Grade 5 Science, Quarter 4, Unit 4.1

Diversity and Change Over Time

Overview

Number of instructional days: 8 (1 day = 45 minutes)

Content to be learned

- State the value of and reasons for classification systems.
- Explain how fossil evidence can be used to understand the history of life on earth.

Science processes to be integrated

- Describe, analyze, and compare various classification systems.
- Describe the purpose and value of various classification systems.
- Use evidence to draw conclusions.

Essential questions

- Why are classification systems important?
- How can evidence from the fossil record be used to trace the history of life on earth?

Written Curriculum

Grade-Span Expectations

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

LS3 (5-8) MAS+FAF – 8

Use a model, classification system, or dichotomous key to illustrate, compare, or interpret possible relationships among groups of organisms (e.g., internal and external structures, anatomical features).

LS3 (5-6) – 8 Students demonstrate an understanding of classification of organisms by …

8a stating the value of, or reasons for, classification systems.

LS3 (5-8) POC-9

Cite examples supporting the concept that certain traits of organisms may provide a survival advantage in a specific environment and therefore, an increased likelihood to produce offspring.

LS3 (5-6) -9 Students demonstrate an understanding of Natural Selection/evolution by …

9c explaining how fossil evidence can be used to understand the history of life on Earth.

Clarifying the Standards

Prior Learning

Students in grades K–2 demonstrated an understanding of classification of organisms by distinguishing between living and nonliving things. They identified and sorted based on similar or different external features. Further, these students observed and recorded the external features that make up living things, (e.g., roots, stems, leaves, flowers, legs, antennae, tail, shell).

Students in grades 3–4 demonstrated an understanding of classification of organisms by citing evidence to distinguish between living and nonliving things. They identified, sorted, and compared based on similar and/or different external features, and they recorded and analyzed observations/data about external features (e.g., within a grouping, which characteristics are the same and which are different). Additionally, these students cited evidence (e.g., prior knowledge, data) to draw conclusions explaining why organisms are grouped/not grouped together (e.g., mammal, bird, and fish).

Current Learning

Students have been classifying organisms as living and nonliving as well as classifying organisms into groups for a few years. In this unit, students will think about the ways organisms are grouped/not grouped together, (e.g., animals/plants, vertebrates/invertebrates, mammals/amphibians/reptiles/fish), and they use their prior knowledge to develop an understanding of the purpose and importance of classification systems, leading to the idea of a taxonomic key. While students in fifth grade will not need to follow a taxonomic key to classify a given organism, according to the standards, they should be able to state the

value of and reasons for classification systems. This concept should be taught at the developmental level to drill-and-practice level of instruction.

In the classroom, students classify groups of organisms, determining similarities and differences. They may develop their own classification systems based on organisms' similarities and differences. They then develop understanding of how a given organism fits into a given classification, (e.g., mammal/plant/amphibian…or a group within that classification, e.g., human/dolphin). Through these investigations, students describe why we use classification systems, as well as the importance of classifying organisms.

Also in this unit of study, grade 5 students explain how fossil evidence can be used to understand the history of life on earth. Prior to fifth grade, students do not study fossils, and elementary students tend to have difficulty conceptually understanding the time spans involved when studying the history of earth. Therefore, this concept should be taught at the developmental level to the reinforcement level of instruction.

In the geology unit, students in grade 5 identified and described layers of the earth. Students' prior knowledge of sedimentary layers will prove helpful as students develop the understanding that fossils found at deeper layers of the earth are older. In the classroom, students can create "fossils" by pressing objects into clay. They will use resources (video, text, and actual fossil samples) to explore the idea that fossils are the remains of organisms from long ago and that by studying fossils, scientists can gain understanding of the history of the earth.

Future Learning

In grade 6, students will apply their knowledge of classification systems to follow a taxonomic key to identify a given organism (e.g., flowering and non-flowering plants). They will demonstrate an understanding of natural selection/evolution by explaining how the traits of a population or species affect their ability to survive over time, and they will research or report on possible causes for the extinction of an animal or plant.

Students in grades 7–8 will demonstrate an understanding of classification of organisms by sorting organisms with similar characteristics into groups based on internal and external structures. They will explain how species with similar evolutionary histories/characteristics are classified more closely together with some organisms than others (e.g., a fish and a human have more in common than a fish and a jellyfish). Furthermore, students will recognize the classification used in modern biology. They will explain that genetic variations/traits of organisms are passed on through reproduction and random genetic changes, and they will gather evidence that demonstrates evolutionary relationships among organisms (e.g., similarities in body structure, early development, traits). Students will differentiate between acquired and inherited characteristics and give examples of each. They will explain how natural selection leads to evolution (e.g., survival of the fittest), and they will describe how scientists' understanding of the way species originate or become extinct has changed over time.

