North Carolina Department of Public Instruction
INSTRUCTIONAL SUPPORT TOOLS
FOR ACHIEVING NEW STANDARDS

This document is designed to help North Carolina educators teach the Essential Standards (Standard Course of Study). NCDPI staff are continually updating and improving these tools to better serve teachers.

Essential Standards: Grade 8 Science ● Unpacked Content
For the Essential Standards that will be effective in all North Carolina schools in the 2012-13 school year.

What is the purpose of this document?
To increase student achievement by ensuring educators understand specifically what the new standards mean a student must know, understand and be able to do.

What is in the document?
Descriptions of what each standard means a student will know, understand and be able to do. The "unpacking" of the standards done in this document is an effort to answer a simple question "What does this standard mean that a student must know and be able to do?" and to ensure the description is helpful, specific and comprehensive for educators.

How do I send Feedback?
We intend the explanations and examples in this document to be helpful and specific. That said, we believe that as this document is used, teachers and educators will find ways in which the unpacking can be improved and made ever more useful. Please send feedback to us at feedback@dpi.state.nc.us and we will use your input to refine our unpacking of the standards. Thank You!

Just want the standards alone?
You can find the standards alone at http://www.ncpublicschools.org/docs/acre/standards/phase1/science/6-8.pdf .

Matter: Properties and Change
Essential Standard and Clarifying Objectives

8.P.1 Understand the properties of matter and changes that occur when matter interacts in an open and closed container.

8.P.1.1 Classify matter as elements, compounds, or mixtures based on how the atoms are packed together in arrangements.

8.P.1.2 Explain how the physical properties of elements and their reactivity have been used to produce the current model of the Periodic Table of elements.

8.P.1.3 Compare physical changes such as size, shape and state to chemical changes that are the result of a chemical reaction to include changes in temperature, color, formation of a gas or precipitate.

8.P.1.4 Explain how the idea of atoms and a balanced chemical equation support the law of conservation of mass.

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.P.1.1

Students know:

- **the structure of the atom:**
  - that it is composed of extremely small particles that are too small to be seen with an optical microscope and that size at the atomic level is measured on the nanoscale.
  - that there are three basic particles in the atom (proton, neutron, and electron).

- **that the atom is the basic building block of matter, that a single atom has mass and takes up space, and that all matter is composed of atoms.** Students know that each of the elements has distinct properties and a distinct atomic structure. All forms of matter are composed of one or more of the elements. Students recognize that scientists have identified more than 100 elements that combine in a multitude of ways to produce compounds that make up all living and nonliving things.

- **that an atom is the smallest unit of an element and that a compound is composed of two or more elements chemically combined.** Students know that scientists identify and classify elements, compounds and mixtures according to their physical and chemical makeup.

- **the differences among elements, compounds and mixtures.**

  Elements
  - Elements are pure substances that cannot be changed into simpler substances.
  - Elements are composed of one kind of atom.

  Compounds
  - Compounds are pure substances that are composed of two or more types of elements that are chemically combined.
  - Compounds can only be changed into simpler substances called elements through chemical changes

  Mixtures
  - Mixtures are physical combinations of two or more different substances that retain their own individual properties and are combined physically (mixed together).
  - Mixtures can be separated by physical means (filtration, sifting, or evaporation). Characteristic properties can be used to identify different materials and to separate a mixture into its components.
  - Mixtures may be heterogeneous or homogeneous.
    - In a *heterogeneous mixture*, which is not uniform throughout, the component substances can be visibly distinguished. Tossed salad, granite, and iced tea are examples of heterogeneous mixtures.
    - In a *homogeneous mixture*, which is uniform throughout, the substances are evenly mixed and cannot be visibly distinguished. Air, steel, clear salt-water are examples of homogeneous mixtures.

- **that in solids the atoms are closely locked in position and can only vibrate; in liquids the atoms and molecules can collide with and move past one another; and in gases the atoms and molecules move independently, colliding frequently.** The atoms or molecules of a solid form a pattern that minimizes the structural energy of the solid. At the melting point temperature, the atoms or molecules acquire enough energy to slide past one another so that the material, now a liquid, can flow. In a gas the atoms or molecules move about freely and collide randomly with the walls of a container and with each other. The distance between molecules in a gas is much larger than that in a solid or a liquid.

- **that there is a relationship between phase and density and that density is mass per unit volume.**

Teacher Notes:

(1) It is not essential for students to understand isotopes or distinguish between covalent and ionic compounds.

(2) Atoms interact to form molecules or crystals. The term molecule is used to describe particles of a pure covalent substance – element or compound. Examples are oxygen (O_2), water (H_2O), and sugar ($C_{12}H_{22}O_{11}$) molecules. Crystalline solids can be metallic elements or ionic compounds. Examples are gold (Au), table salt (NaCl), and hematite (Fe_2O_3). These distinctions will be identified in high school courses.

(3) Heterogeneous and homogeneous mixtures are merely introduced at this grade. Further examination of heterogeneous and homogeneous mixtures will be included in a physical science course.

8.P.1.2

Students know:

- **how the periodic table of elements is organized and how to use the periodic table in order to obtain information about the atom of an element:**
    - symbol
    - atomic number
    - atomic mass
    - state of matter at room temperature
    - number of outer energy level (valence) electrons.

- **how the periodic table of elements is an arrangement of elements according to their properties.** The periodic table of elements is arranged horizontally in order of increasing atomic number (number of protons) and vertically in columns of elements with similar chemical properties. An atom's identity is directly related to the number of protons in its nucleus. This information can be used to predict chemical reactivity.

