Concepts

Living things are organized into systems that are interconnected and interactions with and among living systems cause changes in matter, energy, and environment.

The energy for life is ultimately derived from the sun. Sustaining life requires energy and matter inputs.

Ecosystems are ever-changing, with matter and energy ever-cycling through them.

Questions

How do organisms obtain resources? How do organisms change their environment? How do changing environmental systems affect organisms/man?

What is an ecosystem? What is a food chain and a food web and how are the populations in these connected?

How does energy move through an ecosystem?

How do food webs affect us?

How do ecosystems recycle water, carbon, and nitrogen?

In what ways do ecosystems change?

How do the changes affect populations?

How are living things organized?

What is a biome? Describe the various biomes.

How do humans impact the environment and ecosystems?

NC Science Essential Standards

5.L.2 Understand the interdependence of plants and animals with their ecosystem.

5.L.2.1 Compare the characteristics of several common ecosystems, including estuaries and salt marshes, oceans, lakes and ponds, forests, and grasslands.

5.L.2.2 Classify the organisms within an ecosystem according to the function they serve: producers, consumers, or decomposers (biotic factors).

5.L.2.3 Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem.

Terminology

- food chains
- adaptations
- prey/predator
- life cycles
- producer
- consumer
- food web
- competition
- energy pyramid
- animal and plant
- natural resources

5. L.2.1

Students know that there are different types of ecosystems (terrestrial and aquatic). These ecosystems can be divided into two types according to their characteristics:

Terrestrial

Land-based ecosystems include forests and grasslands.

Forests have many trees (with needles or with leaves), shrubs, grasses and ferns, and a variety of animals.

They usually get more rain than grasslands. Diverse types of animals can be found in forests, depending
on their type. Deciduous: black bear, deer, red fox, vole, rabbit, cardinal. Rain forest: panther, monkeys,
capybara, snakes, spiders. Temperatures in the forests may vary depending on where the forest is located.
Grasslands have fertile soil and are covered with tall grasses. They usually get a medium amount of rain,
but less than forests. Temperatures may also vary depending on where the grassland is located. Some
examples of animals that live in the grasslands are prairie dogs, bison, and grasshoppers.
Aquatic
Water-based ecosystems may be fresh water (lakes and ponds) or saltwater (oceans, estuaries and
saltwater marshes).
Lakes and ponds are bodies of freshwater that are surrounded by land. Ponds are usually shallower than
lakes and the temperature of the water usually stays the same from top to bottom. Plants and algae usually
grow along the edges where the water is shallow. Some examples of animals may be different types of
fish, amphibians, ducks, turtles, or beavers.
Oceans are large bodies of saltwater divided by continents. Oceans have many types of ecosystems
depending on the conditions (sunlight, temperature, depth, salinity) of that part of the ocean.
Most organisms live where the ocean is shallow (from the shoreline to the continental shelf) because
sunlight can reach deep and the water is warm making food abundant. Some examples of organisms that
live in the shallow ocean are drifters (jellyfish or seaweed), swimmers (fish), crawlers (crabs), and those
anchored to the ocean floor (corals).
Some organisms live in the open ocean, near the surface or down to the deep ocean bottom. Plankton
floats in the upper regions of the water. Some organisms swim to the surface to find food or for air
(whales, turtles, sharks) while others live closer to the bottom (certain fish, octopus, tubeworms).
Students know typical visual representations of the various ecosystems, as well as graphic representations
of the food chains and webs, cycles and energy pyramids that are commonly associated with ecosystems.
5.L.2.2
Students know that organisms in an ecosystem can be producers, consumers, or decomposers. Students
know that producers convert energy from the sun into organic matter through the process of
photosynthesis. This organic matter is used by producers and consumers as food which provides the
energy that fuels basic life processes. Consumers sometimes consume only or mostly other consumers as
a food source. Producers and consumers produce wastes as they perform their life processes, and become
waste organic matter when they die. Decomposers use these waste materials and other non living organic
matter to fuel their life processes and recycle nutrients that are necessary for producers to carry out their
life processes.
5.L.2.3
Students know that all of the organisms in an ecosystem have interconnected relationships. Students know
that because of this, factors that impact one population within an ecosystem may impact other populations
within that ecosystem.

Science For All Americans

INTERDEPENDENCE OF LIFE
Every species is linked, directly or indirectly, with a multitude of others in an ecosystem. Plants provide
food, shelter, and nesting sites for other organisms. For their part, many plants depend upon animals for
help in reproduction (bees pollinate flowers, for instance) and for certain nutrients (such as minerals in
animal waste products). All animals are part of food webs that include plants and animals of other species
(and sometimes the same species). The predator/prey relationship is common, with its offensive tools for
predators—teeth, beaks, claws, venom, etc.—and its defensive tools for prey—camouflage to hide, speed
to escape, shields or spines to ward off, irritating substances to repel. Some species come to depend very closely on others (for instance, pandas or koalas can eat only certain species of trees). Some species have become so adapted to each other that neither could survive without the other (for example, the wasps that nest only in figs and are the only insect that can pollinate them).

There are also other relationships between organisms. Parasites get nourishment from their host organisms, sometimes with bad consequences for the hosts. Scavengers and decomposers feed only on dead animals and plants. And some organisms have mutually beneficial relationships—for example, the bees that sip nectar from flowers and incidentally carry pollen from one flower to the next, or the bacteria that live in our intestines and incidentally synthesize some vitamins and protect the intestinal lining from germs.

