Biology
Marine Biology, Anatomy & Physiology and Environmetal Science
Grades 9-12

Strand:

S6 Biology The student demonstrates a conceptual understanding of the organization of life on Earth; that is, the student:

Standard: S6a: Describes, analyzes and compares structure, function, and organization of various cells.

Biology

Components:

S6a1 Analyzes cell differentiation and explains that complex multicellular organisms are formed as a highly organized arrangement of differentiated cells.

S6a2 Explains how individual cells differentiate functions despite having the same genetic materials.

S6a3 Describes the variety of biomolecules in cells and how they join together to form specialized structures.

S6a4 Identifies cell structures and explains how they work together to carry out the functions of the cell (i.e., energy production/transfer, transport, information feedback, waste disposal, storage of genetic material, and synthesis of new molecules).

S6a5 Investigates and illustrates the lipid and protein structure of the cell membrane.

S6a6 Relates the structure of the cell membrane to its diffusion and transport mechanisms (e.g., models how the membrane structure regulates the movement of materials across the membrane).

S6a7 Explains that cells carry out specialized functions as the result of the differential expression of the information in their DNA.

S6a8 Investigates and describes the effect of temperature and acidity on a cell's functioning.

S6a9 Describes the process of cell division (i.e., mitosis) and explains its role in the characteristics of life (i.e., growth, replication, cancer, repair and maintenance).

Anatomy & Physiology

Components:

S6a10 Describes how cells differentiate functions and the importance of this process to multi-cellular organisms.

S6a11 Investigates and describes how cells communicate in order to coordinate body functions.

S6a12 Illustrates and explains how the circulatory system transports nutrients, oxygen, carbon dioxide, cell wastes, and hormones to and from cells throughout the body.

S6a13 Compares and contrasts the structure and function of the components of whole blood.

S6a14 Classifies types of white blood cells and the role-played by each in the immune response.

S6a15 Describes the reactions of antibodies in the body and how they are produced.

S6a16 Determines through investigations the activity of muscle cells in response to a stimulus.

S6a17 Illustrates and describes the mechanisms by which bones produce red and white blood cells.

Biology

Standard: S6b: Analyzes and communicates an understanding of the biochemistry of life including organic compounds, enzymes, cellular respiration and photosynthesis.

Components:

S6b1 Compares and contrasts the molecular structure and functions of biomolecules (i.e., carbohydrates, lipids, proteins, and nucleic acids).

S6b2 Explains the chemical reactions underlying cell functions.

S6b3 Summarizes the characteristics of organic compounds and their importance in organisms by analyzing the chemical composition of biomolecules.

S6b4 Analyzes how cell structures play a role in metabolic processes.

S6b5 Explains how the processes of life depend on metabolism.

S6b6 Traces the flow of molecules and energy from nutrients through the stages of metabolism (i.e., the chemical transformations by which cells break down biomolecules to extract energy and building blocks and create new biomolecules).

S6b7 Analyzes the chemical transformations and transfers of energy that occur during the processes of cellular respiration and describes the temporary storing of energy in the phosphate bonds of ATP.

S6b8 Explains that matter tends toward more disorganized states to the need for continuous input of energy to maintain the chemical and physical organization of living systems.

S6b9 Identifies and describes the properties and functions of enzymes in metabolism (i.e., in catalyzing biochemical reactions through metabolic pathways).

S6b10 Explains the chemical reactions, recycling of matter and transfers of energy that occur during photosynthesis.

S6b11 Analyzes the complementary nature of the processes of photosynthesis and cellular respiration

S6b12 Identifies the importance of proteins in carrying out the work of the cell and their characteristics that are essential to life.

S6b13 Describes the interactions among different molecules within the cell and defines their role in activities such as growth and division.

S6b14 Describes that the diversity of life results from six elements and four types of biomolecules (i.e., carbohydrates, lipids, proteins, and nucleic acids).

S6b15 Models and explains how DNA is made up of pairs of complementary nucleotides (i.e., A, G, C, and T) in a double-helix structure.

