Table 9: Life Science Content Statements for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Structures and Functions of Living Systems		
Organization and Development: From basic needs of organisms (4) to the levels of organization of living systems (8) to the chemical basis of living systems (12).		
L4.1: Organisms need food, water, and air; a way to dispose of waste; and an environment in which they can live[9]	**L8.1:** All organisms are composed of cells, from just one cell to many cells. About two-thirds of the weight of cells is accounted for by water, which gives cells many of their properties. In multicellular organisms, specialized cells perform specialized functions. Organs and organ systems are composed of cells and function to serve the needs of cells for food, air, and waste removal. The way in which cells function is similar in all living organisms.[10] **L8.2:** Following fertilization, cell division produces a small cluster of cells that then differentiate by appearance and function to form the basic tissues of an embryo.	**L12.1:** Living systems are made of complex molecules (including carbohydrates, fats, proteins, and nucleic acids) that consist mostly of a few elements, especially carbon, hydrogen, oxygen, nitrogen, and phosphorous. **L12.2:** Cellular processes are carried out by many different types of molecules, mostly proteins. Protein molecules are long, usually folded chains made from combinations of amino-acid molecules. Protein molecules assemble fats and carbohydrates and carry out other cellular functions. The function of each protein molecule depends on its specific sequence of amino acids and the shape of the molecule. **L12.3:** Cellular processes are regulated both internally and externally by environments in which cells exist, including local environments that lead to cell differentiation during the development of multicellular organisms. During the development of complex multicellular organisms, cell differentiation is regulated through the expression of different genes.

[9] See p. 53 for a textbox on "Food."

[10] Human organs and organ systems are subsumed under this content statement. See details in Table 10, Life Science Content Boundaries.

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Organization and Development: Examples, Observations, and Phenomena		
Common plants and animals that live on land or in water, including vertebrates and insects Food sources for common animals Need for organisms to eliminate waste, waste including undigested food in animals Ecosystems as they provide sources of food and water and air for animals and water and air for plants	Cellular composition of animals (including vertebrates and insects); terrestrial and aquatic plants; and fungi, bacteria, protists Specific organs and organ systems of vertebrates: digestive system (esophagus, stomach, intestines, colon); respiratory system (lungs, gills); circulatory system (heart, arteries, veins, capillaries); urinary system (kidneys, bladder); skin Parts of terrestrial plants: roots, stems, leaves, flowers, seeds Carbon dioxide as an example of waste product in vertebrates, insects, terrestrial and aquatic plants, and many microorganisms Patterns of development in vertebrates, including humans <u>Exclusions</u>: ▪ Specific organs and organ systems of invertebrates ▪ Nitrogen as a component of animal wastes	Complex molecules (listed in the content statement) and their subunits: simple sugars, fatty acids, amino acids Nucleotides as subunits of nucleic acids Cells making the molecules they need: different proteins and their different work (without specific proteins, the processes may not be carried out at all or as well) Cellular processes (e.g., transport of materials, energy capture and release, protein building, waste disposal) in plants and animals <u>Exclusions</u>: ▪ Detailed structure of fats (glycerol, etc.)

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Organization and Development: Instruments, Measurement, and Representations		
Pictures and drawings of common plants and animals Pictures and drawings of common habitats	Microscopes to see cells in plant and animal tissues and cell division Relative scale of organs, tissues, cells (not directly measured) Drawings and photographs of organs and cells of vertebrates Drawings and photographs of developing vertebrate embryos Drawings showing movement of food, water, oxygen, carbon dioxide, and digestive waste through land plants and vertebrates Exclusions: ▪ Drawings of parts of cells (cellular organelles) ▪ Drawings showing movement of nitrogen waste through organisms ▪ Cell differentiation into three tissue layers and blastula formation	Relative scale of organs, tissues, cells, biomolecules (not directly measured) Representations of large biomolecules as polymers of simpler subunits Structural formulas of monomers of fats, proteins, carbohydrates (fatty acids, amino acids, simple sugars)
Organization and Development: Technical Vocabulary		
Exclusions: ▪ Cells and cellular functions ▪ Vertebrates ▪ Ecosystems	Vocabulary associated with organ systems and terrestrial plants in above "Examples, Observations, and Phenomena" category Exclusions: ▪ Seed parts ▪ Organs not listed above such as pancreas, liver, gall bladder ▪ Cellular organelles; stages in development of embryos	Exclusions: ▪ Names of cellular organelles ▪ Primary, secondary, tertiary structure of proteins; names, functional groups, and structural formulas of amino acids ▪ Differentiation among types of amino acids: hydrophobic, hydrophilic ▪ The term "nucleotide" if used in items should be followed by "(a subunit of DNA)."

