Content Review Notes for Parents and Students

Life Science 2016-2017
This resource is intended to be a guide for parents and students to improve content knowledge and understanding in preparation for the cumulative Grade 8 science Standards of Learning test. The information below is detailed information about the Standards of Learning taught in grade 7 Life Science and comes from the *Science Standards of Learning Curriculum Frameworks*, issued by the Virginia Department of Education. The Curriculum Framework in its entirety can be found at the following website.


**LS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which**

a) data are organized into tables showing repeated trials and means;
b) a classification system is developed based on multiple attributes;
c) triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, and probeware are used to gather data;
d) models and simulations are constructed and used to illustrate and explain phenomena;
e) sources of experimental error are identified;
f) dependent variables, independent variables, and constants are identified;
g) variables are controlled to test hypotheses and trials are repeated;
h) data are organized, communicated through graphical representation, interpreted, and used to make predictions;
i) patterns are identified in data and are interpreted and evaluated; and
j) current applications are used to reinforce life science concepts.

**The concepts developed in this standard include the following:**

- The nature of science refers to the foundational concepts that govern the way scientists formulate explanations about the natural world. The nature of science includes the following concepts
  a) the natural world is understandable;
  b) science is based on evidence - both observational and experimental;
  c) science is a blend of logic and innovation;
  d) scientific ideas are durable yet subject to change as new data are collected;
  e) science is a complex social endeavor; and
  f) Scientists try to remain objective and engage in peer review to help avoid bias.

- Expected results are reflected in the organization of a data table, which includes areas to record the number of repeated trials, levels of the independent variable, measured results for the dependent variable, and analysis of the results by calculation of mathematical means.

- Scientists create and apply classification systems to organize information and discern patterns.

- Appropriate tools and techniques are used to gather data during scientific investigations. Measurements are collected using the International System of Units (metric units) of measurement.

- Mental and physical models, including computer and other simulations, can be helpful in explaining events or sequences of events that occur. They can be used as part of scientific explanations to support data or represent phenomena, especially those that are not easily seen directly or must be inferred from data.

- Potential sources of error in the experimental design must be identified.

- To communicate the plan of an experiment accurately, the independent variable, dependent variable, and constants must be explicitly defined.

- To establish that the events of an experiment are the result of manipulating the independent variable, the experiment must be controlled by observing the effects without the application of the independent variable. The results can be compared with this standard or control. Not all experiments have a control.

- Multiple trials of an experiment must be conducted to verify the results.

- Analysis of observed results of systematic investigations includes construction and interpretation of graphs. Such interpretation can be used to make predictions about the behavior of the dependent variable in other situations and to explore potential sources of error in the experiment. This analysis can be used to support conclusions about the results of the investigation.
• Investigations can be classified as observational (descriptive) studies (intended to generate hypotheses), or experimental studies (intended to test hypotheses).
• Science concepts are applied through observations and connections with everyday life and technology.

**Below is a graphic of the steps of the Scientific Inquiry**

![Graphic of Scientific Inquiry Steps]

Stating the problem involves thinking about the question that needs to be answered or the purpose of the investigation.

When forming a hypothesis, it has to be written as an **IF, THEN** statement. Use this formula: If (independent variable), then (dependent variable). For example, Sherri wants to test the effect of different types/brands of fertilizer on the growth of her bean plants. She finds out more (research) information about the types of fertilizer, and then decides which fertilizer she thinks (predicts) will work best. Her hypothesis may be stated this way: If Brand B Fertilizer is used, then the bean plants will grow taller.

Testing the hypothesis involves performing an experiment. The experiment would have the following parts/variables-independent variable, dependent variable, constants, a control/control group, and several repeated trials (at least 3).

Recording and Analyzing Data involves data tables, charts, and graphs. The two main types of graphs used in Life Science are a line graph and bar graph. Below you will find examples of each. On each graph, the independent variable is plotted on the x-axis and the dependent variable is plotted on the y-axis.
When forming a conclusion, summarize the results in word form. Be sure to state whether your hypothesis was accepted or rejected.

Below are two examples of sample experiments

Example 1 - Compost and Bean Plants

After learning about recycling and the effects of recycled products on plant growth, John's lab group compared the effect of different-aged grass compost on bean plants. Because composition is necessary for release of nutrients, the group hypothesized that older grass compost would produce taller bean plants. Three flats of bean plants (25 plants/flat) were grown for 5 days. The plants were then fertilized as follows: (a) Flat A: 450 g of 3-month-old compost, (b) Flat B: 450 g of 6 month-old compost, and (c) Flat C: 0 g compost. The plants received the same amount of sunlight and water each day. At the end of 30 days the group recorded the height of the plants (cm).

Identify the following components of the above experiment.

1. **Independent variable** (what is the tested item or manipulated variable?) - Different-aged compost
2. **Dependent variable** (what responds to the tested item or what is measured as a result?) - Height of the plants
3. **Control** (what part of the experiment does not receive the independent variable?) - Flat C
4. **Constants** (Those items that remain the same throughout the experiment?) - Same amount of sunlight, same amount of water, same time period (30 days), same amount of compost for Flats A & B, same type of plants
Example 2: It’s all in the gas! -YOU TRY!!
Sarah wants to make a difference in her community. She has created a gasoline that she thinks will reduce the production of carbon monoxide gas associated with driving cars. She recruits 100 drivers and has 50 of them (Group A) use the new gasoline. The other 50 (Group B) will use standard gasoline. Both groups were told that they were getting the gas that would reduce the carbon monoxide emissions. Sarah outfitted all the cars gas probeware that would collect measurements every 15 minutes to calculate the change in carbon monoxide emissions. Two hours after changing the gasoline, Group A’s probes showed a decline of 34% in the production of carbon monoxide over Group B. Eight people from Group A also reported their car ran more smoothly.

- Which people are in the control group?
- What is the independent variable?
- What is the dependent variable?
- What should Sarah’s conclusion be?
- Why do you think 8 people in group B reported their cars ran more smoothly?

Below you will find some commonly used science tools along with their corresponding measurements and units within the SI/Metric System.

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>MEASURES</th>
<th>BASE SI/METRIC UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter Stick or Ruler</td>
<td>Length or Distance</td>
<td>Meter</td>
</tr>
<tr>
<td>Graduated Cylinder</td>
<td>Volume</td>
<td>Liters</td>
</tr>
<tr>
<td>Triple Beam Balance</td>
<td>Mass</td>
<td>Grams</td>
</tr>
<tr>
<td>Thermometer</td>
<td>Temperature</td>
<td>Celsius</td>
</tr>
</tbody>
</table>
Below is a graphic which allows the base units to be changed or converted to larger or smaller units based on the prefix needed.

Her are some Released Test Items from the Virginia Standards of Learning Grade 8 Science Test. Answers are located on the last page of this booklet.
1. The line graph shows five years of data about a dog. What information does the graph show?

A How the mass of the dog changed
B How much food the dog consumed
C What kinds of food the dog consumed
D When the dog was measured each month

2. A lab group measured how far two rubber bands stretched when attached to 100-gram masses. Five measurements were made for each rubber band. What is the range of the data collected for rubber band B?

A 0.3 cm
B 0.5 cm
C 2.7 cm
D 2.8 cm

3. This data table shows the results of an investigation. What information should be used for the column headings marked X?

A Trial number
B Number of seeds
C Predicted value for the results
D Average of the data in each column
4. A student predicts that similar ice cubes will melt faster in a microwave than in a pot on the stove. How should this hypothesis be tested?
A Measure and compare the volume of the pot and the microwave.
B Determine the volume of liquid water made by each ice cube.
C Observe and record the time for each ice cube to completely change to a liquid.
D Identify and record the temperature of each ice cube before each trial.

5. The best scientific reason for a scientist to accept a specific theory is —
A to obtain funding for the research
B that research and observations support the theory
C because there can only be one correct theory
D to gain recognition as a great scientist

<table>
<thead>
<tr>
<th>Sample</th>
<th>Indicator</th>
<th>Color Change</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown 1</td>
<td>Litmus Paper</td>
<td>Red</td>
<td>Acid</td>
</tr>
<tr>
<td>Unknown 2</td>
<td>Litmus Paper</td>
<td>Pink</td>
<td>Acid</td>
</tr>
<tr>
<td>Unknown 3</td>
<td>Litmus Paper</td>
<td>Pink</td>
<td>Acid</td>
</tr>
<tr>
<td>Unknown 4</td>
<td>Litmus Paper</td>
<td>Blue</td>
<td>Base</td>
</tr>
</tbody>
</table>

6. Students conducted an investigation to determine if unknown liquids were acids or bases. What was the independent variable in this investigation?
A Sample
B Indicator
C Color change
D Identification

Hypothesis: The addition of a fertilizer to soil will increase plant growth.

Which of these experimental designs would best test this hypothesis?

A
No Fertilizer
No Water

B
Fertilizer
Water
Fertilizer
No Water

C
Fertilizer
Water
No Fertilizer
Water

D
Fertilizer
Water
No Fertilizer
No Water

According to the graph, which air pollutant decreased the most from 1970 to 1991?

A. Carbon monoxide  
B. Sulfur oxides  
C. Particulates  
D. Lead

34. Which instrument would most accurately and precisely determine the mass of a toy car?

A. An electronic light meter  
B. A spring scale  
C. A triple-beam balance  
D. A graduated cylinder

48. Botanists often use leaves to identify plants. Which trait of the leaves shown would be most useful in identifying the plants they came from?