S6b16 Differentiates between DNA and RNA and types of RNA.

S6b17 Describes the major steps in the process of photosynthesis and its importance to life on Earth.

S6b18 Explains the transfers of energy that occur during photosynthesis.

Anatomy & Physiology

Components:

S6b19 Explains how molecules make up cells, which, in turn, make up tissues and organs.

S6b20 Relates the molecular structure of biomolecules to their functions within body systems.

S6b21 Explains the gas exchange processes carried out by the respiratory system.

S6b22 Differentiates between breathing, external respiration, internal respiration, and cellular respiration.

S6b23 Compares and contrasts the microscopic structure, organization, function, and molecular basis of contraction in skeletal, smooth, and cardiac muscle.

S6b24 Describes the mechanisms by which muscles obtain and use energy to power contractions.

S6b25 Relates the chemical structure of bone to its development, repair, and growth.

S6b26 Traces the flow of molecules and energy from nutrients through the biochemical processes involved in metabolism (i.e., catabolism and anabolism).

S6b27 Determines through investigations the role of enzymes in metabolism.

S6b28 Describes the pH scale and the role of buffers in body fluids.

Biology

Standard: S6c: Describes the behavior of organisms and hypothesizes the relationship to nervous and endocrine systems and various external stimuli.

Components:

S6c1 Investigates and describes the role of hormones in regulating growth and sexual development.

S6c2 Describes the role of the nervous and endocrine systems in coordinating the activity of the body's cells and in achieving homeostasis.

S6c3 Illustrates how nerve cells communicate with each other, transmitting information from the internal and external environment to generate physiological or behavioral responses.

S6c4 Differentiates between innate and learned behaviors and speculates about the relationship between genetics and environment in influencing behavior.

Marine Biology

Components:

S6c5 Provides examples of organisms using sense organs to monitor their environment and react to stimuli in ways that maximize their fitness.

S6c6 Compares and contrasts the ways motile and non-motile organisms respond to external stimuli.

S6c7 Compares and contrasts innate and learned responses to stimuli (e.g., prey choice, predator avoidance and deterrence, social behavior).

Anatomy & Physiology

Components:

S6c8 Identifies the interrelationships among the nervous system and other organ systems.

S6c9 Describes the role of the nervous and endocrine systems in achieving homeostasis.

S6c10 Identifies the functional relationships between the endocrine system and other body systems.

S6c11 Analyzes and describes the relationship between the endocrine and reproductive systems.

S6c12 Identifies nerve cells as the cellular units of the nervous system and explains their function in the rapid transmission of information.

S6c13 Determines through investigations how stimulus information is signaled to the brain.

S6c14 Analyzes how rapid electrochemical signals transport from one neuron to the next.

S6c15 Illustrates and explains the structure and function of excitatory and inhibitory neurotransmitters in a synapse.

S6c16 Compares the major chemical classes of hormones and relates them to their functions.

S6c17 Analyzes how endocrine glands are stimulated to release hormones.

S6c18 Relates the functions of hormones to processes such as growth and development, metabolism, reproduction, and body defense.

Biology

Standard: S6d: Elaborates on the principles of genetics and explains the role of DNA, genes, chromosomes, and mutation in reproduction and heredity.

Components:

S6d1 Compares and contrasts the processes of mitosis and meiosis (i.e., that sex cells created through meiosis contain half the number of chromosomes of body cells).

S6d2 Examines and describes how meiosis results in haploid sex cells.

S6d3 Explains how fertilization restores the original chromosome number (i.e., two haploid sex cells fuse together to create a new diploid cell).

S6d4 Explains the relationships between sexual reproduction, meiosis, genetic variation, and evolution.

S6d5 Examines and describes the process of fertilization (i.e., a haploid egg and sperm cell fuse together, creating a diploid cell with two copies of each gene, one from each parent) and the stages of embryo formation and development.

S6d6 Identifies the role of DNA in determining the fate of a cell during the formation and development of an embryo.