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Organization and Development: Clarification		
Analysis of examples of plants and animals that are familiar to them, with consideration of four key needs: ▪ Food ▪ Air ▪ Waste disposal ▪ Environmental conditions See textbox on p. 53 for detail about the use of the word "food." Note connection between this subtopic and content statement L4.7. <u>Exclusions</u>: ▪ Internal structures and functions in plants and animals ▪ Cells, cell organelles	Key idea: How the structures of an organism work together to fulfill its needs and the differentiation of cells that occurs during growth and development Key idea: How organ systems work together physiologically to support the needs of the entire organism and the cells of which it is composed See Appendix G for elaboration of L8.1. <u>Exclusions</u>: ▪ Structure and function of specific tissues and cells within organs (e.g., different types of blood cells or muscle cells)	Subunits (hence complex molecules and living things themselves) are made up of the same elements—carbon, hydrogen, oxygen, nitrogen, phosphorous. Cell processes—replicating genetic information, repairing cell structures, helping other molecules to get in or out of the cell, and generally catalyzing and regulating molecular interactions—are carried out mainly by proteins. Proteins are long and usually folded chains and are made up of amino acids (smaller molecules that are the building blocks of proteins). The function of each protein depends on the amino acid sequence and resulting shape the protein takes when it folds. Note connection between this subtopic and content statement L12.9. See Appendix G for elaboration of L12.2. <u>Exclusions</u>: ▪ How proteins are made (RNA, codons, etc.), how proteins function (e.g., molecular basis of enzyme catalysis, muscle contraction, membrane transport)

Table 9: Life Science Content Statements for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Structures and Functions of Living Systems		
Matter and Energy Transformations: From the basic needs of organisms for growth (4) to the role of carbon compounds in growth and metabolism (8) to the chemical basis of matter and energy transformation in living systems (12).		
L4.2: Organisms have basic needs. Animals require air, water, and a source of energy and building material for growth and repair. Plants also require light.	**L8.3:** Cells carry out the many functions needed to sustain life. They grow and divide, thereby producing more cells. Food is used to provide energy for the work that cells do and is a source of the molecular building blocks from which needed materials are assembled. **L8.4:** Plants are producers—they use the energy from light to make sugar molecules from the atoms of carbon dioxide and water.[11] Plants use these sugars along with minerals from the soil to form fats, proteins, and carbohydrates. These products can be used immediately, incorporated into the plant's cells as the plant grows, or stored for later use. **L8.5:** All animals, including humans, are consumers that meet their energy needs by eating other organisms or their products. Consumers break down the structures of the organisms they eat to make the materials they need to grow and function. Decomposers, including bacteria and fungi, use dead organisms or their products to meet their energy needs.	**L12.4:** Plants have the capability (through photosynthesis) to take energy from light to form higher energy sugar molecules containing carbon, hydrogen, and oxygen from lower energy molecules. These sugar molecules can be used to make amino acids and other carbon-containing (organic) molecules and assembled into larger molecules with biological activity (including proteins, DNA, carbohydrates, and fats). **L12.5:** The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in an ecosystem, some energy is stored in newly made structures, but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going. **L12.6:** As matter cycles and energy flows through different levels of organization of living systems—cells, organs, organisms, communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

[11] The statement "they use the energy from light" does not imply that energy is converted into matter or that energy is lost. See pp. 105-106 for more on energy as Crosscutting Content.