A. Color of the leaf  
B. Function of the leaf  
C. Arrangement of leaves on a stem  
D. Presence or absence of veins
11 Which of the following is used to measure the mass of an object?

A  Balance  
B  Metric ruler  
C  Graduated cylinder  
D  Barometer

44 Echo-Sounding Ocean Profile Chart

How far offshore is the deepest point of the ocean on this graph?

A  0 m  
B  5000 m  
C  160 km  
D  240 km

The diagram shows a graduated cylinder containing water. From which position will the most accurate measure of the volume of the water be made?

A  Position 1  
B  Position 2  
C  Position 3  
D  Position 4

33

Some snapdragon seeds were studied in the experiment above. The seeds were placed in a dish lined with a moist paper towel. Which of these is the independent (manipulated) variable in this experiment?

A  The type of seed  
B  The amount of water used  
C  The number of sprouts  
D  The temperature of each dish
What is the mass of the rock?

A 335.6 g  
B 350.6 g  
C 354.6 g  
D 356.0 g

The picture shows the results of putting a drop of orange ink from a marking pen on a piece of filter paper and allowing the colors in the ink to separate. About how much farther on the filter paper has the yellow pigment moved than the red pigment?

A 0.5 cm  
B 1.6 cm  
C 2.7 cm  
D 3.5 cm

Note that due to varying printer properties, measurement items may not appear in exact proportions.

Crickets chirp to attract other crickets. The temperatures and rates of their chirping are graphed above. Which statement below is most likely true for the data represented in the graph?

A The cooler the temperature, the louder the crickets chirp.  
B The crickets cannot chirp at temperatures lower than 10°C.  
C The warmer the temperature, the more often crickets chirp.  
D The temperature and the chirping of crickets are not related.
What is the mass of this object? Round the answer to the nearest tenth.

573.5 g

SOL LS.2

The student will investigate and understand that all living things are composed of cells. Key concepts include

a) cell structure and organelles;
b) similarities and differences between plant and animal cells;
c) development of cell theory; and
d) cell division.

The concepts developed in this standard include the following:

- The structure of a cell organelle is suited for the function carried out by that organelle. Division of labor within a cell is essential to the overall successful function of the cell.

Below are diagrams of typical plant and animal cells. The functions of the organelles are listed on the vocabulary page.

Plant Cell

Animal Cell

- Similarities and differences in plants and animals are evident at the cellular level. Plant and animal cells contain some of the same organelles and some that differ.
Schleiden said that plants are composed of cells.

Schwann stated that animals are composed of cells.

Virchow stated that all cells come from pre-existing cells.

The original cell theory includes the following components: a) all living things are composed of cells; b) cells are the smallest unit (structure) of living things that can perform the processes (functions) necessary for life; and c) living cells come only from other living cells. (Although it is appropriate for students at this level to understand the three points of the original cell theory, an exploration of the revised cell theory should be reserved for high school Biology.)

- The development of the original cell theory can be attributed to the major discoveries of many notable scientists. The development of the cell theory has been dependent upon improvements in the microscope and microscopic techniques throughout the last four centuries.

- Hooke discovered plant cells -- more precisely, what Hooke saw were the cell walls in cork tissue. In fact, it was Hooke who came up with the word “cells.”
- Continuing advances in microscopes and instrumentation have increased the understanding of cell organelles and their functions. Many of these organelles can now be observed with a microscope (light, electron).
Van Leeuwenhoek used his handcrafted microscope to observe cells.

Cells go through a life cycle known as the cell cycle. The phases of the cell cycle are interphase, mitosis, and cytokinesis. (Although it is appropriate for students at this level to learn to recognize the stages of the cell cycle and mitosis, an exploration of the individual stages of meiosis may be reserved for high school Biology.)

- The purpose of mitosis is to produce new cells for growth, development, and repair that are identical to the parent cell. The purpose of meiosis is to produce reproductive (sex) cells that carry half the genetic material of the parent.

The diagram below shows the difference between the cycle with mitosis and the cycle with meiosis.
1. Robert Hooke looked at a piece of cork under a microscope. The little boxes he saw in the cork are called —
A cells
B genes
C nuclei
D chromosomes

2. Chloroplasts are found only in organisms that are able to —
A generate their own energy
B grow to a larger size
C migrate to other ecosystems
D hunt for prey

7. Which of the following do typical plant cells have that typical animal cells do not?
A Cytoplasm
B Nuclei
C Mitochondria
D Chloroplasts

11. Which of the following do typical animal cells have that typical plant cells do not?
A Cell membrane
B Vacuole
C Cytoplasm
D Nucleus

12. The function of a cell nucleus is to —
A direct the activities of the cell
B help the cell expel waste
C digest foreign substances
D transport substances around the cell

43. During mitosis, the doubling of chromosomes ensures that both new cells —
A have identical genetic makeup
B are twice the size of the parent cell
C serve different functions
D remain attached to each other
Standard LS.3

The student will investigate and understand that living things show patterns of cellular organization. Key concepts include

a) cells, tissues, organs, and systems; and
b) patterns of cellular organization and their relationship to life processes in living things.

The concepts developed in this standard include the following:

- Cells that have the same function group together to form tissues. Tissues that have the same function group together to form organs. Organs with similar functions group to work together in an organ system.
- Unicellular organisms are made of only one cell. Multicellular organisms are made of many cells.
Below are examples of unicellular and multi-cellular organisms.

Unicellular organisms include bacteria and some protists.

Multi-cellular organisms include fungi, plants, and animals.

- Multicellular organisms exhibit a hierarchy of cellular organization. They are complex in that there is a division of labor among the levels of this hierarchy for carrying out necessary life processes.

The levels of organization include:

Cells → Tissues → Organs → Systems → Organism
- Cells perform numerous functions and processes including cellular respiration, waste breakdown and removal, growth and division, and cellular transport.
- Diffusion is the passive transport of substances other than water across a cell membrane. Osmosis is the passive transport of WATER molecules across a cell membrane. Cell membranes are selectively permeable to various substances. (A discussion of facilitated diffusion, tonicity, and active transport should be reserved for high school Biology.)
- To be considered living something must have all of the following characteristics: organization, growth/development, reproduction, response to stimuli, use of energy, and homeostasis.
- Living things carry out life processes including ingestion, digestion and removal of waste, stimulus response, growth and repair, gas exchange, and reproduction.
- Numerous factors can strongly influence the life processes of organisms.

<table>
<thead>
<tr>
<th>CELLULAR PROCESS</th>
<th>DESCRIPTION/DEFINITION</th>
<th>PICTURE/DIAGRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffusion</td>
<td>Process where molecules move from higher to lower concentration. Main method by which small molecules move across the cell membrane</td>
<td><img src="image" alt="Diffusion Diagram" /></td>
</tr>
<tr>
<td>Osmosis</td>
<td>The diffusion of water across a cell membrane</td>
<td><img src="image" alt="Osmosis Diagram" /></td>
</tr>
<tr>
<td>Active Transport</td>
<td>Cellular transport that requires the use of cellular energy and transport proteins (Ex. endocytosis &amp; exocytosis)</td>
<td><img src="image" alt="Active Transport Diagram" /></td>
</tr>
<tr>
<td>Passive transport</td>
<td>Cellular transport that does not require the use of cellular energy. Two examples are diffusion and osmosis</td>
<td><img src="image" alt="Passive Transport Diagram" /></td>
</tr>
<tr>
<td>Cellular respiration</td>
<td>The process by which cells break down simple food molecules to release the energy they contain. (Raw materials are glucose and oxygen. The products are carbon dioxide and water. Energy is also released.)</td>
<td><img src="image" alt="Cellular Respiration Diagram" /></td>
</tr>
</tbody>
</table>
1. Human sweat is the direct result of which life functions?
   A Respiration and cellular growth
   B Digestion and disease prevention
   C Reproduction and cellular transport
   **D Waste removal and temperature control**

2. Which gas do animals need to carry out life processes?
   A Oxygen
   B Carbon monoxide
   C Helium
   D Carbon dioxide

21. **Cells → Tissues → Organs → ?**

   What is next in this series?
   A Habitats
   B Organisms
   C Systems
   D Organelles

22. Which level of organization below is the most basic or primary level of organization?
   A Cell
   B Tissue
   C Organ
   D Organ system

**LS.4** The student will investigate and understand how organisms can be classified. Key concepts include
   a) the distinguishing characteristics of domains of organisms;
   b) the distinguishing characteristics of kingdoms of organisms;
   c) the distinguishing characteristics of major animal phyla and plant divisions; and
   d) the characteristics that define a species.

The concepts developed in this standard include the following:
- Information about physical features and activities is arranged in a hierarchy of increasing specificity. The levels in the accepted hierarchy include domain, kingdom, phylum, class, order, family, genus and species.
As can be seen from the table above there are seven major levels of classification. At the lowest level is the species name. Organisms are usually referred to by their genus and species name together. Always written with the genus capitalized, the species name lower case and in italics, *Aeshna eremite* (genus and species name for a lake darner.) This is unique to that type of organism.