S6d7 Investigates and describes how DNA acts as the blueprint that directs the processes of life.

S6d8 Explains the function of DNA in encoding the complex information needed to direct the synthesis of proteins.

S6d9 Explains the relationship among DNA, genes, chromosomes, proteins, and traits (i.e., that genes are a portion of DNA, contained on chromosomes, which contain the genetic information, as a string of molecular “letters,” to code for a specific sequence of amino acids which comprise a protein, which in turn, is responsible for a specific trait).

S6d10 Explains that cell functions are regulated by selective expression of specific genes.

S6d11 Describes the structure of chromosomes and relates it to their functions.

S6d12 Illustrates and explains the chromosome replication process.

S6d13 Applies the principles of Mendelian genetics (i.e., dominance and recessiveness, segregation, independent assortment) to predict the outcome of genetic crosses.

S6d14 Uses genetic tools, (i.e., Punnett squares and pedigrees) to predict traits of offspring.

S6d15 Examines and explains more complex patterns of heredity which cannot be explained using Mendel’s findings (e.g., incomplete dominance, codominance, multiple alleles, and polygenic traits).

S6d16 Analyzes the statistical effects of recombination on the variety of gene combinations in offspring.

S6d17 Analyzes how mutations in the DNA sequence of a gene may or may not affect the expression of the gene (i.e., that the type of cell in which a mutation occurs determines heritability of the mutation).

S6d18 Describes that mutations may be harmful, beneficial, or have no impact on the survival of the organism.

S6d19 Relates random mutation (i.e., changes in DNA) and recombination within gametes to the heritable variations that give individuals within a species survival and reproductive advantage or disadvantage over others in the species.

S6d20 Examines and explains the effect of mutation on the genetic variation of a population.

Anatomy & Physiology

Components:

S6d21 Explains how meiosis results in haploid gametes and increases genetic variation within a population.

S6d22 Compares and contrasts the processes that form sperm and egg cells (i.e., spermatogenesis and oogenesis).

S6d23 Summarizes the process of fertilization in terms of the number of chromosomes in each sex cell and the resulting zygotic cell.

S6d24 Explains the importance of cell-to-cell communication and the role of DNA in determining the fate of a cell during the formation and development of an embryo.

Biology

Standard: S6e: Relates the theory of biological evolution to geologic time and addresses speciation, biodiversity, natural selection, and biological classification.

Components:

S6e1 Classifies organisms into groups and subgroups based on similarities that reflect their evolutionary relationships or degree of kinship estimated from the similarity of DNA sequences.

S6e2 Explains the relationship between the variation of organisms within a species and the increased likelihood that at least some members of the species will survive under changed environmental conditions.

S6e3 Relates the diversity of species to the increased chance that at least some living things will survive in the face of large changes in the environment.

S6e4 Provides evidence that natural selection can explain both the unity and diversity of life.

S6e5 Examines and describes the role of evolution over the past 4 billion years in creating the great diversity of organisms and filling every available ecological niche with life forms.

S6e6 Identifies how adaptations arise through mutations and create variation in the gene pool.

S6e7 Describes Darwin's theory and how the principles of natural selection can lead to speciation.

S6e8 Analyzes the factors, which contribute to species evolution (i.e., the potential for a species to increase its population; the genetic variability of offspring due to mutation and recombination of genes; a finite supply of the resources required for life; and the ensuing selection by the environment of those offspring better able to survive and reproduce).

S6e9 Explains that evolution involves changes in the genetic make-up of whole populations over time, not changes in the genes of an individual organism.

S6e10 Investigates and explains how natural selection acts as the mechanism for evolution and can lead to speciation.

S6e11 Relates the variation of organisms within a species and the increased likelihood that at least some members of the species will survive under changed environmental conditions.

S6e12 Describes how natural selection provides a scientific explanation for the fossil record of ancient life forms and the molecular and anatomical similarities observed within the diversity of existing organisms.

