, & species).

LS2 - Matter cycles and energy flows through an ecosystem

LS3 - Groups of organisms show evidence of change over time (structures, behaviors, and biochemistry).

LS4-Humans are similar to other species in many ways, and yet unique among Earth's life forms.

Clarifying the Standards

Prior Learning

In grades K–4, students learned to distinguish living from nonliving things. They observed and recorded external features of living things and learned to sort based on those features. They also learned that living things have basic needs, along with the structures to satisfy those needs. Students have a beginning understanding of equilibrium in ecosystems and understand some ways the balance of an ecosystem can be disrupted. In grades 5–8, students learned that cells and organisms have different features and behaviors to meet their specific survival needs. They also learned that these adaptations or behaviors are specific to a niche within an ecosystem. Students were also introduced to levels of structural organization in multicellular organisms. In grades 9–10, students studied conservation of matter and energy conversions as well as energy losses during energy conversions. Students learned how to define a system, how to identify its components, and how to distinguish between open and closed systems.

Current Learning

This unit will provide an overview of this biology course by examining the relationships between the unifying themes in biology, including homeostasis, form and function, interdependence, energy relationships, heredity, adaptation, evolution, and ecology. Students list, describe, and give examples of the characteristics that all living things share, including cells, organization, energy use, reproduction, growth, response to environmental stimuli, and adaptation. Students will revisit the concept of open and closed systems in a biological context particularly as it relates to energy transfer (systems of photosynthesis and cellular respiration), homeostasis (organ systems) and interdependence in nature (ecosystems).

Future Learning

In future units this year, students will learn the specific processes (photosynthesis and respiration) related to flow of energy and matter, the genetic basis of heredity, and the link between genetics, adaptation, and evolution. In addition, students will study ecological interactions and ways humans impact the environment.

Additional Research Findings

According to *Making Sense of Secondary Science*, students have a general misconception about what it means to be alive (pp. 18–22). Students mistakenly believe that adaptations occur at the individual level as an organism changes based on its desire to fulfill some future requirement (p. 52). Students do not see clearly how environmental impacts can have negative effects on humans (pp. 68–69) and they do not appreciate that there is a chemical basis to inheritance (p. 52). Another common misconception is that energy is a physical substance (pp. 143–147). Students are confused about the levels of organization related to molecules and cells, thinking that molecules are made of cells (p. 25).

Notes About Resources and Materials

Biology, Quarter 1, Unit 1.2

Cells and Cell Organelles

Overview

Number of instructional days: 10 (1 day = 53 minutes)

Content to be learned

- Explain the relationship between specialized cell structure and function.
- Explain how unicellular organisms can perform all survival functions.
- Explain how most multicellular organisms have specialized cells that work together to perform critical survival functions.
- Compare and contrast the role of organelles in unicellular organisms to the role of organs or systems in multicellular organisms.

Processes to be used

- Use tools and technology.
- Make and use models.
- Interpret diagrams and illustrations.
- Demonstrate understanding through comparing and contrasting.
- Use data and observations to make connections, explain, or justify an argument.

Essential questions

- What roles do subcellular structures play in the survival of unicellular and multicellular organisms?
- How does a unicellular organism carry out life functions such as digestion and reproduction?
- How do the specialized functions of specific cell types contribute to the survival of a multicellular organism?
- What role does DNA play in regulating the function of specialized cells or cell organelles?
- What is involved in using structural features to classify cells as prokaryote or eukaryote, plant, animal, or fungus?

Written Curriculum

Grade Span Expectations

LS1 - All living organisms have identifiable structures and characteristics that allow for survival (organisms, populations, & species).

LS1 (9-11) INQ+SAE+FAF -1

Use data and observation to make connections between, to explain, or to justify how specific cell organelles produce/regulate what the cell needs or what a unicellular or multi-cellular organism needs for survival (e.g., protein synthesis, DNA replication, nerve cells).

LS1 (9-11)-1 Students demonstrate understanding of structure and function-survival requirements by...

1a explaining the relationships between and amongst the specialized structures of the cell and their functions (e.g. transport of materials, energy transfer, protein building, waste disposal, information feedback, and even movement).