- Current classification systems now generally recognize the categorization of organisms into three domains, Archaea, Bacteria and Eukarya.
- As living things are constantly being investigated, new attributes (physical and chemical) are revealed that affect how organisms are placed in a standard classification system. This system is the basis for scientific binomial nomenclature.
- Any grouping of organisms into domains or kingdoms is based on several factors, including the presence or absence of cellular structures, such as the nucleus, mitochondria, or a cell wall; whether the organisms exist as single cells or are multicellular; and how the organisms get their food. For example, simple, single-celled organisms that are able to survive in extreme environments are believed to be fundamentally different from other organisms and may be classified in their own domain (Archaea). Four different kingdoms of the Eukarya domain of organisms are generally recognized by scientists today (Protista, Fungi, Plants, and Animals).
Some important animal groups (phyla) are the cnidarians, mollusks, annelids, arthropods, echinoderms, and chordates.

**Important Animal Groups**

**Examples of Cnidarians**

- Jellyfish
- Coral Reef
- Sea Anemone

**Examples of Mollusks**

- Squid
- Octopus
- Clams
Examples of Annelids

Earthworms

Leeches

Christmas Tree Worm

Examples of Arthropods: These animals have an exoskeleton

Spiders

Insects

Centipede

Examples of Echinoderms

Starfish

Sea Urchin

Sand Dollar

Examples of Chordates: These animals have a notochord, which is a hollow nerve cord

Fish

Amphibans

Reptiles

Birds

Mammals
• Four important plant groups (divisions) are the mosses, ferns, conifers, and flowering plants.

Four Important Plant Groups

Mosses    Ferns    Gymnosperms    Angiosperms

• A group of similar-looking organisms that can interbreed under natural conditions and produce offspring that are capable of reproduction defines a species.

1. Which characteristic allows frogs to be classified differently from squid, snails, and jellyfish?
   A Frogs are predators.
   B Frogs breathe oxygen.
   C Frogs have backbones.
   D Frogs live on land.

6. Which of the following classification groups contains organisms that have the most characteristics in common?
   A Kingdom
   B Phylum
   C Class
   D Species

25. Sponges are classified as animals because they cannot —
   A move from place to place
   B make their own food
   C get rid of waste products
   D catch their own food

The sea urchin shown has radial symmetry. This means that its body parts are —
   A equally arranged around a central point
   B designed to function in seawater
   C likely to be reformed if any part of the body is damaged
   D able to function on land and in the water
Which of these best enables this animal to rid its body of excess heat in a hot desert environment?

A  Its large ears  
B  Its flexible feet  
C  Its sandy color  
D  Its fur

<table>
<thead>
<tr>
<th>Sea Lions</th>
<th>True Seals</th>
</tr>
</thead>
<tbody>
<tr>
<td>external ears</td>
<td>no external ears</td>
</tr>
<tr>
<td>hind flippers can</td>
<td>hind flippers do not</td>
</tr>
<tr>
<td>turn forward</td>
<td>turn forward</td>
</tr>
<tr>
<td>swim with front</td>
<td>swim with hind</td>
</tr>
<tr>
<td>flippers</td>
<td>flippers</td>
</tr>
<tr>
<td>soles of flippers</td>
<td>flippers fully turre</td>
</tr>
</tbody>
</table>
LS.5 The student will investigate and understand the basic physical and chemical processes of photosynthesis and its importance to plant and animal life. Key concepts include:

a) energy transfer between sunlight and chlorophyll;

b) transformation of water and carbon dioxide into sugar and oxygen; and

c) photosynthesis as the foundation of virtually all food webs.

The concepts developed in this standard include the following:

- Chlorophyll is a chemical in chloroplasts that can absorb or trap light energy. Photosynthesis takes place in chloroplasts, which are found in the cells of the plant's leaf. These chloroplasts contain a chemical known as chlorophyll. Chlorophyll gives plants their green color, and allows plants to capture energy from the sun.

Leaves: Plant Leaf Cells contain Chloroplasts

- Photosynthesis is the necessary life process that transforms light energy into chemical energy. It involves a series of chemical reactions in which the light energy is used to change raw materials (carbon dioxide and water) into products (sugar and oxygen). The energy is stored in the chemical bonds of the glucose (sugar) molecules.
Photosynthesis

Photosynthesis is a process in which green plants use energy from the sun to make water, carbon dioxide, and minerals into oxygen and organic compounds. It shows how people and plants are dependent on each other in sustaining life.

Equation for Photosynthesis

Using the molecular formula names

\[ 6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2 \]

Using words

6 Carbon Dioxide molecules + 6 Water molecules + Light \(\rightarrow\) 1 Glucose (sugar) molecule + 6 Oxygen gas molecules

- Plants perform cellular respiration as well as photosynthesis.

- Plants convert the sugars they produce into other raw materials that are used by plants and animals for growth, repair, and energy needs.

- Energy is a basic need of all living things. Photosynthesizing organisms obtain their energy from the sun and are often called producers because of their ability to produce glucose (sugar).

- Photosynthesizing organisms are the foundation of virtually all food webs.
1. **PHOTOSYNTHESIS**

\[ \text{carbon dioxide} + \text{water} \xrightarrow{\text{light energy}} \text{glucose} + ? \]

The equation for photosynthesis is shown. Which of these is required to complete the equation for photosynthesis?

A. Carbon  
B. Oxygen  
C. Nitrogen  
D. Hydrogen

2. **Chloroplasts are found only in organisms that are able to**

A. generate their own energy  
B. grow to a larger size  
C. migrate to other ecosystems  
D. hunt for prey
11 What process makes food for plants?

A Reproduction
B Photosynthesis
C Respiration
D Condensation

42 When plants undergo photosynthesis, they produce —

A carbon dioxide
B oxygen
C hydrogen
D nitrogen

3 A plant’s green color is due to the presence of which organelle?

A Chloroplast
B Nucleus
C Mitochondrion
D Vacuole

35 Which of the following is produced as a result of photosynthesis?

A Heat
B Water
C Oxygen
D Carbon dioxide
LS.6

The student will investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment. Key concepts include:

- a) the carbon, water, and nitrogen cycles;
- b) interactions resulting in a flow of energy and matter throughout the system;
- c) complex relationships within terrestrial, freshwater, and marine ecosystems; and
- d) energy flow in food webs and energy pyramids.

The concepts developed in this standard include the following:

- Many important elements and compounds cycle through the living and nonliving components of the environment as a chain of events that continuously repeats.

The three cycles of matter in nature include the carbon, water, and nitrogen cycles.

**Carbon Cycle**

![Carbon Cycle Diagram](image)

Plants use carbon dioxide and sunlight to make their own food and grow during the process of photosynthesis. The carbon becomes part of the plant. Once the plants die, they turn into fossil fuels made of carbon like coal and oil over millions of years. When humans burn fossil fuels or clear forests for crops, most of the carbon quickly enters the atmosphere as carbon dioxide.

**Water Cycle**

![Water Cycle Diagram](image)
Nitrogen Cycle

The air is made up of about 78% nitrogen gas, but we cannot use it. Nitrogen moves from the air to the soil into living things and back into the air. The process of changing free nitrogen into a usable form of nitrogen is called nitrogen fixation. Most nitrogen fixation is performed by certain kinds of bacteria, which are found in special plants.

- Materials are recycled and made available through the action of decomposers.

Decomposers

The two main types of decomposers found in nature are bacteria and fungi. They break down dead plants and animals. Decomposers need to eat some of the dead things so they can live and grow. The tiny pieces left over after decomposers eat become part of the soil. Living plants take what they need from these pieces so they can grow. The parts of these pieces that living plants take to grow are called nutrients.
In order to understand how an ecosystem functions, one must understand the concept of a system and be able to envision models of systems.

To analyze the interactions resulting in a flow of energy and matter throughout the ecosystem, one must identify the elements of the system and interpret how energy and matter are used by each organism.

Energy enters an ecosystem through the process of photosynthesis and is passed through the system as one organism eats and is, in turn, eaten. This energy flow can be modeled through relationships expressed in food webs.

This is an example of a food chain. If you follow the arrows, each organism eats the other for food.

**Food Webs**

A food web is a graphic display of interrelated food chains within an environment. In a food web, begin with the producer (a plant) and follow the arrows to the consumers (the animal that eats the plant or another animal).
This example of a food web contains many food chains.

**Example 1:** Snakes eat insectivorous birds that first eat spiders which first eat herbivorous insects which first eat the plants.

plants → insects → spiders → birds → snakes

**Example 2:** Hawks eat the rabbits that first eat the plants.

plants → rabbits → hawks

This is another example of a food web. If you follow the arrows starting at the bottom with producers (blossoms, nuts, bark, leaves), then the animals are the consumers because they eat other consumers or the producers. Each step up an arrow is considered a trophic level. (1st, 2nd and 3rd)

- The amount of energy available to each successive trophic level (producer, first-order consumer, second-order consumer, third-order consumer) decreases. This can be modeled through an energy pyramid, in which the producers provide the broad base that supports the other interactions in the system.