- **how to use the periodic table as a quick reference for associating the name and symbol of an element**.

- **how to find the atomic number and atomic mass of an element listed on the table.** The periodic table of elements is also an arrangement of elements according to properties. The periodic table is both a tool and an organized arrangement of the elements that reveals the underlying atomic structure of the atoms. The periodic table is a tool that is used in all the domains of science.

- **how groups of elements can be classified based on similar properties,** including highly reactive metals, less reactive metals, highly reactive non-metals, less reactive non-metals, and some almost completely non-reactive gases. Students understand that substances are often placed in categories together if they react in similar ways. Examples of this in the periodic table include metals, nonmetals, and noble gases. Students know these are major groups of elements that have different physical properties.

- **that the information that is organized in the periodic table is based on the observations of many scientists over a long period time.** Dmitri Mendeleev is generally credited with the creation of the basis for our modern day table. Mendeleev was not the first to suggest a table, but he was the first to create one that predicted the existence of as-yet-undiscovered elements which were later discovered. As of 2012, the periodic table contains 118 confirmed chemical elements, of which 114 have been recognized by the International Union of Pure and Applied Chemistry (IUPAC) and named.

- **that *chemical symbols* show the atoms of the elements composing a substance.** Symbols are written with one, two, or three letters. The first letter is always capitalized. Each element has a different symbol.
  - Elements are made up of one kind of atom and the symbol for each element is unique.
  - Compounds are composed of more than one element and their formulas have more than one type of symbol showing the different elements that compose the compound.

- **that *chemical formulas* are constructed from the symbols of the elements composing the substances.**
  - In a chemical formula, the numbers as *subscripts* show how many of each kind of atom are in the compound.
  - The subscript is written to the lower right of the element symbol.
  - If no subscript is written, only one atom of that element is part of the compound. For example, in H_2O, the number 2 is the subscript for hydrogen and means that there are 2 atoms of hydrogen in the compound of water; since there is no subscript for oxygen it is assumed to be one atom of oxygen.

- **that atoms are composed of 3 subatomic particles- protons, neutrons and electrons.** The thing that makes elements different is the number of electrons, protons, and neutrons. The protons and neutrons are always in the nucleus (center of the atom). The electrons are always found around the center in areas called orbitals. Protons have a "+" or positive charge. If the charge of an entire atom is "0", that means there are equal numbers of electrons and protons. Neutrons have a neutral charge (a charge of zero). Electrons have a "-" or negative charge.

Students should recognize common substances such as water (H_2O), carbon dioxide (CO_2), sucrose ($C_{12}H_{22}O_{11}$), table salt (NaCl), oxygen (O_2), household bleach (NaClO), hydrochloric acid (HCl), ammonia (NH_3), baking soda ($NaHCO_3$), and vinegar ($HC_2H_3O_2$, 5% solution) through chemical formulas and symbols.

Teacher Note: It is not essential for students to construct atomic models of subatomic particles. They do need to use visual representations and concrete models of elements, compounds and mixtures.

8.P.1.3

Students know:

- **that physical and chemical properties can be used to identify substances.**

- **how to distinguish between physical properties (i.e., shape, density, solubility, odor, melting point, boiling point, and color) and**

chemical properties (i.e., acidity, basicity, combustibility, and reactivity).

- **how to determine the identity of an unknown substance by comparing its properties to those of known substances.**

- **how to compare physical changes (including changes in size, shape, and state) to chemical changes that are the result of chemical reactions (including changes in color or temperature and formation of a precipitate or gas).**

- **that matter can undergo physical and chemical changes.** In physical changes, the chemical composition of the substances does not change. In chemical changes, different substances are formed. Students know that when a substance is broken apart or when substances are combined and at least one new substance is formed, a *chemical reaction* has occurred.

- **how to differentiate between physical and chemical properties:**

  Physical properties can be observed and measured without changing the kind of matter being studied. The following physical properties can be used to help identify a substance:

  Melting Point
    - The temperature at which a solid can change to a liquid.
    - The temperature at which a pure substance melts is unchanging under constant conditions.
    - Therefore, the melting point of a pure substance can be used as a physical property for identification. Ice melts to form liquid water at 0^0C (32^oF).

  Boiling Point
    - The temperature at which a liquid boils.
    - During the process of boiling a substance changes from a liquid to a gas.
    - Boiling begins when the liquid starts to form bubbles throughout, which grow larger, rise to the surface, and burst.
    - As long as the substance is boiling the temperature of the liquid remains constant (at the boiling point).
    - Boiling point is unchanging under constant conditions for a given substance and therefore can be used as a physical property for identification of the substance.
    - The boiling point for pure water at sea level is 100^oC or 212^oF.

  Density
    - Density is a property that describes the relationship between the mass of a material and its volume.
    - Substances that have higher densities contain more matter in a given volume.
    - The density of a substance will stay the same no matter how large or small the sample of the substance, and therefore, density can be used as a physical property for identification of the substance.
    - For example, the density of lead is much greater than the density of aluminum.

Color

- Color can be used to help identify a substance, along with other properties.
- By itself color is not a significant identifier of a substance.
- Absence of color is also a physical property.

