Next Generation Science Standards Life Science

Middle School DCI

From Molecules to Organisms: Structures and Processes

I Structure and Function

a Structure and Function LS1.A

i 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-LS1-2

ii 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-LS1-2

iii 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-LS1-3

II Growth and Development of Organisms

a Growth and Development of Organisms LS1.B

i Animals engage in characteristic behaviors that increase the odds of reproduction. MS-LS1-4

ii Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. MS-LS1-4

iii Genetic factors as well as local conditions affect the growth of the adult plant. MS-LS1-5

III Organization for Matter and Energy Flow in Organisms

a Organization for Matter and Energy Flow in Organisms LS1.C

i 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-LS1-6

ii 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-LS1-7

IV Information Processing

a Information Processing LS1.D

i 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-LS1-8

V Energy in Chemical Processes and Everyday Life

a Energy in Chemical Processes and Everyday Life PS3.D

i 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-LS1-6

ii 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-LS1-7

Ecosystems: Interactions, Energy, and Dynamics

I Interdependent Relationships in Ecosystems

a Interdependent Relationships in Ecosystems LS1.A

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

ii 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-LS2-1

iii Growth of organisms and population increases are limited by access to resources. MS-LS2-1

iv 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-LS2-2

II **Cycle of Matter and Energy Transfer in Ecosystems**

a Cycle of Matter and Energy Transfer in Ecosystems LS2.B

i 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-LS2-3

III **Ecosystem Dynamics, Functioning, and Resilience**

a Ecosystem Dynamics, Functioning, and Resilience LS2.C

i 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-LS2-4) ☒ 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. MC-LS2-5

IV **Biodiversity and Humans**

a Biodiversity and Humans LS4.D

i 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. MC-LS2-5

V **Developing Possible Solutions**

a Developing Possible Solutions ETS1.B

i There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. MS-LS2-5

Heredity: Inheritance and Variation of Traits

I **Growth and Development of Organisms**

a Growth and Development of Organisms LS1.B

i Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. MS-LS3-2

II Inheritance of Traits

a Inheritance of Traits LS3.A

i 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

ii 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

III Variation of Traits

a Variation of Traits LS3.B

i 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-LS3-2

ii 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-LS3-1

Biological Evolution: Unity and Diversity

I Evidence of Common Ancestry and Diversity

a Evidence of Common Ancestry and Diversity LS4.A

i 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

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

II Natural Selection

a Natural Selection LS4.B

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

ii. 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. MS-LS4-5

III Adaptation

a Adaptation LS4.C

i. 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