But the interaction of living organisms does not take place on a passive environmental stage. Ecosystems are shaped by the nonliving environment of land and water—solar radiation, rainfall, mineral concentrations, temperature, and topography. The world contains a wide diversity of physical conditions, which creates a wide variety of environments: freshwater and oceanic, forest, desert, grassland, tundra, mountain, and many others. In all these environments, organisms use vital earth resources, each seeking its share in specific ways that are limited by other organisms. In every part of the habitable environment, different organisms vie for food, space, light, heat, water, air, and shelter. The linked and fluctuating interactions of life forms and environment compose a total ecosystem; understanding any one part of it well requires knowledge of how that part interacts with the others.

The interdependence of organisms in an ecosystem often results in approximate stability over hundreds or thousands of years. As one species proliferates, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to predators, or invasion by parasites. If a natural disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in a succession of stages that eventually results in a system similar to the original one.

The interdependence of organisms in an ecosystem often results in approximate stability over hundreds or thousands of years. As one species proliferates, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to predators, or invasion by parasites. If a natural disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in a succession of stages that eventually results in a system similar to the original one.

Like many complex systems, ecosystems tend to show cyclic fluctuations around a state of approximate equilibrium. In the long run, however, ecosystems inevitably change when climate changes or when very different new species appear as a result of migration or evolution (or are introduced deliberately or inadvertently by humans).

FLOW OF MATTER AND ENERGY

However complex the workings of living organisms, they share with all other natural systems the same physical principles of the conservation and transformation of matter and energy. Over long spans of time, matter and energy are transformed among living things, and between them and the physical environment. In these grand-scale cycles, the total amount of matter and energy remains constant, even though their form and location undergo continual change.

Almost all life on earth is ultimately maintained by transformations of energy from the sun. Plants capture the sun's energy and use it to synthesize complex, energy-rich molecules (chiefly sugars) from molecules of carbon dioxide and water. These synthesized molecules then serve, directly or indirectly, as the source of energy for the plants themselves and ultimately for all animals and decomposer organisms (such as bacteria and fungi). This is the food web: The organisms that consume the plants derive energy and materials from breaking down the plant molecules, use them to synthesize their own structures, and then are themselves consumed by other organisms. At each stage in the food web, some energy is stored in newly synthesized structures and some is dissipated into the environment as heat produced by the energy-releasing chemical processes in cells. A similar energy cycle begins in the oceans with the capture of the sun's energy by tiny, plant-like organisms. Each successive stage in a food web captures only a small fraction of the energy content of organisms it feeds on.
The elements that make up the molecules of living things are continually recycled. Chief among these elements are carbon, oxygen, hydrogen, nitrogen, sulfur, phosphorus, calcium, sodium, potassium, and iron. These and other elements, mostly occurring in energy-rich molecules, are passed along the food web and eventually are recycled by decomposers back to mineral nutrients usable by plants. Although there often may be local excesses and deficits, the situation over the whole earth is that organisms are dying and decaying at about the same rate as that at which new life is being synthesized. That is, the total living biomass stays roughly constant, there is a cyclic flow of materials from old to new life, and there is an irreversible flow of energy from captured sunlight into dissipated heat.

An important interruption in the usual flow of energy apparently occurred millions of years ago when the growth of land plants and marine organisms exceeded the ability of decomposers to recycle them. The accumulating layers of energy-rich organic material were gradually turned into coal and oil by the pressure of the overlying earth. The energy stored in their molecular structure we can now release by burning, and our modern civilization depends on immense amounts of energy from such fossil fuels recovered from the earth. By burning fossil fuels, we are finally passing most of the stored energy on to the environment as heat. We are also passing back to the atmosphere—in a relatively very short time—large amounts of carbon dioxide that had been removed from it slowly over millions of years.

The amount of life any environment can sustain is limited by its most basic resources: the inflow of energy, minerals, and water. Sustained productivity of an ecosystem requires sufficient energy for new products that are synthesized (such as trees and crops) and also for recycling completely the residue of the old (dead leaves, human sewage, etc.). When human technology intrudes, materials may accumulate as waste that is not recycled. When the inflow of resources is insufficient, there is accelerated soil leaching, desertification, or depletion of mineral reserves.

Subject Area/Grade:  Earth Science, grade 5 
Earth Systems, Structures and Processes

Concepts
Earth systems are dynamic. Weather and climate patterns are dynamic.
Heat energy (solar radiation) is a major determinant of the various weather and climate conditions on Earth.
Water on Earth, cycling and stored in a variety of reservoirs (oceans, ice packs, aquifers and streams) is another major determinant of weather and climate conditions on Earth. The oceans, in particular, have a powerful influence on weather and climate.
The interplay of heat energy from the sun, with water, atmosphere and land creates complex weather and climate patterns on Earth.
Weather and climate on Earth can be predicted on small and large scales and have changed (sometimes dramatically) in long- and short-term cycles.
Questions
What causes daily and seasonal weather?
How are daily and seasonal changes in weather interconnected?
How do we create weather models that allow us to make weather predictions?
How do global factors influence local weather conditions?
In what ways do weather conditions in one area or region influence the weather conditions in another area or region?
What factors influence weather and climate on a global scale?
How are weather and climate interconnected?

NC Science Essential Standards
5.E.1 Understand weather patterns and phenomena, making connections to the weather in a particular place and time.
5.E.1.1 Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.
5.E.1.2 Predict upcoming weather events from weather data collected through observation and measurements.
5.E.1.3 Explain how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.

