California Science

Biology

From Molecules to Organisms: Structures and Processes HS-LS1

Students who demonstrate understanding can:

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. HS-LS1-1

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. HS-LS1-2

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. HS-LS1-3

HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. HS-LS1-4

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. HS-LS1-5

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. HS-LS1-6

HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. HS-LS1-7

Ecosystems: Interactions, Energy, and Dynamics HS-LS2

Students who demonstrate understanding can:

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. HS-LS2-1

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. HS-LS2-2

HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. HS-LS2-3

HS-LS2-4. Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. HS-LS2-4

HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. HS-LS2-5

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. HS-LS2-6

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. HS-LS2-7

HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. HS-LS2-8

Heredity: Inheritance and Variation of Traits HS-LS3

Students who demonstrate understanding can:

HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. HS-LS3-1

HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. HS-LS3-2

HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. HS-LS3-3

Biological Evolution: Unity and Diversity HS-LS4

Students who demonstrate understanding can:

HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. HS-LS4-1

HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. HS-LS4-2

HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. HS-LS4-3

HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations. HS-LS4-4

HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. HS-LS4-5

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. HS-LS4-6

Engineering Design HS-ETS1

Students who demonstrate understanding can:

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-1

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-2

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. HS-ETS1-3

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. HS-ETS1-4

Science and Engineering Practices

SEP 4. SEP 4: Analyzing and Interpreting Data SEP 4

Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
- Analyze data using computational models in order to make valid and reliable scientific claims.

SEP 1. SEP 1: Asking Questions and Defining Problems SEP 1

Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
- Ask questions that arise from examining models or a theory to clarify relationships.
- Analyze complex real-world problems by specifying criteria and constraints for successful solutions.

SEP 6. SEP 6: Constructing Explanations and Designing Solutions SEP 6

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects.
- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

SEP 2. SEP 2: Developing and Using Models SEP 2

Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system.
- Use a model to predict the relationships between systems or between components of a system.
- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
- Use a model based on evidence to illustrate the relationships between systems or between components of a system.
- Use a model to provide mechanistic accounts of phenomena.

SEP 7. SEP 7: Engaging in Argument from Evidence SEP 7

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
- Evaluate the evidence behind currently accepted explanations to determine the merits of arguments.
- Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.
- Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.
- Construct an oral and written argument or counter-arguments based on data and evidence.
- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

SEP 8. SEP 8: Obtaining, Evaluating, and Communicating Information SEP 8

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
- Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible.
- Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
- Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
- Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

SEP 3. SEP 3: Planning and Carrying Out Investigations SEP 3

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Scientific Investigations Use a Variety of Methods

Scientific Knowledge is Based on Empirical Evidence

Scientific Knowledge is Open to Revision in Light of New Evidence

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

SEP 5. **SEP 5: Using Mathematics and Computational Thinking** SEP 5

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical representations of phenomena to support claims.
- Use mathematical representations of phenomena to describe explanations.
- Create a computational model or simulation of a phenomenon, designed device, process, or system.
- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.
- Use mathematical and/or computational representations of phenomena or design solutions to support explanations.
- Use mathematical representations of phenomena or design solutions to support and revise explanations.
- Use mathematical representations of phenomena or design solutions to support claims.
- Create or revise a simulation of a phenomenon, designed device, process, or system.
- Use mathematical or computational representations of phenomena to describe explanations.
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.
- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.

Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.

- **Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.**

Science investigations use diverse methods

- **Science investigations use diverse methods and do not always use the same set of procedures to obtain data.**

and do not always use the same set of procedures to obtain data.	
New technologies advance scientific knowledge.	- **New technologies advance scientific knowledge.**
Science knowledge is based on empirical evidence.	- **Science knowledge is based on empirical evidence.**
Science disciplines share common rules of evidence used to evaluate explanations about natural systems.	- **Science disciplines share common rules of evidence used to evaluate explanations about natural systems.**
Science includes the process of coordinating patterns of evidence with current theory.	- **Science includes the process of coordinating patterns of evidence with current theory.**
Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	- **Science arguments are strengthened by multiple lines of evidence supporting a single explanation.**
Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.	- **Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.**
Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.	- **Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.**

Theories and laws provide explanations in science.	- **Theories and laws provide explanations in science.**
Laws are statements or descriptions of the relationships among observable phenomena.	- **Laws are statements or descriptions of the relationships among observable phenomena.**
A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	- **A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.**
Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.	- **Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.**

Disciplinary Core Ideas

A. Structure and Function `LS1.A`

A. Systems of specialized cells within organisms help them perform the essential functions of life. `LS1.A`

A. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. `LS1.A`

A. Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. `LS1.A`

A. 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. `LS1.A`

A. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. `LSA.A`

B. Growth and Development of Organisms `LS1.B`

B. In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. `LS1.B`

C. Organization for Matter and Energy Flow in Organisms `LS1.C`

C. The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. `LS1.C`

C. The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. `LS1.C`

C. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. `LS1.C`

C. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. `LS1.C`

A. Interdependent Relationships in Ecosystems LS2.A

A. Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. LS2.A

B. Cycles of Matter and Energy Transfer in Ecosystems LS2.B

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

B. 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. LS2.B

B. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. LS2.B

C. Ecosystem Dynamics, Functioning, and Resilience LS2.C

C. 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. LS2.C

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

D. Social Interactions and Group Behavior LS2.D

D. roup behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. LS2.D

A. Inheritance of Traits LS3.A

A. 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. LS3.A

B. Variation of Traits LS3.B

B. 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. LS3.B

B. 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. LS3.B

A. Evidence of Common Ancestry and Diversity LS4.A

A. 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. LS4.A

B. Natural Selection LS4.B

B. Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. LS4.B

B. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. LS4.B

C. Adaptation LS4.C

- C. 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. LS4.C
- C. 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. LS4.C
- C. Adaptation also means that the distribution of traits in a population can change when conditions change. LS4.C
- C. 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. LS4.C
- C. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. LS4.C

D. Biodiversity and Humans LS4.D

- D. Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). LS4.D
- D. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. LS4.D

Crosscutting Concepts

CCC 1. CCC 1: Patterns CCC 1

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Empirical evidence is needed to identify patterns.

CCC 2. CCC 2: Cause and Effect CCC 2

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Systems can be designed to cause a desired effect.

Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

CCC 3. CCC 3: Scale, Proportion, and Quantity CCC 3

The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

CCC 4. CCC 4: Systems and System Models CCC 4

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

CCC 5. CCC 5: Energy and Matter CCC 5

In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

The total amount of energy and matter in closed systems is conserved.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

Energy drives the cycling of matter within and between systems.

CCC 6. **CCC 6: Structure and Function** CCC 6

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

CCC 7. **CCC 7: Stability and Change** CCC 7

Much of science deals with constructing explanations of how things change and how they remain stable.

Systems can be designed for greater or lesser stability.

Feedback (negative or positive) can stabilize or destabilize a system.

Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

Influence of Engineering, Technology, and Science on Society and the Natural World

Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

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Interdependence of Science, Engineering, and Technology

Science and engineering complement each other in the cycle known as research and development (R&D).

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Science Addresses Questions About the Natural and Material World

Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.

Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.

Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Science assumes the universe is a vast single system in which basic laws are consistent.

Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.

Science is a Human Endeavor

Technological advances have influenced the progress of science and science has influenced advances in technology.

Science and engineering are influenced by society and society is influenced by science and engineering.

Science is a result of human endeavors, imagination, and creativity.