Arizona Science Standards - High School Essential Standards

Physical Science Standards	
HS.P1U1.1	Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed within the Periodic Table and describe how these models are revised with new evidence.
HS.P1U1.2	Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.
HS.P1U1.3	Ask questions, plan, and carry out investigations to explore the cause and effect relationship between reaction rate factors.
HS.P1U3.4	Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.
HS.P2U1.5	Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic).
HS.P3U1.6	Collect, analyze, and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws.
HS.P3U2.7	Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends.
HS.P4U1.8	Engage in argument from evidence that the net change of energy in a system is always equal to the total energy exchanged between the system and the surroundings.
HS.P4U3.9	Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.
HS.P4U1.10	Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.

Earth and Space Science Standards	
HS.E1U1.11	Analyze and interpret data to determine how energy from the Sun affects weather patterns and climate.
HS.E1U1.12	Develop and use models of the Earth that explains the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere).
HS.E1U1.13	Evaluate explanations and theories about the role of energy and matter in geologic changes over time.
HS.E1U3.14	Engage in argument from evidence about the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other.
HS.E2U1.15	Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star.
HS.E2U1.16	Construct an explanation of how gravitational forces impact the evolution of planetary motion, structure, surfaces, atmospheres, moons, and rings.
HS.E2U1.17	Construct an explanation of the origin, expansion, and scale of the universe based on astronomical evidence.

Life Science Standards	
HS.L2U3.18	Obtain, evaluate, and communicate about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem.
HS.L2U1.19	Develop and use models that show how changes in the transfer of matter and energy within an ecosystem and interactions between species may affect organisms and their environment.
HS.L1U1.20	Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
HS.L2U1.21	Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.
HS.L1U1.22	Construct an explanation for how cellular division (mitosis) is the process by which organisms grow and maintain complex, interconnected systems.
HS.L1U3.23	Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.
HS.L3U1.24	Construct an explanation of how the process of sexual reproduction contributes to genetic variation.
HS.L3U1.25	Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.
HS.L3U3.26	Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
HS.L4U1.27	Obtain, evaluate, and communicate evidence that describes how changes in frequency of inherited traits in a population can lead to biological diversity.
HS.L4U1.28	Gather, evaluate, and communicate multiple lines of empirical evidence to explain the mechanisms of biological evolution.

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Arizona Science Standards - High School Life Science Essential and Plus Standards

Life Science Standards	
HS.L2U3.18	Obtain, evaluate, and communicate about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem.
HS+B.L2U1.1	Develop a model showing the relationship between limiting factors and carrying capacity, and use the model to make predictions on how environmental changes impact biodiversity.
HS+B.L4U1.2	Engage in argument from evidence that changes in environmental conditions or human interventions may change species diversity in an ecosystem.
HS.L2U1.19	Develop and use models that show how changes in the transfer of matter and energy within an ecosystem and interactions between species may affect organisms and their environment.
HS+B.L2U1.3	Use mathematics and computational thinking to support claims for the cycling of matter and flow of energy through trophic levels in an ecosystem.

Essential standards are standards that will be assessed on the state exam and are intended for ALL students to have learned by the end of 3 credits of high school science courses.

Life Science Plus (+) Standards HS+B are supporting standards designed to be used with the essential standards for students taking a high school biology (B) course.

Life Science Standards	
HS.L1U1.20	Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
HS+B.L1U1.4	Develop and use models to explain the interdependency and interactions between cellular organelles.
HS+B.L1U1.5	Analyze and interpret data that demonstrates the relationship between cellular function and the diversity of protein functions.
HS+B.L1U1.6	Develop and use models to show how transport mechanisms function in cells.
HS+B.L1U1.7	Develop and use models to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms (plant and animal).
HS.L2U1.21	Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.
HS+B.L2U1.8	Develop and use models to develop a scientific explanation that illustrates how photosynthesis transforms light energy into stored chemical energy and how cellular respiration breaks down macromolecules for use in metabolic processes.
HS.L1U1.22	Construct an explanation for how cellular division (mitosis) is the process by which organisms grow and maintain complex, interconnected systems.
HS.L1U3.23	Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.
HS+B.L1U1.9	Develop and use a model to communicate how a cell copies genetic information to make new cells during asexual reproduction (mitosis).