Chemical properties can also be used to help identify a substance. Chemical properties can be recognized only when substances react or do not react chemically with one another, that is, when they undergo a change in composition. A chemical property of one substance usually involves its ability to react or not react with another specific substance. Two examples of chemical properties include:

- ***Reacting with Oxygen*** The ability of a substance to ***burn*** is a chemical property that involves a substance reacting quickly with oxygen to produce light and heat. Reacting with oxygen slowly occurs when iron rusts or apples turn brown.
- ***Reacting with Acids*** The ability of a substance to react with an acid is a chemical property. Some metals react with various acids to form compounds. All metals do not react with all acids. Bases react with acids to form water and neutralize the acid.

- **how to differentiate between physical and chemical changes:**

Physical changes do not change the composition of a substance, only the physical properties. Evidences of a physical change include:

Change in state of matter

- When a substance changes from one state of matter to another (for example, changing from solid to liquid, from liquid to solid, or from liquid to gas), the composition of the substance remains the same.
- Examples of change in state might include: melting of ice cream, hardening of melted wax, or evaporating of water from wet clothes.
- When a substance changes directly from a gas to a solid (the forming of frost from water vapor) or from a solid to a gas (dry ice, solid air fresheners) that change of state is called *sublimation*. This is still a physical change because the composition of the substance remains the same.

Change in size or shape

- When a substance changes in size or shape (for example, cutting, tearing, dissolving, stretching, or wrinkling), its composition remains the same.
- Examples of change in size or shape might include: shredding paper, dissolving sugar in water, stretching a rubber band, wadding up a piece of paper, or denting a piece of metal.

Chemical changes result in the formation of one or more new substances with new chemical and physical properties. Evidences that a chemical change may have occurred include:

Color change

- When a substance changes color, the chemical composition of the substance may have_changed (for example, iron turns to a reddish-brown when it rusts, apples brown when they react with oxygen in the air, or marshmallows turn black when burned).
- It is possible to have a color change without a chemical change (for example, adding food coloring to water).

Temperature change

- When a substance is combined with another substance, there may be an increase or decrease in temperature (for example, when wood burns to ash and gases, the temperature increases.
- It is possible to have a temperature change without a chemical change (for example, warming of the water in a pond).

Formation of a precipitate

- When two solutions are combined, they may form a solid substance. This solid substance is called a *precipitate* and indicates that a chemical change has occurred.
- For example when carbon dioxide is combined with aqueous calcium hydroxide (limewater), solid calcium carbonate (chalk) is formed as the precipitate.
- The precipitate may be in the form of very small particles, appearing as cloudiness in the solution or as a solid which settles to the bottom of the container.

Formation of a gas

- When solid or liquid substances are combined, they may form gas bubbles.
- The formation of the gas may indicate that a chemical reaction has taken place. For example when vinegar is added to baking soda, it forms carbon dioxide bubbles.
- It is possible to form gas without a chemical change (for example, when water is heated to boiling).

Students know:

- **that reactions occur at different rates, slow to fast, and that reaction rates can be changed by changing the concentration of reactants, the temperature, the surface areas of solids, and by using a catalyst.**

- **that many substances dissolve in water**. Water is often called the universal solvent, because so many substances can dissolve in it.

- **that solutions can be acidic, basic, or neutral.** The pH scale is used to classify solutions. Neutral solutions have a pH of 7. Acids have a pH of less than 7. Bases have a pH of more than 7.

- **how to distinguish acids and bases and use indicators (including litmus paper, pH paper, and phenolphthalein) to determine their relative pH.**
- **that a chemical equation can be used to represent a chemical reaction that has occurred.** A chemical equation contains the chemical

names or formulas of the substance involved in the reaction. An arrow is used to distinguish between the substance that are broken apart or combined, and can be understood as meaning “yields” or “makes”.

- Reactants are the substances broken apart or combined in a chemical reaction and that they are located on the left side of the arrow in a chemical equation.
- Products are new substances formed in a chemical reaction and that they are located on the right side of the arrow in a chemical equation.
- The amount of matter does not change during a chemical reaction, only that the atoms are rearranged to form new substances. This is evidenced in a balanced chemical equation.

8.P.1.4

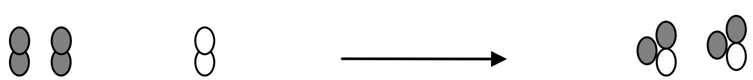
Students know:

- **that when materials react with each other, many changes can take place, but that in every case the total amount of matter afterward is the same as before.**
- **that a balanced chemical equation supports the law of conservation of matter.**
- **how to identify examples that support the law of conservation of matter and can explain the conservation of matter using the idea of atoms.** In chemical reactions, the number of atoms stays the same no matter how they are arranged, and the mass of atoms does not change significantly in chemical reactions, so their total mass stays the same.

Teacher Note: Experiences using concrete models to simulate chemical changes will build conceptual understanding of conservation of matter. Ask students to explain a chemical change identifying how products are formed from the atoms in the reactants.

Example: Hydrogen gas (H_2) reacts with oxygen gas (O_2) to form water (H_2O).

One molecule of hydrogen has two atoms and one molecule of oxygen has two atoms. A molecule of water has one oxygen and two hydrogen atoms. So, the two hydrogen atoms bond with one of the oxygen atoms to form a water molecule. There is an atom of oxygen left over, so another hydrogen molecule is needed in order to make a second water molecule.



The balanced chemical equation would be $2H_2 + O_2 \rightarrow 2H_20$. Two molecules of water are formed from four hydrogen and two oxygen atoms.

Energy: Conservation and Transfer

Essential Standard and Clarifying Objectives

8.P.2 Explain the environmental implications associated with the various methods of obtaining, managing and using energy resources.

