

**California State Science Curriculum Standards
Grades K-12 – Spiraled**

Content Area: LIFE SCIENCE

The following document lists the standards that should be covered from Kindergarten through 12th grade in this content area.

Kindergarten

2. Different types of plants and animals inhabit the earth. As a basis for understanding this concept:
 - a. *Students know* how to observe and describe similarities and differences in the appearance and behavior of plants and animals (e.g., seed-bearing plants, birds, fish, insects).
 - b. *Students know* stories sometimes give plants and animals attributes they do not really have.
 - c. *Students know* how to identify major structures of common plants and animals (e.g., stems, leaves, roots, arms, wings, legs).

Grade 1

2. Plants and animals meet their needs in different ways. As a basis for understanding this concept:
 - a. *Students know* different plants and animals inhabit different kinds of environments and have external features that help them thrive in different kinds of places.
 - b. *Students know* both plants and animals need water, animals need food, and plants need light.
 - c. *Students know* animals eat plants or other animals for food and may also use plants or even other animals for shelter and nesting.
 - d. *Students know* how to infer what animals eat from the shapes of their teeth (e.g., sharp teeth: eats meat; flat teeth: eats plants).
 - e. *Students know* roots are associated with the intake of water and soil nutrients and green leaves are associated with making food from sunlight.

Grade 2

2. Plants and animals have predictable life cycles. As a basis for understanding this concept:
 - a. *Students know* that organisms reproduce offspring of their own kind and that the offspring resemble their parents and one another.
 - b. *Students know* the sequential stages of life cycles are different for different animals, such as butterflies, frogs, and mice.
 - c. *Students know* many characteristics of an organism are inherited from the parents. Some characteristics are caused or influenced by the environment.
 - d. *Students know* there is variation among individuals of one kind within a population.
 - e. *Students know* light, gravity, touch, or environmental stress can affect the germination, growth, and development of plants.
 - f. *Students know* flowers and fruits are associated with reproduction in plants.

Grade 3

3. Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:
 - a. *Students know* plants and animals have structures that serve different functions in growth, survival, and reproduction.
 - b. *Students know* examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.
 - c. *Students know* living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.
 - d. *Students know* when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.
 - e. *Students know* that some kinds of organisms that once lived on Earth have completely disappeared and that some of those resembled others that are alive today.

Grade 4

2. All organisms need energy and matter to live and grow. As a basis for understanding this concept:
 - a. *Students know* plants are the primary source of matter and energy entering most food chains.
 - b. *Students know* producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.
 - c. *Students know* decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.
3. Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:
 - a. *Students know* ecosystems can be characterized by their living and nonliving components.
 - b. *Students know* that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.
 - c. *Students know* many plants depend on animals for pollination and seed dispersal, and animals depend on plants for food and shelter.
 - d. *Students know* that most microorganisms do not cause disease and that many are beneficial.

Grade 5

2. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:
 - a. *Students know* many multicellular organisms have specialized structures to support the transport of materials.
 - b. *Students know* how blood circulates through the heart chambers, lungs, and body and how carbon dioxide (CO₂) and oxygen (O₂) are exchanged in the lungs and tissues.
 - c. *Students know* the sequential steps of digestion and the roles of teeth and the mouth, esophagus, stomach, small intestine, large intestine, and colon in the function of the digestive system.
 - d. *Students know* the role of the kidney in removing cellular waste from blood and converting it into urine, which is stored in the bladder.
 - e. *Students know* how sugar, water, and minerals are transported in a vascular plant.
 - f. *Students know* plants use carbon dioxide (CO₂) and energy from sunlight to build molecules of sugar and release oxygen.
 - g. *Students know* plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide (CO₂) and water (respiration).