Life Science Standards	
HS.L3U1.24	Construct an explanation of how the process of sexual reproduction contributes to genetic variation.
HS.L3U1.25	Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.
HS.L3U3.26	Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
HS+B.L3U1.10	Use mathematics and computational thinking to explain the variation that occurs through meiosis and calculate the distribution of expressed traits in a population.
HS+B.L3U1.11	Construct an explanation for how the structure of DNA and RNA determine the structure of proteins that perform essential life functions.
HS+B.L3U1.12	Analyze and interpret data on how mutations can lead to increased genetic variation in a population.
HS.L4U1.27	Obtain, evaluate, and communicate evidence that describes how changes in frequency of inherited traits in a population can lead to biological diversity.
HS.L4U1.28	Gather, evaluate, and communicate multiple lines of empirical evidence to explain the mechanisms of biological evolution.
HS+B.L4U1.13	Obtain, evaluate, and communicate multiple lines of empirical evidence to explain the change in genetic composition of a population over successive generations.
HS+B.L4U1.14	Construct an explanation based on scientific evidence that the process of natural selection can lead to adaptation.

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Arizona Science Standards - High School Essential Standards and Elements

Life Science Standards

HS.L2U3.18 Obtain, evaluate, and communicate about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem.

- 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.
- 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. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e. the ecosystem is resilient) 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.L2U1.19 Develop and use models that show how changes in the transfer of matter and energy within an ecosystem and interactions between species may affect organisms and their environment.

- 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.L1U1.20 Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.

- 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.L2U1.21 Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.

- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- Photosynthesis and cellular respiration are important components of the carbon cycle in which carbon is exchanged among the biosphere, atmosphere, and oceans, and geosphere through chemical, physical, geologic, and biological processes.

Life Science Standards

HS.L1U1.22 Construct an explanation for how cellular division (mitosis) is the process by which organisms grow and maintain complex, interconnected systems.

- 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 simple cell (fertilized egg) that divides successfully 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.
- Most cells are programmed for a limited number of cell divisions. Organisms die if their cells are incapable of further division.

HS.L1U3.23 Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.

- Diseases, which may be caused by invading microorganisms, environmental conditions or defective cell programming, generally result in disturbed cell function.
- Given a suitable medium, cells from a variety of organisms can be grown in situ, that is, outside the organism. These cell cultures are used by scientists to investigate cell functions and have medical implications such as the production of vaccines, screening of drugs, and in vitro fertilization.

HS.L3U1.24 Construct an explanation of how the process of sexual reproduction contributes to genetic variation.

- In sexual reproduction, a specialized type of cell division called meiosis occurs and results in the production of sex cells, such as gametes (sperm and eggs) or spores, which contain only one member from each chromosome pair in the parent cell.
- 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.L3U1.25)
- 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.

The elements are not to be used as a check-off list, but rather a useful tool to help educators identify the specific pieces of knowledge and skill that make up the practice, crosscutting concept, or core idea at that grade-band.

Life Science Standards

HS.L3U1.25 Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.

- 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.
- 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.L1U3.24)

HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.

- The overall sequence of genes of an organism is known as its genome. More is being learned all the time about genetic information by mapping the genomes of different kinds of organisms.
- When sequences of genes are known genetic material can be artificially changed to give organisms certain features.
- In gene therapy special techniques are used to deliver into human cells genes that are beginning to help in curing disease.
- Biotechnology has made possible the production of genetically identical organisms through artificial cloning in a range of species.

HS.L4U1.27 Obtain, evaluate, and communicate evidence that describes how changes in frequency of inherited traits in a population can lead to biological diversity.

- 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. The traits that positively affect survival are more likely to be reproduced and thus are more common in the population.
- Adaptation also means that the distribution of traits in a population can change when conditions change.
- 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 too drastic, the opportunity for the species' evolution is lost.
- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).

HS.L4U1.28 Gather, evaluate, and communicate multiple lines of empirical evidence to explain the mechanisms of biological evolution.

- 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.
- 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.
- 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.

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