8.P.2.1 Explain the environmental consequences of the various methods of obtaining, transforming, and distributing energy.

8.P.2.2 Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation.

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.P.2.1

Students know:

- **that all organisms on Earth, including humans, use energy derived from resources provided by the environment**. Earth supplies a variety of natural resources that living things use, change, and reuse. Some of these resources can be replaced and/or reused in nature; these are renewable resources. Natural resources that cannot be replaced in nature are nonrenewable.

- **that renewable resources are replaced through natural processes at a rate that is equal to or greater than the rate at which they are being used.** Air, freshwater, soil, living things, and sunlight are renewable resources. Air can be cleaned and purified by plants during the process of photosynthesis as they remove carbon dioxide from the air and replace it with oxygen. The water cycle allows Earth's water to be used over and over within the environment. Topsoil is formed to replace soil that has been carried away by wind and water (although new soil forms very slowly). Trees and other new plants grow to replace those that have been cut down or died. Animals are born to replace animals that have died. Sunlight, or solar energy, is considered a renewable resource because it will continue to be available for billions of years. It provides a source of energy for all processes on Earth.

- **that some resources are nonrenewable.** Nonrenewable resources are exhaustible because they are being extracted and used at a much faster rate than the rate at which they were formed. Fossil fuels (coal, oil, and natural gas), diamonds, metals, and other minerals are nonrenewable. Fossil fuels exist in a fixed amount and can only be replaced by processes that take millions of years.

8.P.2.2

Students know:

- **that natural resources can be depleted or used to the point that they are in effect no longer available.** Conservation measures are necessary for nonrenewable resources because they are known to be in a non-replenishing supply. If renewable resources are used at an increasing rate so that they cannot be naturally replaced fast enough, they too can be depleted.

- **that freshwater can be depleted because of increased demands for water on account of population shifts.** This results in water not being available or not being sufficient to meet demands. Soil can be lost because it is left bare of vegetation and allowed to erode depletes the land of the fertile topsoil needed for plant growth in that area. If living resources, such as trees, are removed without being replanted, this can contribute to environmental changes in the land, air, and water in that area that leads to negative consequences.

- **that as Earth's human population grows, the need for natural resources increases.**
    - The terms *reduce, reuse, recycle* are important ways that people can be involved in conservation of natural resources. *Reducing* involves making a decision to not use a resource when there is an alternative, such as walking or riding a bicycle rather than traveling in a car. *Reusing* involves finding a way to use a resource (or product from a resource) again without changing it or reprocessing it, such as washing a drinking glass rather than throwing away plastic or Styrofoam. *Recycling* involves reprocessing a resource (or product from a resource) so that the materials can be used again as another item, such as metals, glass or plastics being remade into new metal or glass products or into fibers.
    - *Conservation* involves preventing the loss of a resource by way of thoughtful management of it. Increased human consumption can have long-term consequences. Since the Industrial Revolution, human activities have resulted in major impacts on air, water, and soil. Pollution has cumulative ecological effects such as acid rain, global warming, or ozone depletion.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

8.E.1 Understand the hydrosphere and the impact of humans on local systems and the effects of the hydrosphere on humans.

8.E.1.1 Explain the structure of the hydrosphere including:

- Water distribution on earth
- Local river basin and water availability

8.E.1.2 Summarize evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms:

- Estuaries
- Marine ecosystems
- Upwelling
- Behavior of gases in the marine environment
- Value and sustainability of marine resources
- Deep ocean technology and understandings gained

8.E.1.3 Predict the safety and potability of water supplies in North Carolina based on physical and biological factors, including:

- Temperature
- Dissolved oxygen
- pH
- Nitrates and phosphates
- Turbidity
- Bio-indicators

8.E.1.4 Conclude that the good health of humans requires:

- Monitoring of the hydrosphere
- Water quality standards
- Methods of water treatment
- Maintaining safe water quality
- Stewardship

Unpacking What does this standard mean a child will know, understand and be able to do?
8.E.1.1 **Students know:** • **that water is one of the most common substances on the surface of the Earth.** They know that water has unique properties that impact the role it plays on the Earth in all the spheres (hydrosphere, lithosphere, atmosphere, and biosphere). These properties include: o Polarity o Cohesion o Adhesion o High surface tension o Density o High specific heat o High heat of vaporization Water is the only substance on Earth that occurs naturally as a solid, a liquid, and a gas. It is often referred to as 'the universal solvent' because so many other substances dissolve in it. This characteristic is one reason that the water encountered on Earth is rarely pure. Water covers approximately 71% of the Earth's surface (USGS). Most of this water (97%) is not drinkable because it is saltwater. The majority of freshwater (3%) exists in ice caps, glaciers, and oceans. 77% of the freshwater is frozen. Of the 23% that is not frozen, approximately a half of a percent is available to supply living organisms with what they need to survive. The availablilty of water varies with local geography and allows humans to utilize water as a resource. The ocean is salty because of dissolved chemicals eroded from the Earth's crust and washed into the sea. Solid and gaseous ejections from volcanoes, suspended particles swept to the ocean from the land by onshore winds, and materials dissolved from sediments deposited on the ocean floor have also contributed. Salinity in ocean waters is increased by evaporation or by freezing of sea ice and it is decreased as a result of rainfall, runoff, or the melting of ice. The average salinity of seawater is 35 parts per thousand. Salinities are much less than average in coastal waters, in the polar seas, and near the mouths of large rivers. Hydrothermal vents are recently-discovered features on the crest of oceanic ridges that release dissolved minerals into the oceans. These vents are the exit point on the ocean floor from which sea water that has seeped into the rocks of the oceanic crust (heated and containing dissolved materials from the crust) flows back into the ocean. This super-heated water brings large amounts of dissolved minerals with it.