Grade 6

5. Organisms in ecosystems exchange energy and nutrients among themselves and with the environment. As a basis for understanding this concept:
 - a. *Students know* energy entering ecosystems as producers transfer sunlight into chemical energy through photosynthesis and then from organism to organism through food webs.
 - b. *Students know* matter is transferred over time from one organism to others in the food web and between organisms and the physical environment.
 - c. *Students know* populations of organisms can be categorized by the functions they serve in an ecosystem.
 - d. *Students know* different kinds of organisms may play similar ecological roles in similar biomes.
 - e. *Students know* the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

Grade 7

Cell Biology

1. All living organisms are composed of cells, from just one to many trillions, whose details usually are

visible only through a microscope. As a basis for understanding this concept:

- a. *Students know* cells function similarly in all living organisms.
- b. *Students know* the characteristics that distinguish plant cells from animal cells, including chloroplasts and cell walls.
- c. *Students know* the nucleus is the repository for genetic information in plant and animal cells.
- d. *Students know* that mitochondria liberate energy for the work that cells do and that chloroplasts capture sunlight energy for photosynthesis.
- e. *Students know* cells divide to increase their numbers through a process of mitosis, which results in two daughter cells with identical sets of chromosomes.
- f. *Students know* that as multicellular organisms develop, their cells differentiate.

Genetics

2. A typical cell of any organism contains genetic instructions that specify its traits. Those traits may be modified by environmental influences. As a basis for understanding this concept:

- a. *Students know* the differences between the life cycles and reproduction methods of sexual and asexual organisms.
- b. *Students know* sexual reproduction produces offspring that inherit half their genes from each parent.
- c. *Students know* one or more genes can determine an inherited trait.
- d. *Students know* plant and animal cells contain many thousands of different genes and typically have two copies of every gene. The two copies (or alleles) of the gene may or may not be identical, and one may be dominant in determining the phenotype while the other is recessive.
- e. *Students know* DNA (deoxyribonucleic acid) is the genetic material of living organisms and is located in the chromosomes of each cell.

Evolution

3. Biological evolution accounts for the diversity of species developed through gradual processes over many generations. As a basis for understanding this concept:

- a. *Students know* both genetic variation and environmental factors are causes of evolution and diversity of organisms.
- b. *Students know* the reasoning used by Charles Darwin in reaching his conclusion that natural selection is the mechanism of evolution.
- c. *Students know* how independent lines of evidence from geology, fossils, and comparative anatomy provide the bases for the theory of evolution.
- d. *Students know* how to construct a simple branching diagram to classify living groups of organisms by shared derived characteristics and how to expand the diagram to include fossil organisms.
- e. *Students know* that extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient for its survival.

Earth and Life History (Earth Sciences)

4. Evidence from rocks allows us to understand the evolution of life on Earth. As a basis for understanding this concept:

- d. *Students know* that evidence from geologic layers and radioactive dating indicates Earth is approximately 4.6 billion years old and that life on this planet has existed for more than 3 billion years.
- e. *Students know* fossils provide evidence of how life and environmental conditions have changed.
- f. *Students know* how movements of Earth's continental and oceanic plates through time, with associated changes in climate and geographic connections, have affected the past and present distribution of organisms.
- g. *Students know* how to explain significant developments and extinctions of plant and animal life on the geologic time scale.

Structure and Function in Living Systems

5. The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. As a basis for understanding this concept:

- a. *Students know* plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism.
- b. *Students know* organ systems function because of the contributions of individual organs, tissues,

- and cells. The failure of any part can affect the entire system.
- c. *Students know* how bones and muscles work together to provide a structural framework for movement.
 - d. *Students know* how the reproductive organs of the human female and male generate eggs and sperm and how sexual activity may lead to fertilization and pregnancy.
 - e. *Students know* the function of the umbilicus and placenta during pregnancy.
 - f. *Students know* the structures and processes by which flowering plants generate pollen, ovules, seeds, and fruit.
 - g. *Students know* how to relate the structures of the eye and ear to their functions.

Grade 8

Chemistry of Living Systems (Life Sciences)

6. Principles of chemistry underlie the functioning of biological systems. As a basis for understanding this concept:

- a. *Students know* that carbon, because of its ability to combine in many ways with itself and other elements, has a central role in the chemistry of living organisms.
- b. *Students know* that living organisms are made of molecules consisting largely of carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.
- c. *Students know* that living organisms have many different kinds of molecules, including small ones, such as water and salt, and very large ones, such as carbohydrates, fats, proteins, and DNA.