S6e13 Describes the relationships between changes in the genetic makeup of populations and the processes of natural selection, speciation, extinction and species diversity.

S6e14 Describes how all of the species that exist today are related by descent from common ancestors.

S6e15 Provides evidence for common ancestry based on the universal nature of the biomolecules and the metabolic processes found in all organisms.

S6e16 Explains how behaviors have evolved through natural selection and often have an adaptive logic when viewed in terms of evolutionary principles.

Marine Biology

Components:

S6e17 Describes the scope of biological diversity in the marine environment and relationships among major groups of marine organisms.

S6e18 Compares and contrasts early and late successional species.

S6e19 Explains the relationship between organisms living in unpredictable environments and the evolution of characteristics that are flexible enough to accommodate uncertainty and change.

S6e20 Distinguishes adaptation from acclimation.

S6e21 Analyzes the costs and benefits, under different environmental conditions, of characteristics that can be observed at the whole-organism level (i.e., structure, chemistry, behavior).

S6e22 Explains why organisms in similar environments converge in form and function.

S6e23 Analyzes life history patterns (e.g., lifespan, age of reproduction, iteroparous vs. semelparous reproduction) in terms of trade-offs in the allocation of limited resources, in a way that optimizes the fitness of the organism.

S6e24 Analyzes dispersal (e.g., migration, larval transport) in terms of risks (e.g., extinction), rewards (e.g., escaping predators and parasites), and the unpredictability of many environments.

S6e25 Explains why, although diversity has traditionally been defined at the species level, distinctions that are broader (e.g., community, ecosystem) and narrower (e.g., within-species) may be necessary for some conservation-related purposes.

S6e26 Summarizes that molecular evidence is generally substantiating the anatomical evidence for evolution, but sometimes altering dramatically the sequence in which various lines of descent are thought to have branched off from one another.

S6e27 Explains why evolution does not necessitate long-term progress in some set direction, or necessarily create traits that are beneficial to the species in the long term (e.g., explaining that the survival value of inherited characteristics may change when the environment changes).

S6e28 Explains that some traits that reduce an individual's chance of survival spread through and are maintained in a population because of advantages those traits confer in reproductive success.

S6e29 Recognizes that some heritable characteristics can persist in a population due to chance alone.

S6e30 Recognizes that populations of species evolve at different rates and may or may not keep up with rates of environmental change.

Environmental Science

Components:

S6e31 Describes the ways in which biodiversity is important to ecosystems and humans

S6e32 Explains how organisms are adapted to the environment in terms of ecological niches and natural selection.

S6e33 Relates the importance of genetic diversity and population size to the conservation of a species.

S6e34 Investigates and explains how natural selection acts as the mechanism for evolution and can lead to speciation.

S6e35 Provides evidence that natural selection can explain both the unity and diversity of life.

Biology

Standard: 6f: Analyzes ecology as interrelationships of biotic and abiotic factors and explains the transfer of matter and energy within ecosystems.

Components:

S6f1 Describes the scope of biological diversity and relationships among major groups of organisms.

S6f2 Explains the effect of evolutionary forces on the diversity of ecosystems and the species within them.

S6f3 Explains how interspecific population interactions and resource use affects population size.

S6f4 Predicts the impact of changes in an ecosystem to its equilibrium.

S6f5 Identifies effects of human activities (e.g., habitat destruction, pollution, technology, and urbanization) on populations and ecosystems.

S6f6 Describes the effects of natural disasters, disease, population increase, and depletion of food on populations.

S6f7 Explains that the distribution and abundance of organisms and populations in ecosystems is limited by the availability of matter and energy and the ecosystem's ability to recycle them.

S6f8 Traces the flow of matter and energy between living systems and the physical environment and analyzes how chemical elements are recombined in different ways.

S6f9 Analyzes how organisms in food webs recycle nutrients and serve as a source of energy for populations within an ecosystem.

S6f10 Investigates and explains the diminishing amount of energy (e.g., loss by heat) available in each succeeding trophic level.