Estimates of the amount of hydrothermal fluids now flowing from these vents show that the entire volume of the oceans could seep through the oceanic crust in about 10 million years. Thus, this process has a very important effect on salinity.

- **that the ocean is an integral component of the world's climate due to its capacity to collect, drive and mix water, heat, and carbon dioxide.** The ocean can hold and circulate more water, heat and carbon dioxide than the atmosphere although the components of the Earth's climate are constantly exchanged. Because the ocean can store so much heat, seasons occur later than they would and air above the ocean is warmed. Heat energy stored in the ocean in one season will affect the climate almost an entire season later. The ocean and the atmosphere work together to form complex weather phenomena like the North Atlantic Oscillation and El Niño. The many chemical cycles occurring between the ocean and the atmosphere also influence the climate by controlling the amount of radiation released into ecosystems and our environment. Air temperatures all over the world are regulated by the circulation of heat by the oceans. The ocean stores heat in the upper two meters of the photic zone. This is because seawater has a very high density and specific heat and as a result can store vast quantities of energy in the form of heat. The ocean can then buffer changes in temperature by storing heat and releasing heat. Evaporation cools ocean water which cools the atmosphere. It is most noticeable near the equator and the effect decreases closer to the poles.

- **that the water cycle is the continuous movement of water in and around the Earth.** The sun drives the entire water cycle and is responsible for its two major components: condensation and evaporation. When the sun heats the surface of water, it evaporates and ends up in the atmosphere as water vapor. It cools and rises, becoming clouds, which eventually condense into water droplets. Depending on the temperature of the atmosphere and other conditions, the water precipitates as rain, sleet, hail or snow.

  Some of this precipitation is captured by tree canopies and evaporates again into the atmosphere. The precipitation that falls to the ground becomes runoff, which courses over the surface of the earth in streams. (Runoff also comes from snowmelt, which occurs when the sun and climate changes melt snow and ice.) Runoff can accumulate and freeze into snow caps or glaciers. Runoff can also infiltrate the ground and accumulate, becoming groundwater. Permeability is a measure of the ability of a rock or sediment to transmit water or other liquids. Water does not pass through impermeable materials. A substantial amount of water is stored in permeable soil and rock underground. An aquifer is a large deposit of groundwater that can be extracted and used. Finally, runoff makes its way back into lakes and oceans, where it is again evaporated by the sun.

- **that a river basin is the portion of land drained by a river and its tributaries.** It encompasses the entire land surface drained by the various streams and creeks that flow downhill into one another, and eventually into one river. The final destination of the water drained by a river basin is an estuary or an ocean. A river basin sends all the water falling on the surrounding land into a central river and out to the sea.

- **that for land-dwellers, everyone lives in a river basin.** Even if they do not live near the water, land-dwellers live on land that drains to a river or estuary or lake, and their actions on that land affect water quality and quantity far downstream. There are 17 river basins in North Carolina. The topography of each basin determines the area that it drains, and whether that water - from creeks, rivers, springs, and aquifers - flows into the Atlantic Ocean or Gulf of Mexico.

8.E.1.2

Students know:

- **that the ocean is a dynamic system in which many chemical, biological, and physical changes are taking place.** The ocean is an important source of food and mineral resources as well as a venue for human recreation and transportation. Students know that the ocean is the largest reservoir of water on the surface of the Earth. They also know that the ocean is the single largest reservoir of heat at Earth's surface. The stored heat in the ocean drives much of Earth's weather and causes climate near the ocean to be milder than climate in the interior of continents. Many of the cycles that circulate materials between the atmosphere, lithosphere and hydrosphere originate in the ocean. Ocean currents are a source of large scale distribution of energy and resources on the Earth.

- **that estuaries are areas where fresh and salt water mix, producing variations in salinity and high biological activity.** Estuaries trap nutrients and sediment that are carried from the land by rivers and from the ocean by tides. In an estuary, these nutrients are constantly being mixed, due to tidal action and river flow. These conditions create a fertile repository of plant and animal life. Estuaries are one of the most productive ecosystems on earth.

  Because estuarine waters are shallow (in North Carolina, less than thirty feet deep), sunlight penetrates to the bottom. This promotes plant growth. The rivers that feed estuaries deposit sediments rich in nutrients, which settle onto the sand and mud of the estuary floor. These conditions create unique habitats for both plants and animals, and provide the basis for great biological diversity in species (of fish, shrimp, crabs, clams and oysters) that are able to adapt to the brackish conditions. Estuaries are also good nurseries as they provide a protected environment for species to hatch and grow in before they migrate to the sea to live out their adult lives.

  Estuaries are numerous in North Carolina. The largest North Carolina estuary is Pamlico Sound. Water drains into this system from eastern North Carolina and southeastern Virginia, from the Chowan, Roanoke, Pasquotank, Pamlico, and Neuse Rivers, from marshes, swamps, forests, and grasslands. Estuaries help control erosion and reduce flooding of the mainland. Sand bars buffer the impact of waves, while plants and shellfish beds anchor the shore against tides. Swamps and marshes take the initial impact of high winds moving in from the ocean, soak up heavy rain and storm surges, and release the extra water gradually into rivers and groundwater supplies.