**Energy Pyramid**

In the energy pyramid above, the following terms are synonyms:

First-order Consumer= Primary Consumer
Second-Order Consumer=Secondary Consumer
Third-Order Consumer=Tertiary Consumer

Notice that there is more energy available at the producer level.
SOL LS.6 (Cycles, Relationships, and Energy Flow of Ecosystems)

17. Marine Food Chain

```
Orca
↑
Sea otter
↑
Fishes
↑
Seaweed
```

What is the role of the Orca in this food chain?
A. Producer
B. First-order consumer
C. Second-order consumer
D. Third-order consumer

35. Organisms that absorb nutrients from dead plants and animals are called —
A. carnivores
B. decomposers
C. herbivores
D. producers

47. Which of the organisms in a forest ecosystem is an example of a producer?
A. Squirrels
B. Oak trees
C. Black bears
D. Bacteria

49. In this food web, which organism has the greatest number of food sources?
A. Snake
B. Hawk
C. Shrew
D. Mouse

In the food web shown, which of the following consumers eats only producers?
A. Hawk
B. Owl
C. Fox
D. Mouse
Which concept is best illustrated by this diagram?

A  The exchange of CO₂ and O₂ in an ecosystem
B  The effect of limiting factors in a biome
C  Cycling of nutrients in a community
D  Environmental pressures on a population

Each numbered circle represents a process in the water cycle. Identify the numbered processes of the water cycle in this diagram.

The Water Cycle

Processes in the Water Cycle

1. Precipitation
2. Evaporation
3. Condensation
4. Surface Runoff

Directions: Type your answer in the answer box.

How many first-order consumers are in this food web?
Standard LS.7

The student will investigate and understand that interactions exist among members of a population. Key concepts include

a) competition, cooperation, social hierarchy, territorial imperative; and

b) influence of behavior on a population.

The concepts developed in this standard include the following:

- Individual members of a population interact with each other. These interactions include competing with each other for basic resources, mates, territory, and cooperating with each other to meet basic needs.

**Competition**

In their search for food, animals are in competition with others in their own species, as well as those in other species. This is especially an issue if food is in short supply. Typically, animals find food on the basis of their own performance, plus some luck. In some cases, they battle head-on-head for possession of the same food. There are also cases where animals will take food that belongs to another or even eat the other animal as food.
Cooperation

Lions hunt some of the largest prey on Earth, including buffalo and wildebeest. Part of their terrific success as predators comes from the fact that they cooperate in their kills. Lions live in social groups called prides, and all members work together in the hunt.

Orcas or killer whales also hunt cooperatively and live in groups.

- The establishment of a social order in a population may ensure that labor and resources are adequately shared.
- The establishment of a territory ensures that members of a population have adequate habitat to provide for basic resources.
Social Order and Territory
Wolves are an example of animals that have a very complex social structure. The wolf is a territorial animal with boundaries patrolled and defended by all adult members of the pack. Territories vary greatly in size, from 10 to 20 square miles up to more than 5,000 square miles, depending on the abundance and availability of prey.

Highly social animals, gray wolves form packs of from 2 to 12 individuals, influenced by the abundance of prey. The social structure within the pack is a strict hierarchy based primarily on submission to the strongest male. Younger individuals always seek to improve their status within the group and are ready to assert themselves as soon as an older wolf shows any signs of weakness. Within the pack structure, only the dominant male and female wolves, designated as "alpha" individuals, are likely to breed. Their aggressive behavior keeps other members of the pack from mating, ensuring the best chance of survival for the leader’s pups.

- Individual behaviors and group behaviors can influence a population.

Animal Communication
Animals living on their own and within groups all have ways of communicating. Below are the main examples of how they communicate.

<table>
<thead>
<tr>
<th>Method</th>
<th>Pheromones (Chemicals/Scents)</th>
<th>Making Noises (Sound)</th>
<th>Body Language (Sight)</th>
<th>Touching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples of Animals</td>
<td>Skunk, Moth, Deer</td>
<td>Secadas, Whales, Tigers</td>
<td>Peacock, Bears, Rabbits</td>
<td>Birds, Bees</td>
</tr>
</tbody>
</table>

Pheromones are chemicals released by living organisms that send information to other organisms of the same species via scent. These pheromones are released in response to stress, alarm, danger, and sexual fertility. They are released by both insects and mammals in many situations.
Examples of Other Animal Communication Methods

Animals communicate by sound, such as a tiger’s roar. But the roar can mean different things. It could mean “Get Away” or “Let’s Play.” It all depends on the tone and volume of the roar.

Rabbits are territorial animals. They use scent to mark their territory and to communicate with other rabbits. Rabbits also communicate by body language.

Honey bees communicate with one another by "dancing". A honey bee worker who has found a rich food source, when she returns to her colony, will perform a "dance" which contains information about the distance and direction to the food source. This dance sometimes include touching. Touching is sometimes related to body language.

- Animals exhibit needs for food, water, gases, shelter and space for which they compete. These needs may often be met in a range of conditions. Too much may be as harmful as too little (e.g., too much food or too little water).

SOL LS.7 (Interactions of Populations)

38 Lions usually live in prides made up of a few adult females, an adult male, and some younger lions. The females hunt together and the kill is shared with the pride. The lions’ method of hunting best illustrates —

A cooperation
B competition
C territoriality
D parasitism
The student will investigate and understand interactions among populations in a biological community. Key concepts include

a) the relationships among producers, consumers, and decomposers in food webs;
b) the relationship between predators and prey;
c) competition and cooperation;
d) symbiotic relationships; and
e) niches.

The concepts developed in this standard include the following:

- Organisms or populations that rely on each other for basic needs form interdependent communities.
- Energy resources of a community are shared through the interactions of producers, consumers, and decomposers.
- The interaction between a consumer that hunts for another consumer for food is the predator-prey relationship.

**Predator-Prey Relationships**

A predator is an organism that eats another organism. The prey is the organism which the predator eats. Some examples of predator and prey are lion and zebra, bear and fish, and fox and rabbit. The words "predator" and "prey" are almost always used to mean only animals that eat animals, but the same concept also applies to plants: Bear and berry, rabbit and lettuce, grasshopper and leaf.

Lion and Zebra
The prey is part of the predator's environment, and the predator dies if it does not get food, so it adapts to whatever is necessary in order to eat the prey: speed, stealth, camouflage (to hide while approaching the prey), a good sense of smell, sight, or hearing (to find the prey), immunity to the prey's poison, poison (to kill the prey), the right kind of mouth parts or digestive system, etc. Likewise, the predator is part of the prey's environment, and the prey dies if it is eaten by the predator, so it adapts to whatever is necessary to avoid being eaten: speed, camouflage (to hide from the predator), a good sense of smell, sight, or hearing (to detect the predator), thorns, poison (to spray when approached or bitten), etc.

- In a community, populations interact with other populations by exhibiting a variety of behaviors that aid in the survival of the population.
- Organisms may exist as members of a population; populations interact with other populations in a community.
- Populations of one species may compete with populations of other species for resources. Populations of one species may also cooperate with populations of other species for resources.
- A symbiotic relationship may exist between two or more organisms of different species when they live and work together.
- Symbiotic relationships include mutualism (in which both organisms benefit), commensalism (in which one organism benefits and the other is unaffected), and parasitism (in which one organism benefits and the other is harmed).

### Symbiotic Relationships

#### Mutualism

In this interaction, the flower becomes pollinated by the bee while the bee is able to receive food from the flower.

#### Commensalism

In this relationship, the bird is able to benefit from the cow but the cow is not affected by the bird.
Parasitism

In this relationship, the flea is feeding on the cat. The flea is having a "great" time, while the cat's body is affected negatively.

- Each organism fills a specific role or niche in its community.

Niche

Think of a niche as a job someone (human) might have. This farmer's niche or "job" in the community is to plant crops.

Animals also have niches within their ecosystem. Some organisms' niche is to act as predator or prey in the community. A worm's niche is to decompose organic material.
Which of these best describes a relationship shown by this African energy pyramid?

A  The lion is a predator of the giraffes.
B  The lion is the prey of the giraffes.
C  Giraffes are the prey of the trees.
D  Giraffes are predators of the lion.

A tapeworm lives in human intestines, absorbing the nutrients that would normally be absorbed by the person. This eventually causes the person health problems. The relationship between the tapeworm and the human is —

A  parasite/host
B  predator/prey
C  herbivore/omnivore
D  consumer/producer

The picture shows a pond ecosystem. What would most likely happen if all the lily plants were removed from this community?

A  There would be more oxygen in the air.
B  The pond water currents would be slower.
C  There would be more kinds of animals in the pond.
D  The animals would have fewer places to hide.

A tick that feeds on the blood of animals is a —

A  predator
B  host
C  competitor
D  parasite
Standard LS.9
The student will investigate and understand how organisms adapt to biotic and abiotic factors in an ecosystem. Key concepts include

a) differences between ecosystems and biomes;
b) characteristics of land, marine, and freshwater ecosystems; and
c) adaptations that enable organisms to survive within a specific ecosystem.

The concepts developed in this standard include the following:

• The living organisms within a specific area and their physical environment define an ecosystem.
• Characteristics of land, marine, and freshwater ecosystems vary with respect to biotic and abiotic factors.
• The major terrestrial ecosystems are classified into units called biomes — large regions characterized by certain conditions, including a range of climate and ecological communities adapted to those conditions.
• Organisms have specific structures, functions, and behaviors that enable them to survive the biotic and abiotic conditions of the particular ecosystem in which they live.
• Organisms possess adaptations to both biotic and abiotic factors in their ecosystem that increase their chance of survival.

Biomes: Deserts

Deserts get less than 25 cm of rain per year. Plants grow far apart with deep roots (cacti). Animals are active at night. They have very hot temperatures.