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Matter and Energy Transformations: Examples, Observations, and Phenomena		
Common plants and animals that live on land or in the water, including vertebrates and insects	Producers, consumers, and decomposers including animals, plants, protists, fungi, bacteria Gas exchange in plants, animals, decomposers Cells in plants and animals Internal structures and organs of plants and animals responsible for movement of materials <u>Exclusions</u>: ▪ Cellular organelles of plants and animals	Producers, consumers, and decomposers including animals, plants, protists, fungi, bacteria Representative ecosystems (e.g., wetlands, rainforests) that are widely represented in textbooks and of importance to all students, even those not living near them
Matter and Energy Transformations: Instruments, Measurement, and Representations		
Drawings or photographs showing plant parts responsible for taking in water (roots) and sunlight (green leaves) and animals' external organs that take in air, water, and food	Scale of multicellular organisms, cells, molecules Structural formulas of carbon dioxide, oxygen, and water Drawings with arrows showing movements of matter and energy within plants and animals (If arrows are used, their meanings must be clearly explained.) Energy pyramids showing trophic levels and energy transfer in an ecosystem <u>Exclusions</u>: ▪ Structural formulas of biomolecules (sugars, fats, amino acids) ▪ Drawings with arrows showing movements of substances inside plant and animal cells	Representations of large biomolecules as polymers of simpler subunits Labeled structural formulas of monomers of fats, proteins, carbohydrates (amino acids, fatty acids, simple sugars) Chemical equations for overall processes of cellular respiration and photosynthesis General representations of synthesis and breakdown of large biomolecules Diagrams of matter cycling and energy flow in ecosystems <u>Exclusions</u>: ▪ Representations of specific detailed steps of synthesis and decomposition (e.g., intermediate steps and molecules, details of dehydration synthesis)

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Matter and Energy Transformations: Technical Vocabulary		
[No special vocabulary]	Exclusions: ▪ Although the content statements describe the general processes of photosynthesis and cellular respiration, these terms are not included, nor is the word chlorophyll.	Cellular respiration Key elements in biomolecules: carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, potassium, sodium Exclusions: Calvin cycle, Krebs cycle, glycolysis, or intermediate products in respiration and photosynthesis
Matter and Energy Transformations: Clarification		
Materials or sources of energy (light) that plants and animals take in. Legitimate questions include identifying the sources of these essential materials for different plants and animals. See pp. 105-106, "Energy Sources and Transfer" and "Uses, Transformations, and Conservation of Energy," for more on the crosscutting nature of energy. See p. 107, "Biogeochemical Cycles," for more on the crosscutting nature of matter in living systems. Exclusions: ▪ *How* plants take in light	Tracing the sequence of transformations of matter and energy that enable plants and animals to grow and function Transformations that use or produce gases are especially significant and difficult for students. Note connections between this subtopic and content statements P8.13 and E8.11. See pp. 105-106, "Energy Sources and Transfer" and "Uses, Transformations, and Conservation of Energy," for more on the crosscutting nature of energy. See p. 107, "Biogeochemical Cycles," for more on the crosscutting nature of matter in living systems. See Appendix G for elaboration of L8.4.	Tracking particular atoms or elements (especially carbon) through the processes of photosynthesis, growth, food webs, and cellular respiration at multiple levels: cellular, organismal, and ecological Key idea: Conservation of matter and energy in living systems Note connections between this subtopic and content statements P12.14, P12.15, P12.16, E12.9, E12.12. See pp. 105-106, "Energy Sources and Transfer" and "Uses, Transformations, and Conservation of Energy," for more on the crosscutting nature of energy. See p. 107, "Biogeochemical Cycles," for more on the crosscutting nature of matter in living systems. See Appendix G for elaboration of L12.6.