  Estuaries are a type of environmental filter. Plants and animals in estuaries filter pollutants out of the water. For instance, salt marsh plants trap some of the chemicals and pathogens carried by rivers and move them into soils where they can be neutralized. Oysters filter impurities out of water as they eat, collecting the contaminants in their bodies. One oyster can filter twenty-five gallons of water per day. Bacteria eat organic matter found in the sediment and in turn release carbon dioxide, hydrogen sulfate and methane into the atmosphere preventing these gases from being excessively stored up in the estuary. However, toxins can accumulate in estuaries causing many environmental and health problems. Chemical pollution and sedimentation are great threats to the well-being of estuaries and oceans.

- **that from the seashore to the deepest depths, oceans are home to some of the most diverse life on Earth.** Oceanographers divide the ocean into zones according to how far down sunlight penetrates. Plants are found only in the sunlit zone where there is enough light for photosynthesis, however, animals are found at all depths of the oceans. As far as we know, nearly all life in the ocean is dependent on plants. Only plants have the ability to manufacture food out of inorganic substances. Algae in the ocean are an important food source as well as an important source of atmospheric oxygen. The most abundant plants in the ocean are known as phytoplankton. To grow, phytoplankton needs nutrients from sea water and an abundance of sunlight. Currents in the ocean recycle and circulate a variety of organic and inorganic materials. This makes nutrients, minerals, and gases available to organisms.

- **that in the ocean there are innumerable individual food chains overlapping and intersecting to form complex food webs.** Most marine creatures eat a variety of foods. If one link in a chain is depleted, the other consumers in the chain have alternate food sources. Ocean organisms generally belong to several different food chains that are linked to form a food web. Ocean food chains and webs are also connected to land-dwelling organisms.

- **how winds have a powerful effect on the oceans and are an important force in creating ocean currents.** From global circulation to microscopic patterns of turbulence, winds move water and its resident animals and plants. Under certain conditions, a special kind of ocean event known as upwelling can occur. Upwelling happens when warm surface water near coastal areas is blown offshore by winds. This creates a condition in which the cold water along the bottom of the ocean near the shore rises, carrying sediment and organic material to the surface. Phytoplankton uses these nutrients to grow and reproduce at a rapid rate. This attracts organisms that rely on the phytoplankton as food and their consumers in turn. As a result, areas of upwelling tend to become areas of rich biological activity, providing resources to a great diversity of ocean organisms. Approximately half of the fish caught in the world come from areas where there is upwelling.

- **that seawater has many different gases dissolved in it, especially nitrogen, oxygen and carbon dioxide.** The action of ocean wind and waves agitates the ocean surface, stimulating the exchange of these gases between the ocean and the atmosphere. Marine plants depend on dissolved carbon dioxide in order to perform photosynthesis. Photosynthesis releases oxygen into ocean water which is in turn used by ocean organisms for respiration. Respiration releases energy from stored carbohydrates and produces carbon dioxide and water as byproducts. Some properties of seawater affect how much gas can be dissolved in it:
    - Cold water holds more gas than warm water.
    - Seawater with low salinity holds more gas than high salinity water.
    - Deep water, which has a high pressure, holds more gas than shallow water.
- **that carbon dioxide is one of the most important gases that dissolve in the ocean.** Some of it remains as dissolved gas, but most reacts

with the water to form carbonic acid or reacts with carbonates already in the water to form bicarbonates. This reaction removes dissolved carbon dioxide from the water. Many marine organisms use the bicarbonate to form calcium carbonate shells. When these organisms die, some of the bicarbonate is returned to the water, but a lot of it settles down to the sea bed. This process locks up, for long periods of time, carbon that originated in carbon dioxide in the atmosphere. As atmospheric levels of gases rise, so do the levels of the same gases dissolved in ocean water rise.

- **that the ocean is one of Earth's most valuable natural resources.** Marine resources include biotic, mineral and energy resources. The ocean provides food. It is used for travel and shipping. It provides a source of recreation for humans. It is mined for minerals and drilled for crude oil.

The ocean plays a critical role in removing carbon from the atmosphere and providing oxygen. It regulates Earth's climate. The ocean is an increasingly important source of biomedical organisms with potential for fighting disease. The ocean is very important to life on land.

The oceans have been fished for thousands of years and are an integral part of human society. Fish have been important to the world economy for a very long time. Fisheries today provide about 16% of the total world's protein with higher percentages occurring in developing nations.

The word *shipping* refers to the activity of moving cargo with ships in between seaports. Wind-powered ships exist, but more often ships are powered by steam turbine plants or diesel engines. The various types of ships include container ships, tankers, crude oil ships, chemical ships, bulk carriers, cable layers, general cargo ships, ferries, gas and car carriers, tugboats, barges and dredgers.

Tourism is the fastest growing division of the world economy and is responsible for more than 200 million jobs all over the world. The tourism industry is based on natural resources present in each country and tourism often has a negative impact on coastal and ocean ecosystems. However, sustainable tourism can actually promote conservation of the environment. The negative effects of tourism originate with the over development of coastal habitats and the annihilation of entire ecosystems. Garbage and sewage generated by natives and visitors can add to an already existing solid waste and garbage disposal issue. Often visitors produce more waste than locals, and much of it ends up as untreated sewage dumped in the ocean. This causes eutrophication because it results in excessive algal bloom. It can also lead to disease epidemics. Ecotourism and cultural tourism are a new trend that favors low impact tourism and fosters a respect for local cultures and ecosystems.