Temperate Deciduous Forest

A temperate deciduous forest has fertile soil. It is the major biome in Virginia, North Carolina, South Carolina, Georgia. They have warm and cool seasons, trees with leaves that fall off in autumn.
Coniferous Forest

A coniferous forest is made up of evergreen trees (pine trees). It has a cold climate and a short summer. There is plenty of rain and snow.

Tropical Rain Forest

A tropical rain forest is hot and moist, near the equator with thin and poor soil. There is lots of precipitation. This biome has the highest number of species.
Grassland

A grassland has deep rich soil with lots of grass for grazing herbivores. There are scattered clumps of trees. It has a wet and dry season. Fires are common.

Tundra

Permafrost is the permanently frozen ground below the soil surface in the arctic tundra. Mosses and lichen are common plants. There are very few trees. Plants have shallow roots and temperature is extremely cold.

Freshwater Biomes
**Ponds and Lakes have 3 zones:**
1. Littoral (closest to land)
2. Open-water (top of water, far as sunlight can reach)
3. Deep-water (no light)

**Wetlands**

Wetlands are land areas where water is near or at the surface for most of the year. They help to control flooding and prevent erosion.

**Two most common types of wetlands:**
1. Swamp (bald cypress trees and willows)
2. Marsh (treeless, contains grass and low-lying plants)
**SOL LS.9 (Ecosystems and Biomes)**

**35** For separate ecosystems to be classified as the same type of biome, they must —

- A. have deciduous forests
- B. be located along the equator
- C. have similar organisms and climates
- D. be at least one hundred square meters in area

**47** Which of the organisms in a forest ecosystem is an example of a producer?

- A. Squirrels
- B. Oak trees
- C. Black bears
- D. Bacteria

**20** Which biome contains large populations of grazing herbivores, few species of birds, and deep, rich soil?

- A. A taiga
- B. A tundra
- C. A deciduous forest
- D. A grassland

**39** Which of the following are characteristics of the most productive ecological environment?

- A. Stable temperatures and high rainfall amounts
- B. Hot temperatures and low rainfall amounts
- C. Cold temperatures and low rainfall amounts
- D. Low temperatures and high rainfall amounts

**50** In which of the following environments would you expect to find the greatest number of different species of plants and animals per square mile?

- A. An island near the South Pole
- B. A wheat field in North Dakota
- C. A pasture on a Virginia farm
- D. A tropical rain forest in Panama

---

**Diagram**

The picture shows a pond ecosystem. What would most likely happen if all the lily plants were removed from this community?

- A. There would be more oxygen in the air.
- B. The pond water currents would be slower.
- C. There would be more kinds of animals in the pond.
- D. The animals would have fewer places to hide.
Standard LS.10

The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic, change over time, and respond to daily, seasonal, and long-term changes in their environment. Key concepts include

a) phototropism, hibernation, and dormancy;
b) factors that increase or decrease population size; and
c) eutrophication, climate changes, and catastrophic disturbances.

The concepts developed in this standard include the following:

- Organisms may exist as members of a population; populations interact with other populations in a community; and communities together with the physical environment form ecosystems.

- Changes that affect organisms over time may be daily, seasonal, or long term.

- Plants may respond to light by growing toward it or away from it, a behavior known as phototropism.

  Animals may respond to cold conditions with a period of lowered metabolism, a behavior known as hibernation. A bear may respond to very cold temperatures by hibernating.

- Organisms may respond to adverse conditions with a period of lowered or suspended metabolism, a behavior known as dormancy. Plants and animals can do this.
Plants have a period of dormancy in which their growth stops. It helps the plant to survive freezing temperatures and lack of water.

- A variety of environmental factors may cause the size of a population to increase or decrease. (This requires students to brainstorm examples of factors and predict the possible effects.)

- Long-term changes may affect entire communities and ecosystems. Such large-scale changes include the addition of excess nutrients to the system (eutrophication), which alters environmental balance; dramatic changes in climate; and catastrophic events, such as fire, drought, flood, and earthquakes.

- Migrations during the seasons of the year occur in many species of animals. These migrations often provide the animals with more favorable conditions of temperature, living space, food, and/or water.
Thrips are tiny insects that can easily be seen on roses. The thrip population changes shown in the graph above are probably caused by —

A. increases in human population
B. a major climatic change
C. seasonal changes
D. increased use of insecticides

Lemmings are small mammals that experience a population explosion about once every four years. Snowy owls eat lemmings. Which of these statements is supported by the data in this graph?

A. The snowy owls are becoming extinct.
B. Lemmings live much longer than snowy owls.
C. The habitat of the lemmings is continuously decreasing in size.
D. The snowy owl population increases because of an increase in lemmings.

Northern garter snakes exhibit a unique behavior in which they gather in deep dens by the hundreds or thousands. They then coil together in a huge ball. This behavior could help to —

A. reduce heat loss
B. increase camouflage
C. locate food sources
D. increase oxygen consumption

When animals hibernate, their heart rate and respiration decrease and they lose consciousness. Why do some animals hibernate?

A. To increase their body fat during cold periods
B. To conserve energy usage during the winter
C. To give their fur time to grow longer and thicker
D. To rest after a summer of high activity
The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include:

- a) food production and harvest;
- b) change in habitat size, quality, or structure;
- c) change in species competition;
- d) population disturbances and factors that threaten or enhance species survival; and
- e) environmental issues.

The concepts developed in this standard include the following:

- Ecosystems are dynamic systems. Humans are a natural part of the ecosystem. Humans use the ecosystem to meet their basic needs, such as to obtain food.
- Human interaction can directly alter habitat size, the quality of available resources in a habitat, and the structure of habitat components. Such interactions can be positive and/or negative.

<table>
<thead>
<tr>
<th>Human Interactions and Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive</strong></td>
</tr>
<tr>
<td>Planting Trees</td>
</tr>
<tr>
<td>National Parks</td>
</tr>
<tr>
<td>Laws Protecting Endangered Species</td>
</tr>
<tr>
<td>Captive Breeding</td>
</tr>
<tr>
<td>Wildlife Refuges</td>
</tr>
<tr>
<td>Reusing and Recycling</td>
</tr>
<tr>
<td><strong>Negative</strong></td>
</tr>
<tr>
<td>Construction of Businesses</td>
</tr>
<tr>
<td>Littering</td>
</tr>
<tr>
<td>Cutting Down Trees</td>
</tr>
<tr>
<td>Coal Mining</td>
</tr>
<tr>
<td>Overfishing</td>
</tr>
<tr>
<td>Transportation</td>
</tr>
</tbody>
</table>

Below you will find an explanation of some of the activities above.

**Captive breeding** provides a means for conserving species that may not survive in the wild. Captive populations are established for many reasons, such as conservation education, exhibit of interesting species, and research. Establishing captive populations for saving species from extinction is an important contribution of zoos to conservation.

Many species have been saved from extinction because of captive breeding programs. Examples include Black-footed Ferrets, Guam rails, and Dama Gazelle.
**Overfishing** occurs when fishing activities reduce fish below an acceptable level. This may occur in any body of water. It can also be caused by pollution and global warming.

- Human input can disturb the balance of populations that occur in a stable ecosystem. These disturbances may lead to a decrease or increase in a population. Since populations in an ecosystem are interdependent, these disturbances have a ripple effect throughout the ecosystem.

- The interaction of humans with the dynamic ecosystem may lead to issues of concern for continued ecosystem health in areas such as water supply, air quality, energy production, and waste management.

**Water Concerns**
Water conservation is a cost effective and environmentally friendly way to reduce organism’s demand for water. This also stretches our supplies further and saves places like ponds, lakes, and rivers. Saving water also saves energy usage.

Water pollution can be caused by acid rain, runoff from chemicals used in fields, waste, and algae.
Air Quality and Energy Production Concerns

The above picture is a nuclear power plant which causes pollution to the earth by the production of toxic waste.

Global warming can be caused by pollution from cars and from factories. Global warming relates to changes in the climate and the lower level of the atmosphere over a long period of time. Global warming can have many different causes, but it is most commonly associated with the release of excessive amounts of gases such as carbon dioxide. Some of the devastating effects of global warming include excessive heat and lack of precipitation.

Waste Management Concerns

Most of our trash waste ends up in a landfill like the one pictured above.
The following pictures show examples of hazardous waste. It also includes oil and batteries. Once these items are transported to landfills, they have the potential to pollute underground water sources.

Biodegradable waste usually comes from plant or animal sources. It can be broken down by other living organisms. Some examples include food waste, paper waste, sewage, and manure from horses.
According to the graph, which air pollutant decreased the most from 1970 to 1991?

A. Carbon monoxide
B. Sulfur oxides
C. Particulates
D. Lead

Which of these is a result of burning fossil fuels?

A. Acid rain
B. Clean water
C. Hydroelectric energy
D. Solar energy
8 The quality of air is monitored by the government to determine whether a city needs to take steps to control air pollution. To best measure air quality, the air should be tested —

A once a year on a day with very little vehicle traffic
B once a day during rush hour when the most cars are on the road
C several times a day in all kinds of weather
D at night when the air is probably less polluted

19 A group of people were concerned about a new coal-burning power plant that might be built in their neighborhood. What is probably their main concern?