Additional Findings

In the past century, no scientific theory has been more difficult for people to accept than biological evolution by natural selection. It goes against some people's strongly held beliefs about when and how the world and the living things in it were created, and it flies in the face of what people can plainly see—namely that generation after generation, life forms don't change; roses stay roses, worms stay worms. To appreciate how natural selection can account for evolution, students have to understand the important

distinction between the selection of an individual with a certain trait and the changing proportions of that trait in populations. Their ability to grasp this distinction requires some understanding of the mathematics of proportions and opportunities for them to reflect on the individual-versus-population distinction in other contexts (*Benchmarks for Science Literacy*, p. 122). Therefore, the foundation for understanding these concepts is laid in the elementary grades.

Students in grades 3–5 should look for ways in which organisms in one habitat differ from those in another and consider how some of those differences are helpful to survival. The focus should be on the consequences of different features of organisms for their survival and reproduction. The study of fossils that preserve plant and animals structures is one approach to looking at characteristics of organisms. By the end of grade 5, students should know that individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing. Fossils can be compared to one another and to living organisms according to their similarities and differences. Some organisms that lived long ago are similar to existing organisms, but some are quite different (*Benchmarks*, p. 123).

As students become more familiar with the characteristics of more and more organisms, they should be asked to invent schemes for classifying them—but without using formal classification systems. Hopefully, their classification schemes will vary according to the uses made of them as well as according to features such as gross anatomy, behavior patterns, and habitats. The aim is to move students toward the realization that there are many ways to classify things, but how good any classification is depends on its usefulness. A scheme is useful if it contributes either to making decisions on some matter or to a deeper understanding of the relatedness of organisms. By the end of grade 5, students should know that a great variety of kinds of living things can be sorted into groups in many ways using various features to decide which things belong to which group, and the features used for grouping depend on the purpose of the grouping (*Benchmarks for Science Literacy*, p. 103).

According to some research, upper elementary students tend to use a number of mutually exclusive groups rather than a hierarchy when asked to group organisms. Some groups are based on observable features, and others on concepts. By middle school, students can group organisms hierarchically when asked to do so, whereas high school students use hierarchical taxonomies without prompting (*Benchmarks*, p. 340).

High school students and college students, even after some years of biology instruction, have difficulties understanding the notion of natural selection. A major hindrance appears to be students' inability to integrate two distinct processes in evolution, the occurrence of new traits in a population and their effect on long-term survival. Many students believe that environmental conditions are responsible for changes in traits, or that organisms develop new traits because they need them to survive, or that they over-use or under-use certain bodily organs or abilities.

By contrast, students have little understanding that chance alone produces new heritable characteristics by forming new combinations of existing genes or by mutations of genes. Some students believe that a mutation modifies an individual's own form during its life rather than only its germ cells and offspring. Students also have difficulties understanding that changing a population results from the survival of a few individuals that preferentially reproduce, not from the gradual change of all individuals in the population. Explanations about "insects or germs becoming more resistant" rather than "more insects or germs becoming resistant" may reinforce these misunderstandings (*Benchmarks*, p. 343).

In grades 5–8, understanding adaptation can be particularly troublesome. Many students think adaptation means that individuals change in major ways in response to environmental changes (that is, if the environment changes, individual organisms deliberately adapt). Some fundamental concepts for these grade levels include that millions of species of animals, plants, and microorganisms are live today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of chemical processes, and the evidence of common ancestry. Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment. Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist (*National Science Education Standards*, p. 158).

Grade 5 Science, Quarter 4, Unit 4.2

Processes Within an Ecosystem

Overview

Number of instructional days: 8 (1 day = 45 minutes)

Content to be learned

- Identify the sun as the major source of energy for life on earth.
- Beginning with the sun, sequence the flow of energy in an ecosystem.
- Explain the processes of precipitation, evaporation, and condensation as parts of the water cycle.
- Trace how water cycles through the environment.

Science processes to be integrated

- Identify sources of energy within a system.
- Sequence the flow of energy within a system.
- Identify and explain processes within a system.
- Trace changes that occur within a system.

Essential questions

- How does energy flow throughout an ecosystem?
- How does water cycle through an ecosystem?