Humans began to mine the ocean floor for diamonds, gold, silver, metal ores like manganese nodules and gravel in the 1950's. Sands and gravels are often mined for in the United States and are used to protect beaches and reduce the effects of erosion. Mining the ocean can be devastating to natural ecosystems. Dredging of any kind pulls up the ocean floor and a cloud of sediment rises up in the water, interfering with photosynthetic processes of phytoplankton and other marine life. Dredging also introduces previously benign heavy metals into the ocean food chain.

Drilling for oil is another activity that extracts resources from the ocean. Before an offshore oil well can be drilled, it must first be located. Geologists locate potential oil wells beneath the ocean floor through the use of magnetic and seismic surveys. This surveying does not indicate for certain whether a site contains oil until exploratory drilling takes place. In order to drill exploratory wells, government permission must first be obtained. An environmental impact assessment may be carried out at this stage. Then, using an exploratory drilling rig, geologists drill temporary wells to find out if there's a source of oil. If they think they've found a good source of oil, then more drilling takes place to substantiate the findings. Once oil or gas is discovered, then a production well is drilled and a production oil rig is built to replace the exploratory drilling rig. An average well will last from ten to twenty years, and even after it has run dry an oil rig may still be used for processing or storage of petroleum from other wells, so the production oil rig is built to last. The platforms are normally made of steel and are secured to the seabed using concrete or metal foundations. Initially the pressure from the reservoir is enough to pump the oil or gas, but as the pressure decreases various techniques are used to increase the pressure in the reservoir. These techniques include pumping in gas, water, compressed air or steam. The crude oil obtained from the well is then refined at oil refineries onshore.

Drilling for oil under the ocean has many different environmental impacts. The rigs themselves impact living creatures, the actions and processes of drilling affect the oceans and ocean life, and the danger of accidental release of petroleum into the oceans is constant. Conservation of ocean resources and thoughtful long term cost /benefit analyses with regard to the use of the ocean's many natural resources are an integral part of sustaining our oceans well into the future.

- **that the deep ocean has long been of interest to scientists.** In order to understand the ocean, scientists must gain access for themselves or their instruments to very specific parts of it. Traditionally, scientists have used ships to photograph the depths, to drop floats and drifters into the currents, and to collect samples of water, rock, and marine life. In recent years, the spectrum of available observing tools has grown to include human-occupied submersibles, remote-controlled vehicles, and autonomous robots.

At one time, scientists thought that life could not exist on the deep ocean floor. In 1977, scientists diving in *Alvin* to the Galápagos Rift discovered a new community of organisms. These organisms can withstand tremendous pressure, high temperatures, utter darkness, and toxic chemicals. These organisms are called extremophiles because of the extreme nature of their living conditions.

The discovery of life at vents and seeps revolutionized what scientists understand about how and where life can exist on Earth. The organisms that thrive at deep-sea vents and seeps have to survive freezing cold, perpetual darkness, high-pressure, and toxic chemicals.

Hydrothermal vents and cold seeps are places where chemical-rich fluids emanate from the seafloor, often providing the energy to sustain lush communities of life in some very harsh environments. Studying the organisms at hydrothermal vents and cold seeps expands our understanding of how life first took hold and slowly evolved on our planet as well as where it might exist elsewhere in the solar system and beyond.

On land and near the ocean surface, sunlight provides the energy that allows photosynthetic plants to convert carbon dioxide and water into the organic carbon, the fundamental source of nutrients for animals higher up the food chain. Below the photic zone (the sunlit, upper reaches of the ocean) many microbes have evolved chemosynthetic (instead of photosynthetic) processes that create organic matter by using oxygen in seawater to oxidize hydrogen sulfide, methane, and other chemicals present in vent and seep fluids.

Animals such as clams, mussels, snails, and shrimp feed on the microbes, and in turn, provide food for fish and other predators. Some vent and seep animals, such as tubeworms and shrimp, also host chemosynthetic microbes on or within their bodies, providing a place for the microbes to live in exchange for nutrients produced by the microbes.

Cold seeps and hydrothermal vents differ from one another in the underlying conditions that form and drive them. This has implications for the kinds of animals that are able to survive at each.

Hydrothermal vents are driven by heat from volcanism beneath the seafloor. In this environment, chemical reactions take place as seawater percolates through cracks in the seafloor to produce hot (more than 400°C or 750°C), acidic fluids that eventually rise back to the seafloor. Vents, and the ecosystems they support, are created and destroyed as underlying volcanic activity waxes and wanes over tens or hundreds of years. On land and near the ocean surface, sunlight provides the energy that allows photosynthetic plants to convert carbon dioxide and water into a fundamental source of nutrients for organisms in proximal food chains and webs. Below the photic zone many microbes have evolved chemosynthetic (instead of photosynthetic) processes that create organic matter by using oxygen in seawater to oxidize hydrogen sulfide, methane, and other chemicals present in vent and seep fluids. Animals such as clams, mussels, snails, and shrimp feed on the microbes, and in turn, provide food for fish and other predators.

Cold seeps are a little bit different. They produce a diffuse flow of lower-temperature fluids, often composed of natural gas and a mixture of hydrocarbons, at slower rates for longer periods. The methane seeping from the seafloor sustains microbes that serve as the base of the food chain for communities of animals which thrive in the sunless depths. Far more natural gas is sequestered on the seafloor—or leaking from it—than can be drilled from all the existing wells on Earth. Some seeps may be thousands of years old.