Biology/Life Sciences (High School)

Cell Biology

1. The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:
- a. *Students know* cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings.
 - b. *Students know* enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.
 - c. *Students know* how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.
 - d. *Students know* the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.
 - e. *Students know* the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins.
 - f. *Students know* usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.
 - g. *Students know* the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.
 - h. *Students know* most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.
 - i. **Students know* how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.
 - j. **Students know* how eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both.

Genetics

2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

- a. *Students know* meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type.
- b. *Students know* only certain cells in a multicellular organism undergo meiosis.

- c. *Students know* how random chromosome segregation explains the probability that a particular allele will be in a gamete.
- d. *Students know* new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).
- e. *Students know* why approximately half of an individual's DNA sequence comes from each parent.
- f. *Students know* the role of chromosomes in determining an individual's sex.
- g. *Students know* how to predict possible combinations of alleles in a zygote from the genetic makeup of the parents.

3. A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. As a basis for understanding this concept:

- a. *Students know* how to predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).
- b. *Students know* the genetic basis for Mendel's laws of segregation and independent assortment.
- c. * *Students know* how to predict the probable mode of inheritance from a pedigree diagram showing phenotypes.
- d. * *Students know* how to use data on frequency of recombination at meiosis to estimate genetic distances between loci and to interpret genetic maps of chromosomes.

4. Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:

- a. *Students know* the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.
- b. *Students know* how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.
- c. *Students know* how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.
- d. *Students know* specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.
- e. *Students know* proteins can differ from one another in the number and sequence of amino acids.
- f.**Students know* why proteins having different amino acid sequences typically have different shapes and chemical properties.

5. The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:

- a. *Students know* the general structures and functions of DNA, RNA, and protein.
- b. *Students know* how to apply base-pairing rules to explain precise copying of DNA during semi-conservative replication and transcription of information from DNA into mRNA.
- c. *Students know* how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.
- d. * *Students know* how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.
- e. * *Students know* how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

Ecology

6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

- a. *Students know* biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.
- b. *Students know* how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.
- c. *Students know* how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.
- d. *Students know* how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.
- e. *Students know* a vital part of an ecosystem is the stability of its producers and decomposers.
- f. *Students know* at each link in a food web some energy is stored in newly made structures but much

energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.

g. * *Students know* how to distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change.

Evolution

7. The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

- a. *Students know* why natural selection acts on the phenotype rather than the genotype of an organism.
- b. *Students know* why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool.
- c. *Students know* new mutations are constantly being generated in a gene pool.
- d. *Students know* variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.
- e. * *Students know* the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature.
- f. * *Students know* how to solve the Hardy-Weinberg equation to predict the frequency of genotypes in a population, given the frequency of phenotypes.

8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

- a. *Students know* how natural selection determines the differential survival of groups of organisms.
- b. *Students know* a great diversity of species increases the chance that at least some organisms survive major changes in the environment.
- c. *Students know* the effects of genetic drift on the diversity of organisms in a population.
- d. *Students know* reproductive or geographic isolation affects speciation.
- e. *Students know* how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.
- f. * *Students know* how to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.
- g. * *Students know* how several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from one another.

Physiology

9. As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

- a. *Students know* how the complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide.
- b. *Students know* how the nervous system mediates communication between different parts of the body and the body's interactions with the environment.
- c. *Students know* how feedback loops in the nervous and endocrine systems regulate conditions in the body.
- d. *Students know* the functions of the nervous system and the role of neurons in transmitting electrochemical impulses.
- e. *Students know* the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response.
- f. * *Students know* the individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts.
- g. * *Students know* the homeostatic role of the kidneys in the removal of nitrogenous wastes and the role of the liver in blood detoxification and glucose balance.
- h. * *Students know* the cellular and molecular basis of muscle contraction, including the roles of actin, myosin, Ca^{+2} , and ATP.
- i. * *Students know* how hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.

10. Organisms have a variety of mechanisms to combat disease. As a basis for understanding the human immune response:

- a. *Students know* the role of the skin in providing nonspecific defenses against infection.
- b. *Students know* the role of antibodies in the body's response to infection.
- c. *Students know* how vaccination protects an individual from infectious diseases.
- d. *Students know* there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.
- e. *Students know* why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign.
- f. **Students know* the roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system.