High School

From Molecules to Organisms: Structures and Processes HS-LS1

A Structure and Function HS-LS1-A

1. Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) HS-LS1-A-1
2. All cells contain genetic information in the form of DNA molecules. 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. (HS-LS1-1),(secondary to HS-LS3-1) HS-LS1-A-2
3. 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. (HS-LS1-2) HS-LS1-A-3
4. 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. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) HS-LS1-A-4

B Growth and Development of Organisms HS-LS1-B

1. In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. 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. 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 organism. (HS-LS1-4) HS-LS1-B-1

C Organization for Matter and Energy Flow in Organisms HS-LS1-C

1. The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) HS-LS1-C-1
2. 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 larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6) HS-LS1-C-2
3. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1- 7) HS-LS1-C-3

4 As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. 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. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7) HS-LS1-C-4

D Information Processing HS-LS1-D

1 [From the 6-8 grade band endpoints] Each sense receptor responds to different inputs, transmitting them as signals that travel along nerve cells to the brain; The signals are then processed in the brain, resulting in immediate behavior or memories. HS-LS1-D-1

Ecosystems: Interactions, Energy, and Dynamics HS-LS2

A Interdependent Relationships in Ecosystems HS-LS2-A

1 Ecosystems have 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 from such challenges such as predation, competition, and disease. 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. (HS-LS2- 1),(HS-LS2-2) HS-LS2-A-1

B Cycles of Matter and Energy Transfer in Ecosystems HS-LS2-B

1 Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3) HS-LS2-B-1

2 Plants or algae form the lowest level of the food web. 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. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. 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. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) HS-LS2-B-2

3 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. (HS-LS2-5) HS-LS2-B-3

C Ecosystem Dynamics, Functioning, and Resilience HS-LS2-C

1 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. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status, as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6) HS-LS2-C-1

2 Moreover, anthropogenic changes (induced by human activity) in the environment including - habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change - can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) HS-LS2-C-2

D Social Interactions and Group Behavior HS-LS2-D

1 Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) HS-LS2-D-1

Heredity: Inheritance and Variation of Traits HS-LS3

A Inheritance of Traits HS-LS3-A

1 Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1) HS-LS3-A-1

B Variation of Traits HS-LS3-B

1 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. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) HS-LS3-B-1

2 Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3) HS-LS3-B-2

Biological Evolution: Unity and Diversity HS-LS4

A Evidence of Common Ancestry and Diversity HS-LS4-A

1 Genetic information provides evidence of evolution. 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. (HS-LS4-1) HS-LS4-A-1

B Natural Selection HS-LS4-B

1 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. (HS-LS4-2),(HS-LS4-3) HS-LS4-B-1

2 The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3) HS-LS4-B-2

C Adaptation HS-LS4-C

1 Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2) HS-LS4-C-1

2 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. (HS-LS4-3),(HS-LS4-4) HS-LS4-C-2

3 Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3) HS-LS4-C-3

4 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. (HS-LS4-5) HS-LS4-C-4

5 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' evolution is lost. (HS-LS4-5) HS-LS4-C-5

D Biodiversity and Humans HS-LS4-D

1 Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7) HS-LS4-D-1

2 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 through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7),(HS-LS4-6) HS-LS4-D-2