S6f11 Relates death and decomposers to the recycling of organic materials in nature and the transfer of matter and energy in ecosystems.

S6e12 Examines and analyzes the interactions among organisms and their environments.

S6f13 Analyzes the factors which limit the distribution and abundance of organisms in ecosystems (e.g., predators, disease, parasites, resources, and competition).

S6f14 Analyzes the population size that an ecosystem can sustain.

S6f15 Explains how the interrelationships and interdependencies of organisms may generate ecosystems that are stable for hundreds or thousands of years.

Marine Biology

Components:

S6f16 Provides examples of how human activities can alter marine ecosystems in ways hat affect humans (e.g., by introducing new species, adding nutrients to coastal waters, over-harvesting food species).

S6f17 Explains why ecosystems tend to recover from a disturbance in stages that eventually result in a system similar to the original one (e.g., by referring to larval supply, life-history characteristics of organisms, and positive and negative interactions between organisms).

S6f18 Explains why distinct communities can persist in very similar environments (e.g., by referring to succession, trophic cascades, and alternative stable states).

S6f19 Explains that organisms may be well suited for environments other than those in which they are found.Provides examples of interactions between organisms that can be either positive or negative depending on the environmental circumstances.

S6f20 Hypothesizes about how marine ecosystems may change due to climate changes and due to the appearance of one or more new species as a result of migration or transport by humans.

S6f21 Explains why small populations are at increased risk of extinction.

S6f22 Hypothesizes about the likelihood that a given species will become extinct in a given period of time (e.g., based on population size, distribution, specialization, life history traits, and the amount of genetic and phenotypic variation within the species).

S6f23 Justifies recommendations for marine protected areas (e.g., based on source-sink dynamics, analysis of life history characteristics, and human use).

S6f24 Recognizes that the earth is primarily a closed system with respect to matter

S6f25 Recognizes that the earth is primarily a closed system with respect to matter.

S6f26 Analyzes the factors that limit the amount of life a given environment can support (e.g., energy, oxygen, minerals, rate of nutrient cycling).

S6f27 Analyzes the ways in which the physical environment (e.g., currents, tides, waves, weather) influences the structure of marine communities.

S6f28 Explains the effect of heterogeneity within a community and within the larger ecosystem on the abundance and diversity of life that can and does persist within those systems.

S6f29 Compares and contrasts the environmental factors that hold in check different populations of organisms within a given community (e.g., referring to density-dependent vs. density-independent regulation; interactions between disturbance, predation, competition, and larval supply; and different forms of competition).

S6f30 Describes potential effects of size-selective predation on populations, community structure, and ecosystem function.

S6f31 Models simple predator-prey and competitive interactions (e.g., using the Lotka-Volterra models).

S6f32 Provides examples of ecological factors that can allow greater diversity within a community (e.g., facilitation, microhabitats, keystone species, disturbance, prey-switching).

S6f33 Provides examples of factors that limit the distribution of organisms (e.g., larval transport, physiology, predators, food, enemy-free space).

S6f34Explains the role of foundation species in structuring communities.

Environmental Science

Components:

S6f34 Analyzes the natural processes of change in the environment, including examples of succession, evolution, and extinction.

S6f35 Analyzes the natural processes of change in the environment, including examples of succession, evolution, and extinction.

S6f36 Analyzes the stability and sustainability of ecosystems as a result of changes in environmental conditions.

S6f37 Identifies factors that lead to ecological succession, including invasive species, loss of biodiversity, change in abiotic conditions, and catastrophic events.

S6f38 Evaluates the factors that determine the plant life that can exist in a given biome.

S6f39 Identifies environmental issues in terms of interrelationships among natural systems in time and space

S6f40 Evaluates the factors that impact resource availability and explains why certain resources are becoming depleted.

S6f41 Identifies the factors limiting population growth in a given area (carrying capacity).

S6f42 Predicts changes in population size in response to altered environmental conditions.