Terminology
precipitation                  evaporation                condensation               Jet stream
Gulf stream                 air mass
La Nina / El Nino         temperature              air pressure              humidity              latitude /
longitude
hemisphere                thermometer             barometer                anemometer
wind vane                                rain gauge

5.E.1.1 Students know that weather can change from day to day, and that many factors are measured to describe and predict weather conditions. (EG: wind speed and direction, precipitation, temperature and air pressure). Students know that in different latitudes and hemispheres there are different (and sometimes opposite) seasonal weather patterns.
5.E.1.2 Students know that one can collect and compare weather data in order to predict the likelihood of a particular weather condition occurring. Students know how to read basic weather instruments: thermometer, barometer, anemometer, wind vane, and rain gauge. Students also can identify atmospheric conditions (presence and type of clouds [stratus, cirrus, cumulous], fronts) that are associated with predictable weather patterns. Students can make basic weather predictions using these skills.
5.E.1.3 Students know that local weather conditions are influenced by global factors such as air and water currents. The jet stream is an air current in the upper atmosphere, located over North America that has a powerful influence on the weather conditions there. The jet stream flows from the west to the east and changes location depending on global conditions. The Gulf stream is a warm water surface current in the Atlantic ocean that moves from south of Florida up the eastern seaboard and then across the Atlantic. The Gulf stream moderates weather along the eastern seaboard, warming the air and land there during the cooler months. In the Pacific, there is an oscillation of water temperatures known as El Nino/La Nina.
This oscillation impacts the climate of North and South America for long periods of time. Hurricanes are major storms that form over warm ocean water and are caused by global weather patterns.

Science For All Americans
THE EARTH

We live on the Earth. The earth's shape is approximately spherical, the result of mutual gravitational attraction pulling its material toward a common center. Unlike the much larger outer planets, which are mostly gas, the earth is mostly rock, with three-fourths of its surface covered by a relatively thin layer of water and the entire planet enveloped by a thin blanket of air. Bulges in the water layer are raised on both sides of the planet by the gravitational tugs of the moon and sun, producing high tides about twice a day along ocean shores. Similar bulges are produced in the blanket of air as well.

Of all the diverse planets and moons in our solar system, only the earth appears to be capable of supporting life as we know it. The gravitational pull of the planet's mass is sufficient to hold onto an atmosphere. This thin envelope of gases evolved as a result of changing physical conditions on the earth's surface and the evolution of plant life, and it is an integral part of the global ecosystem. Altering the concentration of its natural component gases of the atmosphere, or adding new ones, can have serious consequences for the earth's life systems.

The distance of the earth from the sun ensures that energy reaches the planet at a rate sufficient to sustain life, and yet not so fast that water would boil away or that molecules necessary to life would not form. Water exists on the earth in liquid, solid, and gaseous forms—a rarity among the planets (the others are either closer to the sun and too hot or farther from the sun and too cold).

The motion of the earth and its position with regard to the sun and the moon have noticeable effects. The earth's one-year revolution around the sun, because of the tilt of the earth's axis, changes how directly sunlight falls on one part or another of the earth. This difference in heating different parts of the earth's surface produces seasonal variations in climate. The rotation of the planet on its axis every 24 hours produces the planet's night-and-day cycle—and (to observers on earth) makes it seem as though the sun, planets, stars, and moon are orbiting the earth. The combination of the earth's motion and the moon's own orbit around the earth, once in about 28 days, results in the phases of the moon (on the basis of the changing angle at which we see the sunlit side of the moon).

The earth has a variety of climatic patterns, which consist of different conditions of temperature, precipitation, humidity, wind, air pressure, and other atmospheric phenomena. These patterns result from an interplay of many factors. The basic energy source is the heating of land, ocean, and air by solar radiation. Transfer of heat energy at the interfaces of the atmosphere with the land and oceans produces layers at different temperatures in both the air and the oceans. These layers rise or sink or mix, giving rise to winds and ocean currents that carry heat energy between warm and cool regions. The earth's rotation curves the flow of winds and ocean currents, which are further deflected by the shape of the land.

The cycling of water in and out of the atmosphere plays an important part in determining climatic patterns—evaporating from the surface, rising and cooling, condensing into clouds and then into snow or rain, and falling again to the surface, where it collects in rivers, lakes, and porous layers of rock. There are also large areas on the earth's surface covered by thick ice (such as Antarctica), which interacts with the atmosphere and oceans in affecting worldwide variations in climate.

The earth's climates have changed radically and they are expected to continue changing, owing mostly to the effects of geological shifts such as the advance or retreat of glaciers over centuries of time or a series of huge volcanic eruptions in a short time. But even some relatively minor changes of atmospheric content or of ocean temperature, if sustained long enough, can have widespread effects on climate.

The earth has many resources of great importance to human life. Some are readily renewable, some are renewable only at great cost, and some are not renewable at all. The earth comprises a great variety of minerals, whose properties depend on the history of how they were formed as well as on the elements of which they are composed. Their abundance ranges from rare to almost unlimited. But the difficulty of extracting them from the environment is as important an issue as their abundance. A wide variety of minerals are sources for essential industrial materials, such as iron, aluminum, magnesium, and copper.
Many of the best sources are being depleted, making it more and more difficult and expensive to obtain those minerals.

Fresh water is an essential resource for daily life and industrial processes. We obtain our water from rivers and lakes and from water that moves below the earth's surface. This groundwater, which is a major source for many people, takes a long time to accumulate in the quantities now being used. In some places it is being depleted at a very rapid rate. Moreover, many sources of fresh water cannot be used because they have been polluted.

Wind, tides, and solar radiation are continually available and can be harnessed to provide sources of energy. In principle, the oceans, atmosphere, topsoil, sea creatures, and trees are renewable resources. However, it can be enormously expensive to clean up polluted air and water, restore destroyed forests and fishing grounds, or restore or preserve eroded soils of poorly managed agricultural areas. Although the oceans and atmosphere are very large and have a great capacity to absorb and recycle materials naturally, they do have their limits. They have only a finite capacity to withstand change without generating major ecological alterations that may also have adverse effects on human activities.