1b explaining that most multicellular organisms have specialized cells to survive, while unicellular organisms perform all survival functions. (e.g. nerve cells communicate with other cells, muscle cells contract, unicellular are not specialized).

1c comparing the role of various sub-cellular structures in unicellular organisms to comparable structures in multicellular organisms (e.g. oral groove, gullet, food vacuole in Paramecium compared to digestive systems in multicellular organisms).

LS1 (9-11) FAF+ POC -2

Explain or justify with evidence how the alteration of the DNA sequence may produce new gene combinations that make little difference, enhance capabilities, or can be harmful to the organism (e.g., selective breeding, genetic engineering, mutations).

LS1 (9-11) –2 Students demonstrate an understanding of the molecular basis for heredity by ...

2c describing how DNA contains the code for the production of specific proteins.

Clarifying the Standards

Prior Learning

In grades 5–8, students learned that cells are the building blocks of organisms and that specialized cells perform specialized functions. They also learned that there is a structural organization of an organism—from cells to tissues, tissues to organs, organs to organ systems, and organ systems to organisms.

Current Learning

Students describe the relationship between the structure and function of cells. They also explain specialization of cells and cell organelles. Students compare multicellular and unicellular cell structures,

recognizing the relationship between their structures and functions. Students also compare and contrast prokaryotic and eukaryotic cell types.

Future Learning

Students will make connections between specific organelles and the organelles' biological functions involving use of matter and energy at the cellular, organism, species, and ecosystem levels.

Additional Research Findings

According to *Making Sense of Secondary Science*, students have a general misconception about the concept of cells and/or molecules. They are often confused about the levels of organization related to molecules and cells, thinking that molecules are made of cells (p. 25).

Notes About Resources and Materials

Biology, Quarter 1, Unit 1.3

Disease/Homeostasis

Overview

Number of instructional days: 10 (1 day = 53 minutes)

Content to be learned

- Explain negative and positive feedback mechanisms and how they affect homeostasis in human body systems.
- Explain how human body systems work together to maintain homeostasis.
- Provide specific examples of disruption of homeostasis and its consequences.

Processes to be used

- Draw conclusions based on data.
- Use tools and technology.
- Make and use models.
- Interpret diagrams and illustrations.
- Demonstrate understanding through comparing and contrasting.
- Analyze system interactions.

Essential questions

- How do living systems work to maintain homeostasis?
- What is the role of cell–membrane transport systems in maintaining homeostasis?
- How could the disruption of homeostasis play a role in disease?

Written Curriculum

Grade Span Expectations

LS 4 - Humans are similar to other species in many ways, and yet are unique among Earth's life forms.

LS4 (9-11) SAE+FAF -10

Explain how the immune system, endocrine system, or nervous system works and draw conclusions about how systems interact to maintain homeostasis in the human body.

LS4 (9-11)-10 Students demonstrate an understanding of human body systems by ...

10b investigating the factors that affect homeostasis (e.g. positive and negative feedback).

10a explaining how the roles of the immune, endocrine, and nervous systems work together to maintain homeostasis.

LS4 (Ext)-10 Students demonstrate an understanding of human body systems by ...

10bb investigating and reporting on a human disease and its consequential disruption of homeostasis (e.g. diabetes, cancer, AIDS).

Clarifying the Standards

Prior Learning

In grades K–4, students learned to show connections between external and internal body structures. They also learned how those connections help humans survive. In grades 5–8, students learned to identify, predict, and explain the effect that biotic factors—such as microbes, parasites, food availability, and aging—have on human body systems.

Current Learning

By the end of this unit of study, students explain how body cells and organ systems interact to maintain homeostasis. Students take into consideration normal cell membrane transport processes and pathological effects on homeostasis, such as the effects of infectious disease (e.g., viral and bacterial pathogens) as well as the effects of genetics, diet and nutrition, and environmental factors. This unit also covers the importance of positive and negative feedback mechanisms in maintaining homeostasis.

