Indiana Science

Disciplinary Core Ideas: Grades 6, 7, 8

Adopted 2022

Life Science

1. From Molecules to Organisms: Structures and Processes LS.1

LS1-1. All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). MS.LS1-1

LS1-2. Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. MS.LS1-2

LS1-3. Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. MS.LS1-3

LS1-4. 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. MS.LS1-4

LS1-5. Animals engage in characteristic behaviors that increase the odds of reproduction. MS.LS1-5

LS1-6. Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. MS.LS1-6

LS1-7. Genetic factors as well as local conditions affect the growth of the adult plant. MS.LS1-7

LS1-8. 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. MS.LS1-8

LS1-9. Within individual 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 to release energy. MS.LS1-9

LS1-10. Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. MS.LS1-10

2. Ecosystems: Interactions, Energy, and Dynamics LS.2

LS2-1. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. MS.LS2-1

LS2-2. 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. MS.LS2-2

LS2-3. Growth of organisms and population increases are limited by access to resources. MS.LS2-3

LS2-4. Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations 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. MS.LS2-4

LS2-5. 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. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. MS.LS2-5

LS2-6. Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. MS.LS2-6

LS2-7. Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. MS.LS2-7

LS2-8. 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. MS.LS2-8

3. Heredity: Inheritance and Variation of Traits LS.3

LS3-1. 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. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. MS.LS3-1

LS3-2. Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. MS.LS3-2

LS3-3. In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. MS.LS3-3

LS3-4. In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. MS.LS3-4

4. Biological Evolution: Unity and Diversity LS.4

LS4-1. The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) 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. MS.LS4-1

LS4-2. Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. MS.LS4-2

LS4-3. Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. MS.LS4-3

LS4-4. Natural selection leads to the predominance of certain traits in a population, and the suppression of others. MS.LS4-4

LS4-5. 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 onto offspring. MS.LS4-5

LS4-6. Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. 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. MS.LS4-6

Earth and Space Science

1. Earth's Place in the Universe ESS.1

ESS1-1. Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. MS.ESS1-1

ESS1-2. Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. MS.ESS1-2

ESS1-3. The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. MS.ESS1-3

ESS1-4. This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. MS.ESS1-4

ESS1-5. The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. MS.ESS1-5

ESS1-6. The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. MS.ESS1-6

ESS1-7. Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. MS.ESS1-7

2. Earth's Systems ESS.2

ESS2-1. All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. MS.ESS2-1

ESS2-2. The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. MS.ESS2-2

ESS2-3. Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. MS.ESS2-3

ESS2-4. Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. MS.ESS2-4

ESS2-5. The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. MS.ESS2-5

ESS2-6. Global movements of water and its changes in form are propelled by sunlight and gravity. MS.ESS2-6

ESS2-7. Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. MS.ESS2-7

ESS2-8. Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. MS.ESS2-8

ESS2-9. Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. MS.ESS2-9

ESS2-10. Because these patterns are so complex, weather can only be predicted probabilistically. MS.ESS2-10

ESS2-11. The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. MS.ESS2-11

3. Earth and Human Activity ESS.3

ESS3-1. Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. MS.ESS3-1

ESS3-2. Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. MS.ESS3-2

ESS3-3. Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. MS.ESS3-3

ESS3-4. Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. MS.ESS3-4

ESS3-5. Human activities, such as the release of greenhouse gasses from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. MS.ESS3-5

Physical Science

1. Matter and Its Interactions PS.1

PS1-1. Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. MS.PS1-1

PS1-2. Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. MS.PS1-2

PS1-3. Gasses and liquids are made of molecules or inert atoms that are moving about relative to each other. MS.PS1-3

PS1-4. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. MS.PS1-4

PS1-5. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). MS.PS1-5

PS1-6. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. MS.PS1-6

PS1-7. Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. MS.PS1-7

PS1-8. The total number of each type of atom is conserved, and thus the mass does not change. MS.PS1-8

PS1-9. Some chemical reactions release energy, others store energy. MS.PS1-9

2. Motion and Stability: Forces and Interactions PS.2

PS2-1. For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). MS.PS2-1

PS2-2. The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. MS.PS2-2

PS2-3. All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. MS.PS2-3

PS2-4. Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. MS.PS2-4

PS2-5. Forces that act at a distance (electric and magnetic) can be explained by fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively). MS.PS2-5

3. Energy PS.3

PS3-1. Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. MS.PS3-1

PS3-2. A system of objects may also contain stored (potential) energy, depending on their relative positions. MS.PS3-2

PS3-3. Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. MS.PS3-3

PS3-4. The term "heat" as used in everyday language refers both to thermal motion (the motion of atoms or molecules within a substance) and radiation (particularly infrared and light). In science, heat is used only for this second meaning; it refers to energy transferred when two objects or systems are at different temperatures. MS.PS3-4

PS3-5. Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. When the motion energy of an object changes, there is inevitably some other change in energy at the same time. MS.PS3-5

PS3-6. The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. MS.PS3-6

PS3-7. Energy is spontaneously transferred out of hotter regions or objects and into colder ones. MS.PS3-7

PS3-8. When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. MS.PS3-8

PS3-9. The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon- based organic molecules and release oxygen. MS.PS3-9

PS3-10. Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. MS.PS3-10

4. Waves and Their Applications in Technologies for Information Transfer PS.4

PS4-1. A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. MS.PS4-1

PS4-2. A sound wave needs a medium through which it is transmitted. When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. MS.PS4-2

PS4-3. The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. MS.PS4-3

PS4-4. A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. MS.PS4-4

PS4-5. However, because light can travel through space, it cannot be a matter wave, like sound or water waves. MS.PS4-5

PS4-6. Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. MS.PS4-6

Engineering, Technology, and the Application of Science

1. Matter and Its Interactions EPS.1

EPS1-1. The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. MS.EPS1-1

EPS1-2. A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. MS.EPS1-2

EPS1-3. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. MS.EPS1-3

EPS1-4. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. MS.EPS1-4

EPS1-5. Models of all kinds are important for testing solutions. MS.EPS1-5

EPS1-6. Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. MS.EPS1-6

EPS1-7. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. MS.EPS1-7