S6f43 Gives examples that illustrate how a change in one part of a system can have an impact on other parts of the system.

Anatomy & Physiology

Standard: S6g: Analyzes and explains the relationships between the structures, systems, molecular and cellular organization, and processes of multi-cellular organisms, especially humans.

Components:

S6g1 Examines and classifies tissues and the various cells types found in them.

S6g2 Connects the make-up and organization of tissue types and their functions.

S6g3 Explains the significance of organisms' ability to regulate their internal environment to maintain a stable, constant condition (i.e., homeostasis).

S6g4 Identifies how positive and negative feedback are involved in homeostatic regulation.

S6g5 Investigates and describes how body systems interact to maintain homeostasis.

S6g6 Determines through investigations how the integumentary system distinguishes, separates, protects and informs an organism with regard to its surroundings

S6g7 Explains the role of the integumentary system in regulating body temperature and water balance.

S6g8 Describes how the skin responds to injury and repairs itself.

S6g9 Examines and explains how the skeletal and muscular systems work with other systems to support the body and allow for movement.

S6g10 Categorizes types of bone and their functions.

S6g11 Compares and contrasts the major types of joints in terms of their mobility and the tissues that hold them together.

S6g12 Relates the structures of the heart to its pumping function to propel blood through arteries, capillaries, and veins.

S6g13 Investigates and illustrates the flow of blood through the circulatory system.

S6g14 Connects the functions of the liver and the circulatory system.

S6g15 Identifies the structures and functions of the lymphatic system and the interrelationships with other body systems.

S6g16 Explains how the structures of the lymphatic system are functionally related to the circulatory and immune systems.

S6g17 Describes the immune system and the strategies the body uses to protect itself from microscopic organisms, foreign substances, and cancer cells

S6g18 Analyzes the functions of blood in the immune system (i.e., its role in essential protection to combat invading microorganisms, acute inflammation, and immune responses).

S6g19 Relates respiratory functions and the structural specializations of the tissues and organs in the system.

S6g20 Identifies the interrelationships among the respiratory and circulatory systems.

S6g21 Describes the mechanisms by which the digestive system provides cells in the body with macromolecules from food.

S6g22 Explains why metabolic byproducts must be removed from the body by excretion and identifies the organs that are responsible for their excretion.

S6g23 Identifies the interrelationships among the digestive system and other organ systems.

S6g24 Relates the structures of the urinary system to their functions in removing nitrogenous wastes from the blood and producing, storing and eliminating urine.

S6g25 Examines the distribution of water and electrolytes within the body and explains the kidney's role in balancing these levels.

S6g26 Identifies the interrelationships among the urinary systems and other organ systems, particularly with regard to maintaining homeostasis in body fluids.

S6g27 Identifies the interrelationships among the reproductive system and other organ systems.

S6g28 Identifies effects of aging, their causes, and ways of reducing these effects.

S6g29 Describes the hormonal mechanisms regulating male and female reproductive functions.

S6g30 Identifies the stages of development of germ cell layers, the processes that occur in each stage, and the fate of each germ cell layer in humans.

S6g31 Differentiates between a zygote, embryo, and fetus and describes the characteristics and events associated with each stage.

S6g32 Characterizes the major stages of development after delivery.

S6g33 Compares and contrasts patterns of human development to those of other vertebrates.

S6g34 Describes how growth is regulated.

Environmental Science

Standard: S6h: Identifies the effect of human activities on natural processes and interrelationships within ecosystems.

Components:

S6h1 Describes how people impact their environment through the use of natural resources.

S6h2 Identifies and assesses the effects of human resource use at various scales in terms of ecosystem functioning and human health.

S6h3 Predicts how changes in the availability and use of natural resources will affect society and human activities.

S6h4 Describes the ways in which the use of technology has an impact on the environment and the standard of living.

S6h5 Assesses the environmental and societal costs and benefits of various common natural resource management strategies.

S6h6 Identifies and describes the factors that have contributed to the growth of the human population and examine the impact this growth will have on the environment.