Subject Area/Grade: Physical Science, grade 5      Title: Heat Energy

Concepts

Heat energy is a property of many substances and many processes give off heat energy.
Heat energy moves in predictable ways.
When two objects are rubbed against each other, they both get warmer. In addition, many mechanical and electrical devices get warmer when they are used.
When warmer things are put with cooler ones, the warmer things get cooler and the cooler things get warmer until they all are the same temperature.
When warmer things are put with cooler ones, heat is transferred from the warmer ones to the cooler ones.
A warmer object can warm a cooler one by contact or at a distance.

NC Science Essential Standards

5.P.3 Explain how the properties of some materials change as a result of heating and cooling
5.P.3.1 Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures. (conduction, convection or radiation).
5.P.3.2 Explain how heating and cooling affect some materials and how this relates to their purpose and practical applications.

Questions

What is heat? How can heat change the properties of a substance? Does heat energy behave in predictable ways? How does heat move from one place to another? How do we explain conduction? How do we explain convection? How do we explain radiation? What are some natural examples of each type of heat transfer?
What is temperature?

Terminology
conduction  convection  radiation  temperature
5.P.3.1
Students know that when warmer things are put with cooler things, the warmer things lose heat and the cool things gain it until they are all at the same temperature. Students know that a warmer object can warm a cooler object by contact or at a distance. Conduction is the transfer of thermal energy between things that are touching. Conduction can happen within one object. (For example, thermal energy can be conducted through the handle of a metal pot.) Convection is the movement of thermal energy by the movement of liquids or gases. Convection in the oceans and atmosphere helps to move thermal energy around Earth, and is an important factor influencing weather and climate. Radiation is the transfer of energy by electromagnetic waves. Electromagnetic waves can carry energy through places with or without any matter. The Sun is the main source of electromagnetic energy on Earth. Part of this energy, light, is used by producers to make food. Radiation can also happen in other circumstances (i.e. sitting in front of a fireplace).

5.P.3.2
Students know that heating and cooling can cause changes in the properties of materials, but not all materials respond the same way to being heated and cooled. Students know that heating and cooling cause changes in the properties of materials, such as water turning into steam by boiling and water turning into ice by freezing. Students know and notice that many kinds of changes occur faster at higher temperatures. Students know that some materials conduct heat much better than others, and poor conductors can reduce heat loss.

Subject Area/Grade: Life Science, grade 5
Title: Evolution and Genetics

Questions

• Why do offspring resemble their parents?
• Why don’t offspring look exactly like their parents?
• How do organisms change as they go through life cycles?
• How are organisms of the same kind similar, yet different?
• How are organisms of the same kind different from each other and how might this help them to survive?

NC Science Essential Standards
5.L.3 Understand why organisms differ from or are similar to their parents based on the characteristics of the organism.
5.L.3.1 Explain why organisms differ from or are similar to their parents based on the characteristics of the organism.
5.L.3.2 Give examples of likenesses that are inherited and some that are not.

Terminology
trait   inherit   species   population   community   culture

How are the characteristics of one generation related to the previous generation?
In all organisms the genetic instructions for forming species characteristics are carried in the chromosomes. Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. DNA molecules contain four different kinds of building
blocks, called nucleotides, linked together in a sequential chain. The sequence of nucleotides spells out
the information in a gene. Before a cell divides the DNA sequence of its chromosomes is replicated and
each daughter cell receives a copy. DNA is replicated by physical and chemical mechanisms within the
cell and controls the expression of proteins: it is transcribed into a “messenger” RNA, which is translated
in turn by the cellular machinery into a protein. In effect, proteins build an organism’s identifiable traits.
When organisms reproduce, genetic information is transferred to their offspring, with half coming from
each parent in sexual reproduction. Inheritance is the key factor in similarity among individuals in a
species population.
Grades Band Endpoints for LS3.A
By the end of grade 2. Organisms have characteristics that can be similar or different. Young animals are
very much, but not exactly, like their parents and also resemble other animals of the same kind. Plants
also are very much, but not exactly, like their parents and resemble other plants of the same kind.
By the end of grade 5. Many characteristics of organisms are inherited from their parents. Other
characteristics result from individuals’ interactions with the environment, which can range from diet to
learning. Many characteristics involve both inheritance and environment.
LS3.B: Variation of Traits
Why do individuals of the same species vary in how they look, function, and behave?
Variations among individuals of the same species can be explained by both genetic and environmental
factors. Individuals within a species have similar but not identical genes. In sexual reproduction,
variations in traits between parent and offspring arise from the particular set of chromosomes (and their
respective multiple genes) inherited, with each parent contributing half of each chromosome pair. More
rarely, such variations result from mutations, which are changes in the information that genes carry.
Although genes control the general traits of any given organism, other parts of the DNA and external
environmental factors can modify an individual’s specific development, appearance, behavior, and
likelihood of producing offspring. Thus, the set of variations of genes present, together with the
interactions of genes with their environment, determines the distribution of variation of traits in a
population.
Grades Band Endpoints for LS3.B
By the end of grade 2. Individuals of the same kind of plant or animal are recognizable as similar but can
also vary in many ways.
By the end of grade 5. Offspring acquire a mix of traits from their biological parents. Different organisms
vary in how they look and function because they have different inherited information. In each kind of
organism there is variation in the traits themselves, and different organisms may have different versions
of the trait. The environment also affects the traits that an organism develops—differences in where they
grow or in the food they consume may cause organisms that are related to end up looking or behaving
differently.