A Burning coal produces more heat than burning wood.
B The heat from burning coal can drive generators that produce electricity.
C Burning coal produces sulfur dioxide which contributes to acid rain.
D There is more coal in the earth than there is oil and gas.

32 Items Collected in a Beach Cleanup

- Plastics 95,560
- Wood 4,160
- Metals 22,100
- Paper 10,340
- Styrofoam 19,280
- Glass 20,040

This chart represents the type and number of items collected in a beach cleanup. Based on the above chart, what percentage of the total items collected from the beaches was plastic?

A 46%
B 49%
C 56%
D 70%
The student will investigate and understand that organisms reproduce and transmit genetic information to new generations. Key concepts include

- the structure and role of DNA;
- the function of genes and chromosomes;
- genotypes and phenotypes;
- characteristics that can and cannot be inherited;
- genetic engineering and its applications; and
- historical contributions and significance of discoveries related to genetics.

The concepts developed in this standard include the following:

- DNA is a double helix molecule.
- DNA is a molecule that includes different components — sugars, nitrogenous bases, and phosphates. The arrangement of the nitrogenous bases within the double helix forms a chemical code.
- DNA is found in all living things. It carries the genetic code or hereditary information for living things. The diagrams below show the basic structure of DNA. It resembles a twisted ladder or a spiral staircase.
Chromosomes are strands of tightly wound DNA. Genes are sections of a chromosome that carry the code for a particular trait. An allele is an alternate form of a gene. The double helix structure of DNA allows it to be packed tightly within the chromosomes of living cells.
Bacteria have a single chromosome because they do not have a nucleus.

Other living things, such as plants and animals, have many chromosomes located within their nuclei (plural for nucleus).

Fruit Fly Chromosomes
- The basic laws of Mendelian genetics explain the transmission of most traits that can be inherited from generation to generation.
- A Punnett square is a model used to predict the possible combinations of inherited factors resulting from single trait crosses. (An investigation of dihybrid crosses, multiple alleles, and incomplete dominance should be reserved for high school Biology.)
- Dominant traits mask the expression (phenotype) of recessive traits. Genotype is the specific combination of dominant and recessive gene forms.
The diagram below shows the seven characteristics of pea plants studied by Mendel.

- Round or wrinkled ripe seeds
- Yellow or green seed interiors
- Purple or white petals
- Inflated or pinched ripe pods
- Axial or terminal flowers
- Green or yellow unripe pods
- Long or short stems

Mendel found these traits to be controlled by factors known as genes. Alleles are the different forms of a gene. An organism's traits are controlled by the alleles it inherits from its parents. Some alleles are dominant while other alleles are recessive.

- Traits that are expressed through genes can be inherited. Characteristics that are acquired through environmental influences, such as injuries or practiced skills, cannot be inherited.

**Examples of Inherited Traits**

- Attached and detached earlobes
- Widow's peak is dominant over straight hairline.
Examples of Acquired Traits

Some traits, like musical talents and athletic abilities, are considered to be acquired traits.

- In genetic engineering, the genetic code is manipulated to obtain a desired product.
- Genetic engineering has numerous practical applications in medicine, agriculture, and biology.

Examples of Genetic Engineering

Example 1

Gardeners sometimes make plants from small plant samples grown in test tubes. This method produces very large numbers of nearly identical plants from one individual plant with desired characteristics. This technique is extensively used in hundreds of laboratories around the world for example for generating disease-free banana plants, and has potential applications in forestry.
Example 2

The DNA coding for human insulin was isolated from a human. This piece of DNA is then inserted into a small ring of DNA called a plasmid. This allows the DNA to be transported into cells. Cells which have this plasmid inside them will act as a tiny factory making lots of insulin. This insulin can then be purified and given to diabetics.

A series of contributions and discoveries led to the current level of genetic science.

- Chemist Rosalind Franklin created images of DNA molecules using X-Ray diffraction.

James Watson and Francis Crick concluded that DNA molecules are a twisted ladder shape they named a double helix and made models to represent DNA’s structure.

Gregor Mendel studied pea plants, how their physical characteristics (traits) were passed from one generation to the next and he is known as the “Father of Genetics”
1. All of these can be inherited by people EXCEPT —
A height
B eye color
C blood type
D language

19 DNA is essential to living organisms because it —
A carries the genetic code
B is a spiral helix
C can prevent diseases
D can break apart

22 Which of these is due entirely to inheritance in humans?
A Reading skill
B Eye color
C Endurance
D Broken bones

27 Ranchers historically have used genetics to produce new varieties of cattle. Buffalo can tolerate both hot and cold temperatures but have meat that is not as tasty and tender as beef. Cattle that are subjected to severe temperature extremes produce meat that is neither tender nor good-tasting. What good qualities might a “beefalo” (cross between cattle and buffalo) possess?
A Animals that tolerate heat and cold but do not have good-tasting meat
B Animals with good-tasting meat but not tolerance to heat
C Animals that tolerate heat and cold and have good-tasting meat
D Animals that tolerate cold but do not have good-tasting meat
31 Mendel's early work with pea plants demonstrated a significant genetic discovery. The crossing of homozygous tall pea plants with homozygous short pea plants always resulted in tall plants and demonstrated that tallness in pea plants is a trait that is —

A blended
B dominant
C mutated
D recessive

44 Most of the hereditary information within the cell is carried in the —

A ribosomes
B vacuoles
C chromosomes
D Golgi bodies

2 Which type of characteristics can be inherited?

A Those controlled by genes
B Those caused by accidents
C Those produced by exercise
D Those produced by diet
The student will investigate and understand that populations of organisms change over time. Key concepts include:

a) the relationships of mutation, adaptation, natural selection, and extinction;

b) evidence of evolution of different species in the fossil record; and

c) how environmental influences, as well as genetic variation, can lead to diversity of organisms.

The concepts developed in this standard include the following:

- The mechanisms through which evolution takes place are a related set of processes that include mutation, adaptation, natural selection, and extinction. This results in changes in populations of organisms over time.

- Mutations are inheritable changes because a mutation is a change in the DNA code.

- Adaptations are structures, functions, or behaviors that enable a species to survive.

- Natural selection is the survival and reproduction of the individuals in a population that exhibit the traits that best enable them to survive in their environment.

- A mutation may result in a favorable change or adaptation in genetic information that improves a species' ability to exist in its environment, or a mutation may result in an unfavorable change that does not improve or impedes a species' ability to exist in its environment.

The evidence for evolution is drawn from a variety of sources of data, including the fossil record, radiometric dating, genetic information, the distribution of organisms, and anatomical and developmental similarities across species.
Individuals of a population each exhibit a range of variations in a trait as a result of the variations in their genetic codes. These variations may or may not help them survive and reproduce in their environment.

If a species does not include traits that enable it to survive in its environment or to survive changes in the environment, then the species may become extinct.
1. Otters have adaptive traits that allow them to survive by eating shellfish and crustaceans. If changes in biotic factors of the ecosystem result in reduced numbers of shellfish and crustaceans, the otters will most likely —

A experience a population decline
B adapt to a different ecosystem
C change the genetic makeup of their bodies
D increase reproduction rates

27 What most likely happened to species that are found in the fossil record but have no living members?

A They had offspring of a different species.
B They mutated to other species.
C They became extinct.
D They never really existed.

The diagram above shows the changes over time in the horse. Evidence for these changes most likely came from —