Table 9: Life Science Content Statements for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Structures and Functions of Living Systems		
Interdependence: From the interdependence of organisms (4) to specific types of interdependence (8) to consequences of interdependence (12).		
L4.3: Organisms interact and are interdependent in various ways including providing food and shelter to one another. Organisms can survive only in environments in which their needs are met. Some interactions are beneficial; others are detrimental to the organism and other organisms. **L4.4:** When the environment changes, some plants and animals survive and reproduce; others die or move to new locations.	**L8.6:** Two types of organisms may interact with one another in several ways: They may be in a producer/consumer, predator/prey, or parasite/host relationship. Or, one organism may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other. **L8.7:** The number of organisms and populations an ecosystem can support depends on the biotic resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. **L8.8:** All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organisms or other organisms, whereas others are beneficial.	**L12.7:** Although the interrelationships and interdependence of organisms may generate biological communities in ecosystems that are stable for hundreds or thousands of years, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution. The impact of the human species has major consequences for other species.

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Interdependence: Examples, Observations, and Phenomena		
Common plants and animals that live on land or in the water, including vertebrates and insects Environmental conditions and changes in environmental conditions that affect survival of plants and animals, including temperature, shelter, light, food sources, water Beneficial and detrimental interactions among organisms that affect survival	Populations of producers, consumers, and decomposers in all five kingdoms Examples of relationships of the types listed in the content statement Examples of disturbances to ecosystems that cause changes in size of populations (e.g., changes in factors listed in content statement, invasive species, human interventions)	Anthropogenic disturbances in ecosystems or environments, including local and global climate change, uses of tilling and pesticides to favor human crops, human land use, harvesting of fish stocks, pollution, invasive species, etc. Natural disturbances in ecosystems (e.g., fires, sedimentation, volcanism) Responses of ecosystems to changes, including succession patterns, alterations due to natural or anthropogenic disturbances Representative ecosystems (e.g., wetlands, rainforests) that are widely represented in textbooks and of importance to all students, even those not living near them
Interdependence: Instruments, Measurement, and Representations		
Identifying and counting organisms in plots Identifying evidence of interactions (e.g., parasites on plants or animals, evidence of predation) Temperature on the Celsius scale Drawings or photographs of plants, animals, and their interactions	Measures of population size and density: range, number of individuals per plot Graphic or geographic representations of size, range, density of populations Food webs identifying relationships among producers, consumers, and decomposers in an ecosystem	Qualitative descriptions of biodiversity in different ecosystems Qualitative descriptions of fluctuations in populations due to natural and anthropogenic disturbances Graphic or geographic representations of size, diversity, key species in ecosystems Analysis of quantitative data on biodiversity
Interdependence: Technical Vocabulary		
Descriptions of environmental conditions and interactions in non-technical language <u>Exclusions</u>: ▪ Predation, symbiosis, parasitism	[No special vocabulary]	See above descriptions of natural and anthropogenic disturbances. <u>Exclusions</u>: ▪ Anthropogenic (use "human-generated" or similar term)

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Interdependence: Clarification		
Key idea: Individual plants and animals interact with their environments or with plants and animals of other species, and those interactions affect their survival or ability to reproduce.	Key idea: Populations, their interactions with other populations and the non-living environment, and how changes in the environment or interactions can affect the size and composition of populations See Appendix G for elaboration of L8.7.	Key idea: Ecosystems (including coupled human and natural systems such as farms and cities) are dynamic systems that are constantly changing, especially in response to the large and increasing scale of human impact on ecosystems. See Appendix G for elaboration of L12.7.