Core Idea LS4 Biological Evolution: Unity and Diversity
How can there be so many similarities among organisms yet so many different kinds of plants, animals,
and microorganisms?
How does biodiversity affect humans?
Biological evolution explains both the unity and the diversity of species and provides a unifying principle
for the history and diversity of life on Earth. Biological evolution is supported by extensive scientific
evidence ranging from the fossil record to genetic relationships among species. Researchers continue to
use new and different techniques, including DNA and protein sequence analyses, to test and further their
understanding of evolutionary relationships. Evolution, which is continuous and ongoing, occurs when
natural selection acts on the genetic variation in a population and changes the distribution of traits in that
population gradually over multiple generations. Natural selection can act more rapidly after sudden
changes in conditions, which can lead to the extinction of species. Through natural selection, traits that
provide an individual with an advantage to best meet environmental challenges and reproduce are the
ones most likely to be passed on to the next generation. Over multiple generations, this process can lead
to the emergence of new species. Evolution thus explains both the similarities of genetic material across all species and the multitude of species existing in diverse conditions on Earth—its biodiversity—which humans depend on for natural resources and other benefits to sustain themselves.

LS4.A: EVIDENCE OF COMMON ANCESTRY AND DIVERSITY
What evidence shows that different species are related?
Biological evolution, the process by which all living things have evolved over many generations from shared ancestors, explains both the unity and the diversity of species. The unity is illustrated by the similarities found between species; which can be explained by the inheritance of similar characteristics from related ancestors. The diversity of species is also consistent with common ancestry; it is explained by the branching and diversification of lineages as populations adapted, primarily through natural selection, to local circumstances. Evidence for common ancestry can be found in the fossil record, from comparative anatomy and embryology, from the similarities of cellular processes and structures, and from comparisons of DNA sequences between species. The understanding of evolutionary relationships has recently been greatly accelerated by using new molecular tools to study developmental biology, with researchers dissecting the genetic basis for some of the changes seen in the fossil record, as well as those that can be inferred to link living species (e.g., the armadillo) to their ancestors (e.g., glyptodonts, a kind of extinct gigantic armadillo).

LS4.A: Evidence of Common Ancestry and Diversity
What evidence shows that different species are related?
Biological evolution, the process by which all living things have evolved over many generations from shared ancestors, explains both the unity and the diversity of species. The unity is illustrated by similarities found across all species; it can be explained from the inheritance of similar characteristics from similar ancestors. The diversity of species is also consistent with common ancestry; it is explained by the branching and diversification of lineages as populations adapted, primarily through natural selection, to local circumstances. Evidence for common ancestry can be found in the fossil record, from comparative anatomy, from comparative embryology, and from the similarities of cellular processes and structures and of DNA across all species. The understanding of evolutionary relationships has recently been greatly accelerated by molecular biology, especially as applied to developmental biology, with researchers investigating the genetic basis of some of the changes seen in the fossil record, as well as those that can be inferred to link living species (e.g., the armadillo) to their ancestors (e.g., glyptodonts, a kind of extinct gigantic armadillo).

Grade Band Endpoints for LS4.A
By the end of grade 2. Some kinds of plants and animals that once lived on Earth (e.g., dinosaurs) are no longer found anywhere, although others now living (e.g., lizards) resemble them in some ways.
By the end of grade 5. Fossils provide evidence about the types of organisms (both visible and microscopic) that lived long ago and also about the nature of their environments. Fossils can be compared with one another and with living organisms according to their similarities and differences.

LS4.B: NATURAL SELECTION
How does genetic variation among organisms affect survival and reproduction?
Genetic variation in a species results in individuals with a range of traits. In any particular environment individuals with particular traits may be more likely than others to survive and produce offspring. This process is called natural selection and may lead to the predominance of certain inherited traits in a population and the suppression of others. Natural selection occurs only if there is variation in the genetic information within a population that is expressed in traits that lead to differences in survival and reproductive ability among individuals under specific environmental conditions. If the trait differences do not affect reproductive success, then natural selection will not favor one trait over others.

LS4.B: Natural Selection
How does genetic variation among organisms affect survival and reproduction?
Genetic variation in a species results in individuals with a range of traits. In any particular environment individuals with particular traits may be more likely than others to survive and produce offspring. This
process is called natural selection and may lead to the predominance of certain inherited traits in a population and the suppression of others. Natural selection occurs only if there is variation in the genetic information within a population that is expressed in traits that lead to differences in survival and reproductive ability among individuals under specific environmental conditions. If the trait differences do not affect reproductive success, then natural selection will not favor one trait over others.

Grade Band Endpoints for LS4.B
By the end of grade 5. Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.

Benchmarks for Science Literacy
Students can begin to 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 animal structures is one approach to looking at characteristics of organisms. Evidence for the similarity within diversity of existing organisms can draw upon students' expanding knowledge of anatomical similarities and differences.

By the end of the 5th grade, 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. 5F/E1
• 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. 5F/E2

Unpacked Content
5.L.3.1
Students know that the life processes and species characteristics that define a population will be transmitted from parent to offspring. Students also know that these processes and characteristics cover a broad range of structures, functions and behaviors that can vary substantially from individual to individual.

5.L.3.2
Students know some likenesses between parents and children are inherited. Other likenesses are learned from parents or within the community (population/culture). Students know that in order for offspring to resemble their parents there must be a reliable way to transfer genetic information from parent to offspring. Students can be encouraged to keep lists of characteristics that animals and plants acquire from their parents, things that they don't, and things that the students are not sure about either way. This is also the time to start building the notion of a population whose members are alike in many ways but show some variation.
Concepts

Nothing in the universe is at rest. Motion is as essential to understanding the physical world as matter and energy are. All motion is relative. All motion is governed by the same basic rules.