Written Curriculum

Grade-Span Expectations

LS2 - Matter cycles and energy flows through an ecosystem.

LS2 (5-8) SAE– 6

Given a scenario trace the flow of energy through an ecosystem, beginning with the sun, through organisms in the food web, and into the environment (includes photosynthesis and respiration).

LS2 (5-6) –6 Students demonstrate an understanding of energy flow in an ecosystem by …

6a identifying the sun as the major source of energy for life on earth and sequencing the energy flow in an ecosystem.

LS2 (5-8) SAE-7

*Given an ecosystem, trace how matter cycles among and between organisms and the physical environment (includes water, oxygen, food web, decomposition, recycling but **not** carbon cycle or nitrogen cycle).*

LS2 (5-6)-7 Students demonstrate an understanding of recycling in an ecosystem by …

7a explaining the processes of precipitation, evaporation, condensation as parts of the water cycle.

Clarifying the Standards

Prior Learning

In grades K–2, students demonstrated understanding of energy flow in an ecosystem by caring for plants and animals—including identifying and providing for their needs—and they experimented with a plant's growth under different conditions, including light and no light. They acted out and constructed simple diagrams (pictures or words) to show a simple food web, and they used information about a simple food web to determine how basic needs (e.g., shelter and water) are met by the habitat/environment. Students observed how clouds are related to forms of precipitation. They identified the sun as a source of heat energy, and described that the sun warms land and water.

In grades 3–4, students demonstrate an understanding of energy flow in an ecosystem by identifying sources of energy for organisms' survival (food or light). Students demonstrated in a food web that all animals' food begins with the sun. They used information about organisms to design habitats and explained how the habitat provides for the needs of the organisms that live there; they also explained the way that plants and animals in the habitat depend on each other.

Students demonstrated an understanding of processes and changes over time within earth systems by describing that water changes into vapor in the air and reappears as a liquid when it's cooled, and explaining how the water cycle relates to weather and the formation of clouds.

Current Learning

At the reinforcement level of instruction, grade 5 students demonstrate an understanding of energy flow in an ecosystem by identifying the sun as the major source of energy for life on earth, and by sequencing the energy flow in an ecosystem. In the classroom, students should have opportunities to draw/diagram food chains and food webs for given ecosystems, and they need additional time to discuss the energy flow that each food web depicts. Additionally, they should discuss what happens when a given ecosystem changes, and the effect the change has on the organisms that are part of the ecosystem's food web.

At the reinforcement level to the drill-and-practice level of instruction, students demonstrate an understanding of recycling in an ecosystem by explaining the processes of precipitation, evaporation, and condensation as parts of the water cycle. Earlier in grade 5, when students studied weather, they diagrammed, labeled, and explained the processes of the water cycle. In this unit, students draw on their prior experiences in order to explain the processes of the water cycle as nature's way of recycling water. This recycling makes fresh water constantly available for the living organisms in an ecosystem. Therefore, in this unit, students do not need to diagram and label models of the water cycle. Instead, students can use diagrams of the water cycle that were created during the weather unit as they observe the recycling of water in a model ecosystem, such as a closed terrarium.

Future Learning

In grade 6, students will demonstrate an understanding of equilibrium in an ecosystem by identifying and defining an ecosystem and the variety of relationships within it (e.g., predator/prey, host/parasite, consumer/producer/decomposer, catastrophic events). Students will demonstrate an understanding of recycling in an ecosystem by completing a basic food web for a given ecosystem. In addition, students will demonstrate an understanding of energy flow in an ecosystem by describing the basic processes and recognizing the substances involved in photosynthesis and respiration.

In grades 7–8, students will demonstrate an understanding of equilibrium in an ecosystem by identifying which biotic and abiotic factors affect a given ecosystem, and analyzing how biotic and abiotic factors affect a given ecosystem. They will predict the outcome of a given change in biotic and abiotic factors in an ecosystem, and will use a visual model to track population changes in an ecosystem. Students will demonstrate an understanding of energy flow in an ecosystem by explaining the transfer of the sun's energy through living systems and its effect upon them, and by describing the basic processes and recognizing the names and chemical formulas of the substances involved in photosynthesis and respiration.

They will also explain the relationship between photosynthesis and respiration. Students will demonstrate an understanding of food webs in an ecosystem by creating or interpreting a model that traces the flow of energy in a food web. Students will demonstrate an understanding of recycling in an ecosystem by diagramming or sequencing a series of steps showing how matter cycles among and between organisms and the physical environment, and developing a model for a food web of local aquatic and local terrestrial environments. They will explain the inverse nature or complementary aspects of photosynthesis/respiration in relation to carbon dioxide, water and oxygen exchange, and will conduct a controlled investigation that shows that the total amount of matter remains constant, even though its form and location change as matter is transferred among and between organisms and the physical environment.