A carbon-dating
B hypotheses of scientists
C observations of modern horses
D the fossil record
<table>
<thead>
<tr>
<th><strong>scientific method/inquiry</strong></th>
<th>The processes used by scientists to study the world around them and carry out experiments to find possible explanations and solutions to what they observe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>hypothesis</strong></td>
<td>An educated guess that is used to predict the outcome of experiments; Written in “IF...,THEN...” format</td>
</tr>
<tr>
<td><strong>independent variable</strong></td>
<td>“Manipulated Variable” of an experiment-It is the item being tested or changed on purpose by the scientist or person conducting the experiment</td>
</tr>
<tr>
<td><strong>dependent variable</strong></td>
<td>“Responding Variable” of an experiment-the result, response, or outcome the is measured</td>
</tr>
<tr>
<td><strong>constants</strong></td>
<td>Items that remain the same throughout the experiment (EX. Same/equal quantities or types of substances/things)</td>
</tr>
<tr>
<td><strong>controls</strong></td>
<td>Group or part of the experiment that does not receive the item being tested (does not receive independent variable)</td>
</tr>
<tr>
<td><strong>observational studies</strong></td>
<td>Descriptive studies using the five senses that are intended to generate hypotheses</td>
</tr>
<tr>
<td><strong>investigational studies</strong></td>
<td>Experimental studies intended to test hypothesis</td>
</tr>
<tr>
<td><strong>SI/metric system</strong></td>
<td>The global system of measurements used all over the world</td>
</tr>
<tr>
<td><strong>gram</strong></td>
<td>The base unit in the SI system for measuring mass</td>
</tr>
<tr>
<td><strong>triple beam balance</strong></td>
<td>The scientific instrument/tool used for measuring mass</td>
</tr>
<tr>
<td><strong>meter</strong></td>
<td>The base unit in the SI system for measuring length/distance</td>
</tr>
<tr>
<td><strong>meter stick</strong></td>
<td>The scientific instrument/tool used for measuring length/distance</td>
</tr>
<tr>
<td><strong>liter</strong></td>
<td>The base unit in the SI system for measuring volume</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>graduated cylinder</td>
<td>The scientific instrument/tool used for measuring volume</td>
</tr>
<tr>
<td>Celsius</td>
<td>The base unit in the SI system for measuring temperature</td>
</tr>
<tr>
<td>thermometer</td>
<td>The scientific instrument/tool used for measuring temperature</td>
</tr>
<tr>
<td>SOL LS.2</td>
<td></td>
</tr>
<tr>
<td>mitosis</td>
<td>The stage during which the cell’s nucleus divides into two new nuclei: it involves four phases</td>
</tr>
<tr>
<td>meiosis</td>
<td>The process of cell division in which the number of chromosomes is reduced by half to form sex cells (sperm and eggs)</td>
</tr>
<tr>
<td>cell theory</td>
<td>The widely accepted explanation of the relationship between cells and living things: Involves 3 statements/parts</td>
</tr>
<tr>
<td>cell wall</td>
<td>The rigid layer of nonliving material that surrounds the cells of PLANTS and some unicellular organisms: it provides support and protection</td>
</tr>
<tr>
<td>cell membrane</td>
<td>The outside boundary of the cell that controls what substances enter and leave the cell: found in both plant and animal cells</td>
</tr>
<tr>
<td>cytoplasm</td>
<td>The jelly-like or substance within the cell which holds the organelles in place and provides structural support for the cell</td>
</tr>
<tr>
<td>nucleus</td>
<td>The control center of the cell; it directs all cellular activities and stores genetic information in the form of chromosomes</td>
</tr>
<tr>
<td>vacuole</td>
<td>Stores water, food, waste products, and other materials for the cell: It is much larger in the plant cell.</td>
</tr>
<tr>
<td>mitochondria</td>
<td>Breaks down food molecules to release energy for the cell: often called the “powerhouse” of the cell</td>
</tr>
<tr>
<td>endoplasmic reticulum (ER)</td>
<td>A network of passageways that carries materials from one part of the cell to another: Also functions in the production of lipids for the cell</td>
</tr>
<tr>
<td><strong>endoplasmic reticulum (ER)</strong> (rough)</td>
<td>A network of passageways that carries materials from one part of the cell to another: Had ribosomes embedded or attached to it</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>chloroplast</strong></td>
<td>A structure in <strong>PLANT</strong> cells that captures energy from sunlight and uses it to produce food (glucose) during the process of photosynthesis</td>
</tr>
<tr>
<td><strong>lysosomes</strong></td>
<td>Small organelles in <strong>ANIMAL</strong> cells that break down food particles and worn-out cell parts and rids the cell of foreign invaders: known as the “clean-up crew”</td>
</tr>
<tr>
<td><strong>Golgi bodies (apparatus)</strong></td>
<td>Receives materials from the ER and send them to other parts of the cell: also release materials outside the cell</td>
</tr>
<tr>
<td><strong>ribosomes</strong></td>
<td>Small organelles that produce proteins: Ribosomes may be found in the cytoplasm or attached to the rough ER.</td>
</tr>
<tr>
<td><strong>cell cycle</strong></td>
<td>The regular sequence of growth and division the cells undergo</td>
</tr>
<tr>
<td><strong>interphase</strong></td>
<td>The first stage of the cell cycle that takes place before division occurs: During this stage the cell grows to its mature size and makes a copy of its DNA</td>
</tr>
<tr>
<td><strong>cytokinesis</strong></td>
<td>The final stage of the cell cycle, in which the cell’s cytoplasm divides producing two new cells.</td>
</tr>
<tr>
<td><strong>cell plate</strong></td>
<td>A structure that forms across the middle of <strong>PLANT</strong> cells during cytokinesis: It gradually develops into new cell membranes</td>
</tr>
</tbody>
</table>

**SOL LS.3**

<table>
<thead>
<tr>
<th><strong>unicellular organism</strong></th>
<th>A living organism made up of only one cell (Ex. Bacteria and protists)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>multicellular organism</strong></td>
<td>A living organism made up of many cells (Ex. Fungi, plants, and animals)</td>
</tr>
<tr>
<td><strong>waste removal</strong></td>
<td>The process living organisms use to remove excess and/or potentially harmful materials from their cells and bodies</td>
</tr>
<tr>
<td><strong>irritability</strong></td>
<td>The process living organisms use to respond to stimuli</td>
</tr>
<tr>
<td><strong>reproduction</strong></td>
<td>Process by which cells and other organisms produce other cells and organisms of the same kind</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>diffusion</strong></td>
<td>Process where molecules move from higher to lower concentration. Main method by which small molecules move across the cell membrane</td>
</tr>
<tr>
<td><strong>osmosis</strong></td>
<td>The diffusion of water across a cell membrane</td>
</tr>
<tr>
<td><strong>passive transport</strong></td>
<td>Cellular transport that does not require the use of cellular energy. Two examples are diffusion and osmosis</td>
</tr>
<tr>
<td><strong>active transport</strong></td>
<td>Cellular transport that requires the use of cellular energy and transport proteins (Ex. Endocytosis &amp; Exocytosis)</td>
</tr>
<tr>
<td><strong>active transport</strong></td>
<td>Cellular transport that requires the use of cellular energy and transport proteins (Ex. Endocytosis &amp; Exocytosis)</td>
</tr>
<tr>
<td><strong>photosynthesis</strong></td>
<td>The process in which some organisms use water along with sunlight and carbon dioxide to make their own food.</td>
</tr>
<tr>
<td><strong>cellular respiration</strong></td>
<td>The process by which cells break down simple food molecules to release the energy they contain.</td>
</tr>
<tr>
<td><strong>cells</strong></td>
<td>The basic units of structure and function in living things</td>
</tr>
<tr>
<td><strong>tissues</strong></td>
<td>Similar cells that work together to carry out a particular function/job</td>
</tr>
<tr>
<td><strong>organs</strong></td>
<td>Groups of tissues that work together to carry out a particular function/job</td>
</tr>
<tr>
<td><strong>organ system</strong></td>
<td>Groups of organs that work together to carry out a particular function/job</td>
</tr>
<tr>
<td><strong>organism</strong></td>
<td>A living thing</td>
</tr>
</tbody>
</table>
**SOL LS.4**

<table>
<thead>
<tr>
<th>classification groups/levels</th>
<th>Kingdom, phylum, class, order, family, genus, species</th>
</tr>
</thead>
<tbody>
<tr>
<td>mnemonic for classification levels</td>
<td>King Phillip Came Over For Grape Soda</td>
</tr>
<tr>
<td>species</td>
<td>group of similar-looking organisms that can produce fertile offspring</td>
</tr>
<tr>
<td>binomial nomenclature</td>
<td>two-word scientific name: includes Genus and species (EX. Homo sapiens)</td>
</tr>
<tr>
<td>six kingdoms of classification</td>
<td>animal, plant, fungi, protist, eubacteria, archaebacteria</td>
</tr>
<tr>
<td>animal phyla</td>
<td>cnidarians, mollusks, annelids, arthropods, echinoderms, chordates</td>
</tr>
<tr>
<td>important plant groups</td>
<td>mosses, ferns, conifers, flowering plants</td>
</tr>
</tbody>
</table>

**SOL LS.5**

<table>
<thead>
<tr>
<th>chlorophyll</th>
<th>The chemical in chloroplasts that traps light energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>photosynthesis</td>
<td>Process in plants that transforms light energy into chemical energy: organisms use water along with sunlight and carbon dioxide to make their own food.</td>
</tr>
<tr>
<td>carbon dioxide &amp; water</td>
<td>Two raw materials needed for photosynthesis</td>
</tr>
<tr>
<td>glucose sugar &amp; oxygen</td>
<td>Two products created during photosynthesis</td>
</tr>
<tr>
<td>chloroplast</td>
<td>Plant organelle is mainly involved in photosynthesis</td>
</tr>
<tr>
<td>CO₂ + H₂O → C₆H₁₂O₆ + O₂</td>
<td>Chemical equation/reaction for photosynthesis</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>producers</td>
<td>organisms that produce glucose using energy from the sun and they form the base of the energy pyramid</td>
</tr>
<tr>
<td>sunlight</td>
<td>Supplies the energy plants need to carry out photosynthesis</td>
</tr>
<tr>
<td>leaf</td>
<td>Plant organ involved in photosynthesis</td>
</tr>
<tr>
<td>cellular respiration</td>
<td>The process by which cells break down simple food molecules to release the energy they contain</td>
</tr>
<tr>
<td>glucose sugar &amp; oxygen</td>
<td>Raw materials needed for cellular respiration</td>
</tr>
<tr>
<td>carbon dioxide &amp; water</td>
<td>Products created during cellular respiration</td>
</tr>
<tr>
<td>mitochondria</td>
<td>Organelle involved in cellular respiration</td>
</tr>
<tr>
<td>C₆H₁₂O₆ + O₂ → CO₂ + H₂O</td>
<td>Chemical equation/reaction for cellular respiration</td>
</tr>
</tbody>
</table>