Gravity is an attractive interaction. The earth's gravity pulls any object on or near the earth toward it without touching it. A gravitational field is caused by an object with mass.

Changes in speed or direction of motion are caused by forces. The greater the force is, the greater the change in motion will be. The more massive an object is, the less effect a given force will have.

The motion of an object can be described by its position, direction, motion and speed. Motion can be measured and represented on a graph.

NC Science Essential Standards

5.P.1 Understand force, motion and the relationship between them.

5.P.1.1 Explain how factors such as gravity, friction, and change in mass affect the motion of objects.
5.P.1.2 Infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel.
5.P.1.3 Illustrate the motion of an object using a graph to show a change in position over a period of time.
5.P.1.4 Predict the effect of a given force or a change in mass on the motion of an object.

Questions

What is the origin of motion?
How are motion and gravity connected?
What is gravity? How does gravity ‘work’?
How are force and motion connected? How can we describe their relationship?
How can we model the relationship of position, motion, direction and speed?

Terminology
Gravity mass friction axis

Unpacked Content

5.P.1.1 Students know that gravity pulls any object on or near the earth toward it without touching it. Students know that friction is a force that is created anytime two surfaces move or try to move across each other. Students know that all matter has mass. Students understand that changing any or all of these factors will affect the motion of an object.
5.P.1.2 Students know that it is possible to measure the motion of an object based on the distance it will travel in a certain amount of time.
5.P.1.3 Students know that a graph can be created using one axis to represent the distance that an object travels, and the other axis to represent the period of time the object is traveling. Students know how to construct a graph that demonstrates a relation of distance to time.
5.P.1.4
Students know that the greater a force is, the greater the change (in motion) it produces. The greater the mass of the object being acted on, the less the effect of the (same) force.

Motion is as much a part of the physical world as matter and energy are. Everything moves—atoms and molecules; the stars, planets, and moons; the earth and its surface and everything on its surface; all living things, and every part of living things. Nothing in the universe is at rest.

Since everything is moving, there is no fixed reference point against which the motion of things can be described. All motion is relative to whatever point or object we choose. Thus, a parked bus has no motion with reference to the earth's surface; but since the earth spins on its axis, the bus is moving about 1,000 miles per hour around the center of the earth. If the bus is moving down the highway, then a person walking up the aisle of the bus has one speed with reference to the bus, another with respect to the highway, and yet another with respect to the earth's center. There is no point in space that can serve as a reference for what is actually moving.

Changes in motion—speeding up, slowing down, changing direction—are due to the effects of forces. Any object maintains a constant speed and direction of motion unless an unbalanced outside force acts on it. When an unbalanced force does act on an object, the object's motion changes. Depending on the direction of the force relative to the direction of motion, the object may change its speed (a falling apple) or its direction of motion (the moon in its curved orbit), or both (a fly ball).

The greater the amount of the unbalanced force, the more rapidly a given object's speed or direction of motion changes; the more massive an object is, the less rapidly its speed or direction changes in response to any given force. And whenever some thing A exerts a force on some thing B, B exerts an equally strong force back on A. For example, iron nail A pulls on magnet B with the same amount of force as magnet B pulls on iron nail A—but in the opposite direction. In most familiar situations, friction between surfaces brings forces into play that complicate the description of motion, although the basic principles still apply.

Everything in the universe exerts gravitational forces on everything else, although the effects are readily noticeable only when at least one very large mass is involved (such as a star or planet). Gravity is the force behind the fall of rain, the power of rivers, the pulse of tides; it pulls the matter of planets and stars toward their centers to form spheres, holds planets in orbit, and gathers cosmic dust together to form stars. Gravitational forces are thought of as involving a gravitational field that affects space around any mass. The strength of the field around an object is proportional to its mass and diminishes with distance from its center. For example, the earth's pull on an individual will depend on whether the person is, say, on the beach or far out in space.

Subject Area/Grade: Physical Science, grade 5      Title: Matter and Energy

Questions
Why is the Sun important? How does the Sun impact the Earth?
What is the water cycle? Why is the water cycle an important process for Earth? How is the Sun connected to the water cycle?
What is matter? What is mass? What is weight? How are mass and weight related?
How can we describe matter?
How can matter be changed?
How can we describe the changes that take place in matter?

Terminology
evaporation transpiration condensation precipitation runoff matter energy

Unpacked Content

5.P.2.1
Students know that the sun provides the energy that is a driving force for most biotic and abiotic cycles on the surface of the earth. Students know that the sun’s energy fuels the water cycle and impacts different aspects of the water cycle (evaporation, transpiration, condensation, precipitation).

5.P.2.2
Students know that the weight of an object is equal to the weight of the sum of its parts. This is true in all closed systems.

5.P.2.3
Students know that by making qualitative and quantitative data records, we are able to create before/after representations of materials (and their properties), so that we can compare before/after versions of materials.

THE EARTH
The earth has a variety of climatic patterns, which consist of different conditions of temperature, precipitation, humidity, wind, air pressure, and other atmospheric phenomena. These patterns result from an interplay of many factors. The basic energy source is the heating of land, ocean, and air by solar radiation. Transfer of heat energy at the interfaces of the atmosphere with the land and oceans produces layers at different temperatures in both the air and the oceans. These layers rise or sink or mix, giving rise to winds and ocean currents that carry heat energy between warm and cool regions. The earth's rotation curves the flow of winds and ocean currents, which are further deflected by the shape of the land. The cycling of water in and out of the atmosphere plays an important part in determining climatic patterns—evaporating from the surface, rising and cooling, condensing into clouds and then into snow or rain, and falling again to the surface, where it collects in rivers, lakes, and porous layers of rock. There are also large areas on the earth's surface covered by thick ice (such as Antarctica), which interacts with the atmosphere and oceans in affecting worldwide variations in climate.