Table 9: Life Science Content Statements for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Changes in Living Systems		
Heredity and Reproduction: From life cycles (4) to reproduction and the influence of heredity and the environment on an offspring's characteristics (8) to the molecular basis of heredity (12).		
L4.5: Plants and animals have life cycles. Both plants and animals begin life and develop into adults, reproduce, and eventually die. The details of this life cycle are different for different organisms. **L4.6:** Plants and animals closely resemble their parents.	**L8.9:** Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually. **L8.10:** The characteristics of organisms are influenced by heredity and environment. For some characteristics, inheritance is more important; for other characteristics, interactions with the environment are more important.	**L12.8:** Hereditary information is contained in genes, located in the chromosomes of each cell. A human cell contains many thousands of different genes. One or many genes can determine an inherited trait of an individual, and a single gene can influence more than one trait. **L12.9:** The genetic information encoded in DNA molecules provides instructions for assembling protein molecules. Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment. **L12.10:** Sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents.

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Heredity and Reproduction: Examples, Observations, and Phenomena		
Variety of plant and animal life cycles Descriptions of organisms in terms of characteristics (e.g., height, eye color, hair color) and traits that express variation of these characteristics (e.g., brown eyes, black hair) Different external features of organisms that may resemble their parents (e.g., height, color of hair and eyes)	Sexual and asexual reproduction as part of a life cycle of animals, plants, protists, bacteria	Changes in DNA (mutations) Genetic variation in cells arising from gamete formation and sexual reproduction—inherited traits, mutations Effects of mutations on proteins and protein functions Basic bioinformatics (DNA fingerprinting, reproductive and therapeutic cloning) used as context for items (information on bioinformatics would need to be supplied in the item) <u>Exclusions</u>: ▪ Details of transcription and translation ▪ Mendelian genetics ▪ Details of meiosis and mitosis (content to be assessed limited to the following: the result of DNA duplication in cell division is the copying of all DNA for the descendent cells whereas the result of gamete formation is eggs/sperm with only half of the DNA) ▪ Nature of bonding between DNA strands

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Heredity and Reproduction: Instruments, Measurement, and Representations		
Drawings and photographs of plants and animals and their external features	Representations showing degree of relatedness (e.g., pedigree charts) used to decide which pairs of organisms are more/less closely related	Using microscopes to identify chromosomes Electrophoresis as a technique for separating molecules based on differences in their properties (e.g., mass) Dyes, binding of radioactive labels as a way to visualize molecules (most of which are colorless) Double helix as a representation to include understanding that it is the sequence of nucleotides that gets passed from one generation to the next and that is responsible for DNA functions Graphic results of electrophoresis <u>Exclusions</u>: ▪ PCR ▪ How electrophoresis works ▪ Structure of nucleotides ▪ Graphic demonstration of mitosis or meiosis
Heredity and Reproduction: Technical Vocabulary		
Descriptions of organisms in commonly understood terms	Common terms related to reproduction including egg, sperm, fertilization <u>Exclusions</u>: ▪ Mendelian genetics (e.g., dominant, recessive) ▪ Details of reproduction and development (e.g., gamete, zygote, alternation of generations)	<u>Exclusions</u>: ▪ Names and structures of nucleotides

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12

GRADE 4	GRADE 8	GRADE 12
Heredity and Reproduction: Clarification		
[No clarification needed]	Key idea: Every organism has a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another. When cells divide, they are reproducing asexually. In asexual reproduction, the new cell (organism) is identical to the parent. In sexual reproduction, a sperm and egg unite (fertilization); half of an individual's traits come from one parent and half from the other.	Understanding the molecular basis of heredity requires a coherent understanding of two main functions of DNA: (1) determining the characteristics of organisms, and (2) passing information from one generation to the next. Clarification of the role of DNA in determining the characteristics of an organism (function 1): An organism's characteristics reflect the actions of its proteins; proteins carry out the work of cells (and organs/organ systems); and DNA directs the production of proteins. Clarification of DNA carrying hereditary information from one generation to the next (function 2): DNA is what gets passed from parents to offspring. Genes and chromosomes are then defined in terms of DNA. See DNA's role in function 1. Double helix as a representation includes understanding of its significance to heredity. Note connections between this subtopic and content statements L12.1, L12.2, and L12.3. See Appendix G for elaboration of L12.8 and L12.9.

