



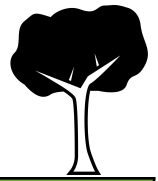


<p>From Molecules to Organisms: Structures and Processes (LS1)</p> 	<p>Ecosystems: Interactions, Energy, and Dynamics (LS2)</p> 	<p>Heredity: Inheritance and Variation of Traits (LS3)</p> 	<p>Biological Unity and Diversity (LS4)</p> 
<p>LS1.A: Structure and Function</p> <p>LS1.B: Growth and Development</p> <p>LS1.C: Organization of Matter, Energy, and Dynamics</p>	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <p>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems</p> <p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <p>LS2.D: Social Interactions and Group Behavior</p>	<p>LS3.A: Inheritance of Traits</p> <p>LS2.B: Variation of Traits</p>	<p>LS4.A: Evidence of Common Ancestry and Diversity</p> <p>LS4.B: Natural Selection</p> <p>LS4.C: Adaptation</p> <p>LS4.D: Biodiversity and Humans</p>

LS1: From Molecules to Organisms: Structures and Processes

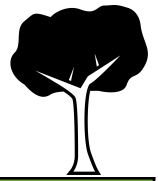


LS1.A: Structure and Function

1st Grade	4th Grade	6th Grade	Biology
<p>All organisms have external parts</p> <p>Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air.</p> <p>Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow.</p>	<p>Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.</p>	<p>All living things are made up of cells, which is the smallest unit that can be said to be alive.</p> <p>An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).</p> <p>Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.</p> <p>In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.</p>	<p>Systems of specialized cells within organisms help them perform the essential functions of life.</p> <p>All cells contain genetic information in the form of DNA molecules.</p> <p>Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.</p> <p>Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.</p> <p>Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Outside that range (e.g., at too high or cool low external temperature, with too little food or water available) the organism cannot survive.</p>

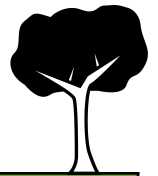
LS1: From Molecules to Organisms: Structures and Processes

LS1.B: Growth and Development of Organisms



1st Grade	3rd Grade	7th Grade	Biology
<p>Adult plants and animals can have young</p> <p>In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.</p>	<p>Reproduction is essential to the continued existence of every kind of organisms.</p> <p>Plants and animals have unique and diverse life cycles.</p>	<p>Animals engage in characteristic behaviors that increase the odds of reproduction.</p> <p>Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.</p> <p>Genetic factors as well as local conditions affect the growth of the adult plant.</p> <p>Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring</p>	<p>In multicellular organisms individual cells grow and then divide via a process mitosis, thereby allowing the organism to grow.</p> <p>The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells.</p> <p>Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organisms.</p>

LS1: From Molecules to Organisms: Structures and Processes

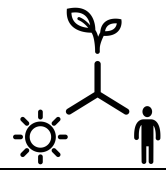


LS1.C: Organization for matter and Energy Flow in Organisms

Kindergarten	5th Grade	6th Grade	8th Grade	Biology
<p>All animals need food in order to live and grow.</p> <p>Animals obtain their food from plants or from other animals.</p> <p>Plants need water and light to live and grow.</p>	<p>Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.</p> <p>Plants acquire their material for growth chiefly from air and water.</p>	<p>Plants, algae (including phytoplankton) and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.</p>	<p>Within an individuals organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or release energy.</p>	<p>The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.</p> <p>(Builds on HS-LS1-5) The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into large molecules that can be assembled into large molecules (such as proteins or DNA), used for example to form new cells.</p> <p>As matter and energy flow through different organization levels of living systems, chemical elements are recombined in different ways to form different products.</p> <p>As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another.</p> <p>Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles.</p> <p>Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.</p>

LS2: Ecosystems: Interactions, Energy, and Dynamics

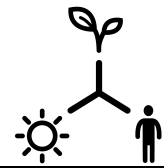
LS2.A: Interdependent Relationships in Ecosystems



2nd Grade	5th Grade	6th Grade	Biology	Environmental
<p>Plants depend on water and light to grow.</p> <p>Plants depend on animals for pollination or to move their seeds.</p>	<p>The food of almost any kind of animal can be traced back to plants.</p> <p>Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.</p> <p>Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers."</p> <p>Decomposition eventually restores (recycles) some materials back to the soil.</p> <p>Organism can survive only in environments in which their particular needs are met.</p> <p>A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life.</p> <p>Newly introduced species can damage the balance of an ecosystem</p>	<p>Organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.</p> <p>In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.</p> <p>Growth of organisms and populations increases are limited by access to resources.</p> <p>Predatory interactions may reduce the number of organisms or eliminate whole population of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.</p>	<p>Ecosystems having carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and form such challenges such as predation, competitions, and disease.</p> <p>Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals of species in any given ecosystem.)</p>	<p>Ecosystems have carrying capacities, which are limits to the number of organism and populations they can support.</p> <p>These limits result from such factor as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.</p> <p>Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite.</p> <p>This fundamental tension affects the abundance (number of individuals) of species in any given ecosystems</p>

LS2: Ecosystems: Interactions, Energy, and Dynamics

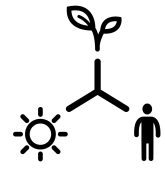
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems



5th Grade	6th Grade	Biology	Environmental
<p>Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die.</p> <p>Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment</p>	<p>Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem.</p> <p>Transfers of matter into and out of the physical environment occur at every level</p> <p>Decomposers recycle nutrients from dead plant and animal matter back to the soil in terrestrial environments or to the water in aquatic environments.</p> <p>The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.</p>	<p>Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for live processes.</p> <p>Plants or algae form the lowest level of the food chain.</p> <p>At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level.</p> <p>Given this inefficiency, there are generally fewer organisms at higher levels of a food web.</p> <p>Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded.</p> <p>The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways.</p> <p>At each link in an ecosystem, matter and energy are conserved.</p> <p>Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.</p>	<p>Plants or algae form the lowest level of the food web.</p> <p>At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level.</p> <p>Given this inefficiency, there are generally fewer organisms at higher levels of food web.</p> <p>Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded.</p> <p>The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways.</p> <p>The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways.</p> <p>At each link in an ecosystem, matter and energy are conserved.</p>

LS2: Ecosystems: Interactions, Energy, and Dynamics

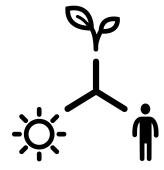
LS2.C: Ecosystem Dynamics, Functioning, and Resilience



3rd Grade	6th Grade	Biology	Environmental
<p>When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)</p>	<p>Ecosystems are dynamic in nature; their characteristics can vary over time.</p> <p>Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.</p> <p>Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems.</p> <p>The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health</p>	<p>A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.</p> <p>If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status(i.e. the ecosystems resilient) as opposed to becoming a very different ecosystem.</p> <p>Extreme fluctuations in conditions or the size of any populations, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.</p>	<p>A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.</p> <p>If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status(i.e. the ecosystems resilient) as opposed to becoming a very different ecosystem.</p> <p>Extreme fluctuations in conditions or the size of any populations, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.</p> <p>Anthropogenic changes (induced by human activity) in the environment can disrupt an ecosystem and threaten the survival of some species.</p>

LS2: Ecosystems: Interactions, Energy, and Dynamics

LS2.D: Social Interactions and Group Behavior



3rd Grade	Biology
<p>Being part of a group helps animals obtain food, defend themselves, and cope with changes</p> <p>Groups may serve different functions and vary dramatically in size.</p>	<p>Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.</p>

LS3: Heredity: Inheritance and Variation of Traits

LS3.A: Inheritance of Traits



1st Grade	3rd Grade	7th Grade	Biology
<p>Young animals are very much, but not exactly like, their parents.</p> <p>Plants also are very much, but not exactly like their parents.</p>	<p>Many characteristics of organisms are inherited from their parents.</p> <p>Many characteristics of organisms are inherited from their parents.</p> <p>Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.</p>	<p>Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual.</p> <p>Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.</p>	<p>Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA.</p> <p>The instructions for forming species' characteristics are carried in DNA.</p> <p>All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.</p> <p>Not all DNA codes for protein, some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known functions.</p>

LS3: Heredity: Inheritance and Variation of Traits

LS3.B: Variation of Traits



1st Grade	3rd Grade	7th Grade	Biology
<p>Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.</p>	<p>Different organisms vary in how they look and function because they have different inherited information.</p> <p>Different organisms carry in how they look and function because they have different inherited information.</p> <p>The environment also affects the traits that an organism develops.</p>	<p>In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations.</p> <p>Though rare, mutations may result in changes to the structure and function of proteins.</p> <p>Some changes are beneficial, others harmful, and some neutral to the organism.</p>	<p>In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation.</p> <p>Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which also cause mutations in genes, and variables in mutations are also inherited.</p> <p>Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in the population. Thus the variation and distribution of traits observe depends on both genetic and environmental factors.</p>

LS4: Biological Unity and Diversity

LS4.A: Evidence of Common Ancestry and Diversity



3rd Grade	7th Grade	8th Grade	Biology
<p>Some kinds of plants and animals that once lived on Earth are no longer found anywhere.</p> <p>Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.</p>	<p>Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy</p>	<p>The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.</p>	<p>Genetic information provides evidence of common ancestry and diversity. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.</p>

LS4: Biological Unity and Diversity

LS4.B: Natural Selection



3rd Grade	7th Grade	Biology
<p>Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.</p>	<p>Natural selection leads to the predominance of certain traits in a population, and the suppression of others.</p> <p>In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring.</p>	<p>Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.</p> <p>The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.</p>

LS4: Biological Unity and Diversity

LS4.C: Adaptation



3rd Grade	7th Grade	Biology
<p>For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.</p>	<p>Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions.</p> <p>Traits that support successful survival and reproduction in the new environment become more common; those that do not, become less common. Thus, the distribution of traits in a population changes</p>	<p>Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.</p> <p>Adaptation also means that the distribution of traits in a population can change when conditions change. Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment.</p> <p>That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.</p> <p>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline- and sometimes the extinction-of some species.</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' adaptation over time is lost</p>

LS4: Biological Unity and Diversity

LS4.D: Biodiversity and Humans



2nd Grade	3rd Grade	6th Grade	Environmental
<p>There are many different kinds of living things in any area, and they exist in different places on land and in water.</p>	<p>Populations live in a variety of habitats, and change in those habitats affects the organisms living there.</p>	<p>(secondary to MS-LS2-5) Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.</p>	<p>(secondary to HS-LS2-7) Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).</p> <p>Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity.</p> <p>Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth.</p> <p>Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.</p>