Additional Findings

Organisms are linked to one another and to their physical setting by the transfer and transformation of matter and energy. This fundamental concept brings together insights from the physical and life sciences,

but energy transfer in life systems is less obvious than in physical systems. Tracing where energy comes from through its various forms is usually directly observable in physical systems. But energy stored in life systems is difficult to show, even with models. The cycling of matter and flow of energy can be found at many levels of biological organization, from molecules to ecosystems. The study of food webs can start in the elementary grades with the transfer of matter, and continue in the middle grades with the flow of energy through organisms. The whole picture grows slowly over time for students (*Benchmarks for Science Literacy,* p. 118).

In grades K–2, children should begin to be aware of the basic parts of the food chain: Plants need sunlight to grow, some animals eat plants, and other animals eat both plants and animals. The key step that plants *make their own food* is very difficult for elementary students and should be saved for middle school. An awareness of recycling, both in nature and in human societies, may play a helpful role in the development of children's thinking. Familiarity with the recycling of materials fosters the notion that matter continues to exist even though it changes from one form to another (*Benchmarks,* p. 119).

In grades 3–5, students should begin to notice that substances may change form and move from place to place, but they never appear out of nowhere and never just disappear. Questions should encourage students to consider where substances come from and where they go and to be puzzled when they cannot account for the origin or the fate of a substance. By the end of grade 5, students should know that almost all kinds of animals' food can be traced back to plants. Some source of energy is needed for all organisms to stay alive and grow. Over the whole earth, organisms are growing, dying, and decaying, and new organisms are being produced by the old ones (*Benchmarks,* p. 119).

Students in grades 5–8 understand ecosystems and the interactions between organisms and environments well enough to be introduced to ideas about energy flow, although some students might be confused by charts and flow diagrams. Some fundamental concepts for these grade levels include that a population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem. Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some microorganisms are producers—they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem. For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs (*National Science Education Standards*, pp. 156–158).

According to the *Atlas of Science Literacy*, some students of all ages have difficulty identifying the sources of energy for plants and also for animals. Students tend to confuse energy and other concepts such as food, force, and temperature. As a result, students may not appreciate the uniqueness and importance of energy conversion processes like respiration and photosynthesis (*Atlas of Science Literacy, Vol. 1*, p. 78). Some students also hold misconceptions about plant nutrition. They think plants get their food from the environment rather than manufacturing it internally, and that food for plants is taken in from the outside. These misconceptions are particularly resistant to change. Even after traditional instruction, students have difficulty accepting that plants make food from water and air, and that this is their only source of food. Understanding that the food made by plants is very different from other nutrients such as water or minerals is a prerequisite for understanding the distinction between plants as producers and animals as consumers (*Atlas for Science Literacy, Vol. 1*, p. 76).

Grade 5 Science, Quarter 4, Unit 4.3

Heredity and Human Development

Overview

Number of instructional days: 6 (1 day = 45 minutes)

Content to be learned

- Differentiate between inherited and acquired traits.
- Observe, record, and compare differences in inherited traits (e.g., connected earlobe, tongue rolling).
- Using data provided, select evidence that supports the concept that traits are passed on from parents to offspring.

Science processes to be integrated

- Make and record observations.
- Identify similarities and differences.
- Use data and cite evidence to support conclusions.

Essential questions

- What is the difference between traits that are inherited and those that are acquired?
- How can data provide evidence that traits are passed on from parents to offspring?

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 (5-8) INQ+POC-11

Using data provided, select evidence that supports the concept that genetic information is passed on from both parents to offspring.

LS4 (5-6)-11 Students demonstrate an understanding of human heredity by …

11b observing, recording and comparing differences in inherited traits (e.g. connected earlobe, tongue rolling).

11a differentiating between inherited and acquired traits.

Clarifying the Standards

Prior Learning

In grades K–2, students demonstrated an understanding of human heredity by observing and comparing their physical features with those of parents, classmates, and other organisms, and by identifying that some behaviors are learned.

In grades 3–4, students demonstrated an understanding of human heredity by identifying similarities that are inherited from a biological parent and identifying that some behaviors are learned while others are instinctive.