**SOL LS.6**

<table>
<thead>
<tr>
<th>ecosystem</th>
<th>The community of organisms that live in a particular area along with their nonliving (abiotic) surroundings</th>
</tr>
</thead>
<tbody>
<tr>
<td>producer</td>
<td>An organism that carries out photosynthesis to make its own food (AUTOTROPH) (EX. Plants and some unicellular organisms)</td>
</tr>
<tr>
<td><strong>consumer</strong></td>
<td>An organism that eats other organisms (HETEROTROPHS) (EX. Animals)</td>
</tr>
<tr>
<td><strong>decomposer</strong></td>
<td>Special consumers that break down waste and dead organisms and return the raw materials to environment (EX. Bacteria and Fungi)</td>
</tr>
<tr>
<td><strong>food chain</strong></td>
<td>A series of events in which one organism eats another organism to obtain energy</td>
</tr>
<tr>
<td><strong>food web</strong></td>
<td>An illustration showing the overlapping food chains in an ecosystem</td>
</tr>
<tr>
<td><strong>energy pyramid</strong></td>
<td>The triangle that shows the decreasing energy available at each trophic (feeding) level of a food web/chain</td>
</tr>
<tr>
<td><strong>producer, 1st-order consumer, 2nd-order consumer, 3rd-order consumer</strong></td>
<td>Trophic/Feeding levels in an ecosystem</td>
</tr>
<tr>
<td><strong>herbivore</strong></td>
<td>Consumers that eat producers (plants) (Ex. Cows, squirrels)</td>
</tr>
<tr>
<td><strong>carnivore</strong></td>
<td>Consumers that eat only meat (other animals) (Ex. Snakes, wolves)</td>
</tr>
<tr>
<td><strong>omnivore</strong></td>
<td>Consumers that eat both plants and meat/other animals (Ex. Raccoons)</td>
</tr>
<tr>
<td><strong>scavenger</strong></td>
<td>Consumers that feed on the bodies of dead organisms (Ex. Vultures, buzzards)</td>
</tr>
<tr>
<td><strong>carbon cycle</strong></td>
<td>The recycling of a key element in all living things from air and water to plants, to animals, and back to the air and water</td>
</tr>
<tr>
<td><strong>nitrogen cycle</strong></td>
<td>The recycling of an essential plant nutrient to animals, and eventually through decomposers back to soil</td>
</tr>
<tr>
<td><strong>SOL LS.7 &amp; LS.8</strong></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td><strong>population</strong></td>
<td>All the organisms of the same species that live in an area at the same time</td>
</tr>
<tr>
<td><strong>community</strong></td>
<td>Populations living together in one ecosystem</td>
</tr>
</tbody>
</table>
| **cooperation & competition** | How members of a population interact  
|                     | cooperation=working together  
<p>|                     | competition=working against one another |
| <strong>symbiotic relationship</strong> | A relationship of different organisms that live &amp; work together |
| <strong>mutualism, commensalism, parasitism</strong> | 3 types of symbiotic relationships |
| <strong>mutualism</strong>       | A symbiotic relationship in which both organisms benefit |
| <strong>commensalism</strong>    | A symbiotic relationship in which one organism benefits and the other organism is unaffected |
| <strong>parasitism</strong>      | A symbiotic relationship in which one organism benefits and the other organism is harmed |
| <strong>niche</strong>           | An organism's specific role in its community |
| <strong>predator-prey</strong>   | The relationship between a consumer who hunts another consumer for food |
| <strong>social hierarchy</strong>| Organization of position or power in an animal community |
| <strong>territorial imperative</strong> | The geographic area occupied by a single animal, mating pair or group |</p>
<table>
<thead>
<tr>
<th>limiting factors</th>
<th>An environmental factor that prevents a population from increasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>carrying capacity</td>
<td>The largest population that an area can support</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOL LS.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>ecosystem</td>
</tr>
<tr>
<td>biome</td>
</tr>
<tr>
<td>climate</td>
</tr>
<tr>
<td>biotic factors</td>
</tr>
<tr>
<td>abiotic factors</td>
</tr>
<tr>
<td>adaptations</td>
</tr>
<tr>
<td>Tundra</td>
</tr>
<tr>
<td>Desert</td>
</tr>
<tr>
<td>Grassland</td>
</tr>
<tr>
<td>Rainforest</td>
</tr>
<tr>
<td>Deciduous Forest</td>
</tr>
<tr>
<td>Coniferous Forest/Taiga</td>
</tr>
</tbody>
</table>
### SOL LS.10

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>phototropism</td>
<td>A plant’s response to light by growing toward it or away from it</td>
</tr>
<tr>
<td>hibernation</td>
<td>An animal’s response to cold with a period of lowered metabolism</td>
</tr>
<tr>
<td>dormancy</td>
<td>Plants response to adverse winter weather - lowered metabolism</td>
</tr>
<tr>
<td>eutrophication</td>
<td>The addition of excess nutrients</td>
</tr>
<tr>
<td>catastrophic</td>
<td>Something that brings on a sudden great disaster</td>
</tr>
<tr>
<td>ecosystem</td>
<td>Organisms in a specific area and their physical environment</td>
</tr>
<tr>
<td>community</td>
<td>Populations living together in one ecosystem</td>
</tr>
<tr>
<td>population</td>
<td>All the organisms of the same species that live in an area at the same time</td>
</tr>
<tr>
<td>organism</td>
<td>A living thing</td>
</tr>
<tr>
<td>migration</td>
<td>Animals respond to weather changes by moving to another location</td>
</tr>
<tr>
<td>estivation</td>
<td>Animals respond to warm temperatures with period of lowered metabolism</td>
</tr>
</tbody>
</table>

### SOL LS.11

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>habitat</td>
<td>The specific environment that provides the things an organism needs to live, grow, and reproduce</td>
</tr>
<tr>
<td>air quality</td>
<td>The extent to which the air is free of pollutants</td>
</tr>
<tr>
<td>pollution</td>
<td>The presence of harmful substances in the environment</td>
</tr>
<tr>
<td><strong>DNA</strong></td>
<td>Chemical in living things that contains coded instructions that store and pass on genetic information</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>double helix</strong></td>
<td>describes the structure of DNA because it looks like a twisted ladder or spiral staircase</td>
</tr>
<tr>
<td><strong>Chromosomes</strong></td>
<td>Strands of tightly wound DNA</td>
</tr>
<tr>
<td><strong>genes</strong></td>
<td>sections of a chromosome that carry the code for a particular trait</td>
</tr>
<tr>
<td><strong>Mendelian genetics</strong></td>
<td>explains how traits are passed on through generations</td>
</tr>
<tr>
<td><strong>allele</strong></td>
<td>Form of a gene for a particular trait</td>
</tr>
<tr>
<td><strong>dominant allele</strong></td>
<td>The form of the trait that masks or hides the other form</td>
</tr>
<tr>
<td><strong>recessive allele</strong></td>
<td>Form of a trait that is masked or covered up when the dominant form of the trait is present.</td>
</tr>
<tr>
<td><strong>genotype</strong></td>
<td>The genetic makeup of an organism</td>
</tr>
<tr>
<td><strong>phenotype</strong></td>
<td>The physical trait that shows up as a result of the genotype</td>
</tr>
<tr>
<td><strong>Punnett Square</strong></td>
<td>A tool used to predict genotype and phenotype of offspring</td>
</tr>
<tr>
<td><strong>genetic engineering</strong></td>
<td>manipulation of the genetic code for medicine, agriculture etc.</td>
</tr>
<tr>
<td><strong>inherited</strong></td>
<td>Traits expressed in genes</td>
</tr>
<tr>
<td><strong>acquired</strong></td>
<td>Skills acquired through practice and injuries occurring from the environment</td>
</tr>
<tr>
<td><strong>sugars, nitrogenous bases, phosphates</strong></td>
<td>the components of DNA</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>Gregor Mendel</td>
<td>often considered the &quot;father of genetics&quot; for his study of the inheritance of traits in pea plants</td>
</tr>
<tr>
<td>Rosalind Franklin</td>
<td>discovered that DNA is a strand of molecules in spiral form</td>
</tr>
<tr>
<td>Watson and Crick</td>
<td>came up with the double helix model of DNA</td>
</tr>
<tr>
<td>genetics</td>
<td>The scientific study of heredity</td>
</tr>
<tr>
<td>heredity</td>
<td>The passing of traits from parents to offspring</td>
</tr>
</tbody>
</table>

### SOL LS.13

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>mutation</td>
<td>A change in the genetic code</td>
</tr>
<tr>
<td>adaptation</td>
<td>Structures, functions, or behaviors that enable a species to survive</td>
</tr>
<tr>
<td>natural selection</td>
<td>The survival of those best able to survive is known</td>
</tr>
<tr>
<td>extinction</td>
<td>The disappearance of all members of species from Earth: Often happens when a species can't survive environmental changes</td>
</tr>
<tr>
<td>evolution</td>
<td>The gradual change in a species over time</td>
</tr>
<tr>
<td>fossil record, radiometric dating, genetic information, etc.</td>
<td>evidence exists for evolution</td>
</tr>
<tr>
<td>fossil</td>
<td>The preserved remains or traces of organisms that lived in the past</td>
</tr>
<tr>
<td>fossil record</td>
<td>The millions of fossils that scientists have collected</td>
</tr>
<tr>
<td>radiometric (radioactive) dating</td>
<td>A technique used to determine the actual age of a fossil on the basis of the amount of a radioactive element it contains</td>
</tr>
<tr>
<td>relative dating</td>
<td>A technique used to determine which of two fossils is older</td>
</tr>
</tbody>
</table>