STRUCTURE OF MATTER
The things of the physical world seem to be made up of a stunningly varied array of materials. Materials differ greatly in shape, density, flexibility, texture, toughness, and color; in their ability to give off, absorb, bend, or reflect light; in what form they take at different temperatures; in their responses to each other; and in hundreds of other ways. Yet, in spite of appearances, everything is really made up of a relatively few kinds of basic material combined in various ways. As it turns out, about 100 such materials—the chemical elements—are now known to exist, and only a few of them are abundant in the universe.

When two or more substances interact to form new substances (as in burning, digestion, corrosion, and cooking), the elements composing them combine in new ways. In such recombinations, the properties of the new combinations may be very different from those of the old. An especially important kind of reaction between substances involves combination of oxygen with something else—as in burning or rusting.

The basic premise of the modern theory of matter is that the elements consist of a few different kinds of atoms—particles far too tiny to see in a microscope—that join together in different configurations to form
substances. There are one or more—but never many—kinds of these atoms for each of the approximately 100 elements.

There are distinct patterns of properties among the elements. There are groups of elements that have similar properties, including highly reactive metals, less-reactive metals, highly reactive non-metals (such as chlorine, fluorine, and oxygen), and some almost completely nonreactive gases (such as helium and neon). Some elements don't fit into any of these categories; among them are carbon and hydrogen, essential elements of living matter. When the elements are listed in order by the masses of their atoms, similar sequences of properties appear over and over again in the list.

Subject Area/Grade: Life Science, grade 5

Human Body

Concepts

There are structures and systems in organisms that are independent as well as interdependent. The structures in living things function to meet the needs of living things.

All living things are composed of cells. Some living things consist of a single cell. Some living things are made of a collection of similar cells. Some organisms' cells vary greatly in appearance and perform very different roles in the organism. Different cells can work together as a system in an organism to coordinate activities that meet its needs.

All living things have similar needs. They need food, water, and air; a way to dispose of waste; and an environment they can live in.

Parts of the human body interact for growth and survival. Humans have distinct body systems.

Questions

How are structure and function related in living things?

What are the systems of the human body? What features of the human body (structure and function) are common to all humans? How do human body systems function? How are parts of human body systems independent, and interdependent?

NC Science Essential Standards

5.L.1 Understand how structures and systems of organisms (to include the human body) perform functions necessary for life.

5.L.1.1 Explain why some organisms are capable of surviving as a single cell while others require many cells that are specialized to survive.
5.L.1.2 Compare the major systems of the human body (digestive, respiratory, circulatory, muscular, skeletal, and cardiovascular) in terms of their functions necessary for life.

Terminology

<table>
<thead>
<tr>
<th>unicellular</th>
<th>multicellular</th>
<th>transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulatory System</td>
<td>heart, blood, vessels</td>
<td></td>
</tr>
<tr>
<td>Respiratory System</td>
<td>nose, trachea, lungs</td>
<td></td>
</tr>
<tr>
<td>Skeletal System</td>
<td>bones</td>
<td></td>
</tr>
<tr>
<td>Muscular System</td>
<td>muscles</td>
<td></td>
</tr>
<tr>
<td>Digestive System</td>
<td>mouth, esophagus, stomach, intestines</td>
<td></td>
</tr>
</tbody>
</table>

Unpacked Content

5.L.1.1 Students know that unicellular organisms consist of a single cell and perform all life processes within a single cell. Students know that multicellular organisms are organisms that consist of more than one cell and have differentiated cells that perform specialized functions in the organism. Students know that many organisms—including humans—are multicellular. Students know that in complex multicellular organisms, only the surface cells that are in contact with the external environment are able to exchange substances with it. Cells within the organism are too far away from the environment for direct exchange. This is the reason multicellular organisms have developed transport systems.

5.L.1.2 Students know that there are many systems in the human body. Some of these systems are:
• Circulatory System (heart, blood, vessels)
• Respiratory System (nose, trachea, lungs)
• Skeletal System (bones)
• Muscular System (muscles)
• Digestive System (mouth, esophagus, stomach, intestines)
• Nervous System (brain, spinal cord, nerves)

Students know that each system performs a special life process function and that the systems work together to maintain health and fitness.

Science For All Americans

CELLS

All self-replicating life forms are composed of cells—from single-celled bacteria to elephants, with their trillions of cells. Although a few giant cells, such as hens' eggs, can be seen with the naked eye, most cells are microscopic. It is at the cell level that many of the basic functions of organisms are carried out: protein synthesis, extraction of energy from nutrients, replication, and so forth.

All living cells have similar types of complex molecules that are involved in these basic activities of life. These molecules interact in a soup, about 2/3 water, surrounded by a membrane that controls what can enter and leave. In more complex cells, some of the common types of molecules are organized into structures that perform the same basic functions more efficiently. In particular, a nucleus encloses the DNA and a protein skeleton helps to organize operations. In addition to the basic cellular functions common to all cells, most cells in multicelled organisms perform some special functions that others do not. For example, gland cells secrete hormones, muscle cells contract, and nerve cells conduct electrical signals.
BASIC FUNCTIONS in Humans

The human body is a complex system of cells, most of which are grouped into organ systems that have specialized functions. These systems can best be understood in terms of the essential functions they serve: deriving energy from food, protection against injury, internal coordination, and reproduction.