Future Learning

Students will learn the role that inheritance plays in terms of health and disease. They will also learn the ecology of parasite and host interactions. In addition, students will study bacterial structure, reproduction, classification, beneficial roles, and infectious behaviors.

Additional Research Findings

As cited in *Making Sense of Secondary Science*, students have a general misconception about the causes of disease and the link between microbes and disease (pp. 55–57).

Additionally, according to the *Atlas of Science Literacy*, students fail to see the connection between cultural factors and lifestyle choices (such as exercise, diet, and high-risk behaviors) and the risk of disease (p. 88). Elementary students believe that any germ can cause illness, that all illnesses are caused by the same germ, and that healing takes place immediately after medicine is administered (p. 86).

Notes About Resources and Materials

Biology, Quarter 1, Unit 1.4

Biochemistry

Overview

Number of instructional days: 11 (1 day = 53 minutes)

Content to be learned

- Understand the cycling of matter and flow of energy in a living system.
- Explain how chemical elements and compounds combine to make up living things.

Processes to be used

- Make and use models.
- Interpret diagrams and illustrations.
- Demonstrate understanding through comparing and contrasting.
- Use tools and technology.
- Examine patterns of change.
- Evaluate systems.

Essential questions

- How do chemical elements combine in different ways to make up the structures of organic molecules?
- What is the relationship between the building and decomposition of molecules and changes in the amount of energy within living system?
- What is the relationship between the structure of organic molecules and their functions within living systems?

Written Curriculum

Grade Span Expectations

LS2 - Matter cycles and energy flows through an ecosystem.

LS2 (9-11) POC+ SAE –4

Trace the cycling of matter (e.g., carbon cycle) and the flow of energy in a living system from its source through its transformation in cellular, biochemical processes (e.g., photosynthesis, cellular respiration, fermentation).

LS2 (9-11)–4 Students demonstrate an understanding of matter and energy flow in an ecosystem by ...

4b explaining how the chemical elements and compounds that make up living things ~~pass through food webs and~~ are combined and recombined in different ways (e.g. nitrogen, carbon cycles, O₂, & H₂O cycles).

Clarifying the Standards

Prior Learning

In grades K–4, students learned that energy is needed for all organisms to stay alive and grow. In grades 5–8, students learned the basic processes involved in photosynthesis and respiration. They also recognized the names and chemical formulas of the substances involved in photosynthesis and respiration. Students learned that energy can be stored in many ways, and they learned to recognize that different substances have unique properties. In grades 9–10, students learned how to define a system, identify its components and distinguish between open and closed systems.

Current Learning

This unit provides the foundational knowledge that will be further developed in unit 2.1: Matter and Energy in Ecosystems. By the end of this unit of study, students explain the importance of carbon in the structure of organic molecules. Students list, describe, and give examples of the four major classes of organic molecules (carbohydrates, lipids, proteins, and nucleic acids). They learn that energy can be stored and released within each organic molecule's structure. In order to meet the requirement of the standard—which mandates that students examine this GSE through the lens of systems and energy (SAE)—students learn how molecules act as systems as they perform their functions within larger living systems. The individual elements that make up the molecule are the component parts of each of the systems. As in any system, if changes are made to the components of the system, the way that the system functions also changes. For example, when molecules undergo dehydration synthesis and hydrolysis the molecular structure changes, and therefore, the molecule functions within the living system also changes.

They also learn about the specific processes (dehydration synthesis and hydrolysis) in relation to organic molecules, studying the patterns of building and decomposing macromolecules. These changes cause changes in how the molecule functions. Students build on their understanding of catalysts through an introduction to enzymes.

Future Learning

Students will learn the specific biochemical processes of photosynthesis, respiration, protein synthesis, and nucleic acid synthesis as well as the role of organic molecules in these processes.

Additional Research Findings

According to *Making Sense of Secondary Science*, students have a general misconception about the concept of food as a source of energy for metabolic processes (p. 27). They also misunderstand how molecules combine and recombine (pp. 96–97) and they have a misconception that proteins, carbohydrates, and water are made of cells (p. 25).

Notes About Resources and Materials