Table 9: Life Science Content Statements for Grades 4, 8, and 12 (cont)

GRADE 4	GRADE 8	GRADE 12
Changes in Living Systems		
Evolution and Diversity: From differences and adaptations of organisms (4) to preferential survival and relatedness of organisms (8) to the mechanisms of evolutionary change and the history of life on Earth (12).		
L4.7: Different kinds of organisms have characteristics that enable them to survive in different environments. Individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing.	**L8.11:** Individual organisms with certain traits in particular environments are more likely than others to survive and have offspring. When an environment changes, the advantage or disadvantage of characteristics can change. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the Earth no longer exist. **L8.12:** Similarities among organisms are found in anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance.	**L12.11:** Modern ideas about evolution (including natural selection and common descent) provide a scientific explanation for the history of life on Earth as depicted in the fossil record and in the similarities evident within the diversity of existing organisms. **L12.12:** Molecular evidence substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched. **L12.13:** Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection from environmental pressure of those organisms better able to survive and leave offspring.

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12 (cont)

GRADE 4	GRADE 8	GRADE 12
Evolution and Diversity: Examples, Observations, and Phenomena		
Different plants and animals in the context of their populations and environments. Adaptations of populations of plants and animals to their environments Differences among plants and animals in a population	Examples of more and less closely related organisms, including primates Examples of fossils, remains of recently extinct organisms, major extinctions during Earth's history Examples of modern changes in populations (e.g., development of insect resistance to pesticides) <u>Exclusions</u>: ▪ Phylogenetic taxonomy (e.g., kingdoms, phyla)	Examples of modern diversity and evolutionary changes in populations (e.g., development of insect resistance to pesticides, bacterial resistance to antibiotics, viral strains). Such examples illustrate the four numbered factors in L12.13. Examples of fossil records and existing organisms with evident similarities, including humans Examples of lines of descent accompanied by molecular evidence, including humans
Evolution and Diversity: Instruments, Measurement, and Representations		
Measurements or descriptions of characteristics of plants and animals: height, weight, leaf size, color, etc. Photographs or pictures that show differences among individuals within and between populations (can be used to hypothesize relationships between organisms and their environments)	Measurements or descriptions of similarities and differences in internal and external structures of organisms Photographs or pictures that show differences among individuals in a population in internal or external characteristics Simple timelines depicting fossil records and extinction of species	Graphs or tables showing distribution of traits in populations Representations of degree of biochemical similarity in terms of percentages (e.g., 85% of DNA in common)
Evolution and Diversity: Technical Vocabulary		
Words in common language that describe adaptive characteristics and characteristics that differentiate individuals <u>Exclusions</u>: ▪ Trait ▪ Species	Adaptation, fitness	[No special vocabulary]

Table 10: Life Science Content Boundaries for Grades 4, 8, and 12 (cont)

GRADE 4	GRADE 8	GRADE 12
Evolution and Diversity: Clarification		
Note that this includes *both* diversity of species (different species have different traits) and diversity within populations (different individuals in a population have different traits). Describing and comparing individual organisms and reasoning about how their traits might help or hinder their survival Note connection between this subtopic and content statement L4.1. See Appendix G for elaboration of L4.7. <u>Exclusions</u>: ▪ Distinguish heritable from non-heritable characteristics	Fossils and internal and external anatomical evidence of appearance and disappearance of species, including extinction Fossils and internal and external anatomical evidence of relatedness of species Note connections between this subtopic and the Earth and Space Science subtopic, "History of Earth." <u>Exclusions</u>: ▪ Chemical evidence of change in populations over time ▪ Chemical evidence of relatedness of species	Producing accounts of changes in populations that include all four of the numbered factors in L12.13 Key idea: Process of evolutionary change in populations through natural selection Linking evidence (including molecular and anatomical) of similarity within diversity of organisms to common descent Note connections between this subtopic and the Earth and Space Science subtopic, "History of Earth."