The continual need for energy engages the senses and skeletal muscles in obtaining food, the digestive system in breaking food down into usable compounds and in disposing of undigested food materials, the lungs in providing oxygen for combustion of food and discharging the carbon dioxide produced, the urinary system for disposing of other dissolved waste products of cell activity, the skin and lungs for getting rid of excess heat (into which most of the energy in food eventually degrades), and the circulatory system for moving all these substances to or from cells where they are needed or produced.

Like all organisms, humans have the means of protecting themselves. Self-protection involves using the senses in detecting danger, the hormone system in stimulating the heart and gaining access to emergency energy supplies, and the muscles in escape or defense. The skin provides a shield against harmful substances and organisms, such as bacteria and parasites. The immune system provides protection against the substances that do gain entrance into the body and against cancerous cells that develop spontaneously in the body. The nervous system plays an especially important role in survival; it makes possible the kind of learning humans need to cope with changes in their environment.

The internal control required for managing and coordinating these complex systems is carried out by the brain and nervous system in conjunction with the hormone-excreting glands. The electrical and chemical signals carried by nerves and hormones integrate the body as a whole. The many cross-influences between the hormones and nerves give rise to a system of coordinated cycles in almost all body functions. Nerves can excite some glands to excrete hormones, some hormones affect brain cells, the brain itself releases hormones that affect human behavior, and hormones are involved in transmitting signals between nerve cells. Certain drugs—legal and illegal—can affect the human body and brain by mimicking or blocking the hormones and neurotransmitters produced by the hormonal and nervous systems.

PHYSICAL HEALTH in Humans

To stay in good operating condition, the human body requires a variety of foods and experiences. The amount of food energy (calories) a person requires varies with body size, age, sex, activity level, and metabolic rate. Beyond just energy, normal body operation requires substances to add to or replace the materials of which it is made: unsaturated fats, trace amounts of a dozen elements whose atoms play key roles, and some traces of substances that human cells cannot synthesize—including some amino acids and vitamins. The normal condition of most body systems requires that they perform their adaptive function: For example, muscles must effect movement, bones must bear loads, and the heart must pump blood efficiently. Regular exercise, therefore, is important for maintaining a healthy heart/lung system, for maintaining muscle tone, and for keeping bones from becoming brittle.

Good health also depends on the avoidance of excessive exposure to substances that interfere with the body's operation. Chief among those that each individual can control are tobacco (implicated in lung cancer, emphysema, and heart disease), addictive drugs (implicated in psychic disorientation and nervous-system disorders), and excessive amounts of alcohol (which has negative effects on the liver, brain, and heart). In addition, the environment may contain dangerous levels of substances (such as lead, some pesticides, and radioactive isotopes) that can be harmful to humans. Therefore, the good health of individuals also depends on people's collective effort to monitor the air, soil, and water and to take steps to keep them safe.

Other organisms also can interfere with the human body's normal operation. Some kinds of bacteria or fungi may infect the body to form colonies in preferred organs or tissues. Viruses invade healthy cells and cause them to synthesize more viruses, usually killing those cells in the process. Infectious disease also may be caused by animal parasites, which may take up residence in the intestines, bloodstream, or tissues.

The body's own first line of defense against infectious agents is to keep them from entering or settling in the body. Protective mechanisms include skin to block them, tears and saliva to carry them out, and varied secretions to kill them. Related means of protecting against invasive organisms include keeping the
skin clean, eating properly, avoiding contaminated foods and liquids, and generally avoiding needless exposure to disease.

The body's next line of defense is the immune system. White blood cells act both to surround invaders and to produce specific antibodies that will attack them (or facilitate attack by other white cells). If the individual survives the invasion, some of these antibodies remain—along with the capability of quickly producing many more. For years afterward, or even a lifetime, the immune system will be ready for that type of organism and be able to limit or prevent the disease. A person can "catch a cold" many times because there are many varieties of germs that cause similar symptoms. Allergic reactions are caused by unusually strong immune responses to some environmental substances, such as those found in pollen, on animal hair, or in certain foods. Sometimes the human immune system can malfunction and attack even healthy cells. Some viral diseases, such as AIDS, destroy critical cells of the immune system, leaving the body helpless in dealing with multiple infectious agents and cancerous cells.

Infectious diseases are not the only threat to human health, however. Body parts or systems may develop impaired function for entirely internal reasons. Some faulty operations of body processes are known to be caused by deviant genes. They may have a direct, obvious effect, such as causing easy bleeding, or they may only increase the body's susceptibility to developing particular diseases, such as clogged arteries or mental depression. Such genes may be inherited, or they may result from mutation in one cell or a few cells during an individual's own development. Because one properly functioning gene of a pair may be sufficient to perform the gene's function, many genetic diseases do not appear unless a faulty form of the gene is inherited from both parents (who, for the same reason, may have had no symptoms of the disease themselves).

The fact that most people now live in physical and social settings that are very different from those to which human physiology was adapted long ago is a factor in determining the health of the population in general. One modern "abnormality" in industrialized countries is diet, which once included chiefly raw plant and animal materials but now includes excess amounts of refined sugar, saturated fat, and salt, as well as caffeine, alcohol, nicotine, and other drugs. Lack of exercise is another change from the much more active life-style of prehistory. There are also environmental pollutants and the psychological stress of living in a crowded, hectic, and rapidly changing social environment. On the other hand, new medical techniques, efficient health care delivery systems, improved sanitation, and a fuller public understanding of the nature of disease give today's humans a better chance of staying healthy than their forebears had.