Current Learning

At the developmental level to the drill-and-practice level of instruction, grade 5 students demonstrate an understanding of human heredity by observing, recording, and comparing differences in inherited traits (connected earlobes, tongue rolling) and by differentiating between inherited and acquired traits (large muscles, frizzy/straightened hair). Acquired traits are more difficult for students at this age to understand but might be more easily seen in animals than in people. For example, dolphins inherit the trait of jumping; however, dolphins must learn to jump through a hoop, which is an acquired trait.

In the classroom students can record and compare evidence of traits by making observations of the traits of other students. Students can see examples of inherited traits by observing and recording traits that they have inherited from their parents or that they have in common with other family members. They can see examples of inherited versus acquired traits by watching videos of dog shows, old television shows, such as *Flipper* and *Lassie*, and animal videos. Students can also use Internet resources and trade books to see examples of inherited and acquired traits.

Future Learning

The content in this unit is not addressed in grade 6.

In grades 7–8, students will demonstrate an understanding of human heredity by recognizing that characteristics of an organism results from inherited traits of one or more genes from the parents and other results from interactions with the environment. Students will trace a genetic characteristic through a given pedigree to demonstrate the passage of traits, and they will identify that genetic material is located in the cell's nucleus.

Additional Findings

By middle school, most students know about the basic process of sexual reproduction in humans. However, the student might have misconceptions about the role of sperm and eggs and about the sexual reproduction of flowering plants. Concerning heredity, younger middle-school students tend to focus on observable traits, and older students have some understanding that genetic material carries information. Some fundamental concepts include that reproduction is a characteristic of all living systems. Because no individual organism lives forever, reproduction is essential to the continuation of every species. Sexually produced offspring are never identical to either parent. Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to the next. The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment. All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment. Behavior is one kind of response an organism can make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels, and is determined in part by heredity and in part from experience. An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger is based in the species' evolutionary history (*National Science Education Standards*, pp. 156–157).

Children should begin their study of heredity by observing themselves, their classmates, and their pets. They can then compare their own physical appearance to that of their siblings, parents, and grandparents. Learning the genetic explanation for how traits are passed on from one generation to the next can begin in the middle years and carry into high school. In grades 3–5, students should move from describing individuals directly to naming traits and classifying individuals with respect to those traits. Students can be encouraged to keep lists of things that animals and plants get from their parents, things that they don't get, and things that the students are not sure about either way. This is also time to start building the notion of a population whose members are alike in many ways but show some variation. Students should know that some likenesses between children and parents, such as eye color in human beings, or fruit or flower color in plants, are inherited. Other likenesses, such as people's table manners or carpentry skills, are learned. For offspring to resemble their parents, there must be a reliable way to transfer information from one generation to the next (*Benchmarks for Science Literacy*, pp. 106–107). Human behavior results from the interaction of inheritance and learning. Besides being a basic function of most animals, learning defines the most prominent way in which human beings are different from other species (*Benchmarks*, p. 139).

When asked to explain how physical traits are passed from parents to offspring, elementary school, middle school, and some high school students express a number of misconceptions. Some students believe that traits are inherited from only one of the parent (for example, the traits are inherited from the mother because she gave birth or has the most contact as children grow up; or the same sex parent will be the determiner). Other students believe that certain characteristics are always inherited from the mother and others come form the father. Some students believe in a "blending of characteristics." It may not be until the end of 5th grade that some students can use arguments based on chance to predict the outcome of

inherited characteristics from observing those characteristics in the parents. Early middle school students can explain inheritance only in observable features, but upper middle school and high school students have some understanding that characteristics are determined by a particular genetic entity, which carries information translatable by the cell. Students of all ages believe that some environmentally produced characteristics can be inherited, especially over generations (*Benchmarks*, p. 341).

Most research studies in the area of variation and resemblance assume that the subjects grasp the concepts of variation within a species and of offspring resembling their parents. In one study, most students (94%) understood that one's characteristics come from parents, half understood that inheritance and reproduction occur together, and less than half (44%) understood that one gets a mixture of features from both parents. In a similar study, 52% of students recognized that variation between species occurs, but they regarded it as a response to environmental conditions rather than due to inheritance. Students had firm ideas of transmission of characteristics from generation to generation. Male students believed in blending inheritance and they regarded characteristics from the male parent as being stronger in their expression. Other studies have also found similar notions regarding lack of equality of parental contribution, including a tendency to favor the mother as providing the main contribution or to support same-sex inheritance (*Making Sense of Secondary Science*, p. 51).