8.E.1. 3
Students know:

- **that the health of a water system is determined by the balance between physical, chemical and biological variables.** Physical variables include temperature, turbidity, and water movement. Chemical variables include dissolved oxygen and other gases, pH, nitrates, and salinity. Both natural and man-made forces are constantly changing these variables. Freshwater systems are of particular concern because they are the source of most of the potable water consumed by humans. Testing for the occurrence of chemicals and other factors that can influence water quality, such as nutrients and pesticides in water resources is a normal part of public health maintenance and stewardship of freshwater resources. Water that is safe to drink is called potable water, or drinking water, in contrast to safe water, which can be used for bathing or cleaning. In the United States, the Environmental Protection Agency sets maximum levels for the 90 most commonly occurring contaminants.

- **that the temperature of water in rivers and lakes determines the kinds of organisms that can survive there.** Particular aquatic species have preferred water temperature ranges within which they will live and thrive. Warm water dissolves more of a solid substance as it gets warmer, but it also dissolves less of important gases like oxygen and carbon dioxide. Very warm water may not contain enough dissolved oxygen for aquatic life to survive.

- **that measuring dissolved oxygen is an important factor in determining water quality**. Dissolved oxygen (commonly called DO, pronounced dee-oh) is oxygen that is dissolved in water. Dissolved oxygen (DO) is a measure of the amount of oxygen in water that is available for chemical reactions and for use by aquatic organisms. In the aquatic ecosystem, dissolved oxygen balance in water is important for the survival of certain microorganisms and higher organisms such as zooplankton and fish. Normally oxygen in water gets there through diffusion with the air and as a waste product of photosynthesis by aquatic plants. Dissolved oxygen in surface water is used by all forms of aquatic life; therefore, it is measured to assess the "health" of lakes and streams. Dissolved oxygen levels vary with seasons, and over 24 hour cycles. When dissolved oxygen levels in a body of water decline, sensitive animals may move away, weaken, or die. High DO levels in potable water usually make it taste better.

- **that pH is a measure of how acidic or basic water is.** pH is important because it controls many chemical and biological processes that occur in the water. pH is measured on a scale that ranges from 0 to 14, with 7 considered neutral. Values of pH less than 7 are acidic, while values higher than 7 are basic. The pH scale ranges from 0 (high concentration of positive hydrogen ions, strongly acidic) to 14 (high concentration of negative hydroxide ions, strongly basic). In pure water the pH measures exactly 7. Students know that the pH of a body of water is important because pH has a synergistic effect. This means that the impact of other materials in a body of water - such as iron, aluminum, ammonia, or mercury - is amplified or diminished depending on the pH of the water. For example, when acidic waters come into contact with certain chemicals and metals, it makes these chemicals and metals more poisonous than normal. This has special significance in water treatment processes, because specific water treatment processes require specific pH ranges.

- **that nitrogen and phosphorous are essential plant nutrients.** The nitrates and phosphates derived from them are chemicals that pose possible health risks to humans if their presence in drinking water is not controlled. The major sources of nitrates in surface water include runoff contaminated with fertilizers, septic tank leakage, sewage, and erosion of natural deposits. Phosphates, on the other hand, usually enter waterways from human and animal waste, laundry, cleaning and industrial effluents.

- **that turbidity is a measure of how clear water is.** The more suspended solids there are in a water sample, the less transparent it is. Turbidity is considered a good measure of water quality. In drinking water, high turbidity is generally not considered a favorable sign because it can be associated with organic pollution that might include pathogenic materials. In surface bodies of water, high turbidity can lead to increased water temperatures, low dissolved oxygen, and even physical impairment of aquatic organisms.

- **that the water quality of a body of water can also be assessed by using bioindicators (macroinvertebrates)**. The presence, condition, and numbers of the types of fish, insects, algae, plants and other aquatic life provide accurate information about the health of freshwater, coastal and marine waters. Bioindicators include living macroinvertebrates. Macroinvertebrates are easy for people to collect and identify. Because many macroinvertebrates are sensitive to pollution in water, they are a good indicator of whether or not a body of water is livable. Good water quality is indicated by a variety of macroinvertebrates. Poor water quality is indicated by a few of one type of macroinvertebrates in one place.

8.E.1.4

Students know:

- **that water quality is a term used to describe the chemical, physical, and biological characteristics of water.** Scientifically, an array of chemical, physical, and biological measurements is used to define water quality. Water quality is also described in terms of the purpose for which water is intended to be used. Water that is safe to drink is called potable water, or drinking water, in contrast to safe water, which can be used for bathing or cleaning. In the United States, the Environmental Protection Agency sets maximum levels for the 90 most commonly occurring contaminants.

- **that water quality standards outline the water quality pollution control program that is mandated and regulated by local, regional and federal agencies.** Standards outline the goals for a body of water by identifying its uses, establishing how to protect those uses and establishing provisions to protect and preserve the water bodies in the long term. Point and non-point environmental stressors such as urban and/or agricultural runoff, industrial inputs and over-fishing can impact a variety of aquatic and land-based populations. Because the water quality of a given water body is so closely linked to the surrounding environment and land use, monitoring and regulation at local, regional, and national levels is important.

- **clear water may contain odorless, tasteless, and colorless harmful contaminants.** Water must be tested for specific contaminants such as bacteria, nitrates, arsenic and others. Natural supplies of potable water are very limited and do not exist in sufficient quantities to meet human needs. Because of this, humans have developed water treatments that process water so that it can be used for a particular purpose. Drinking water treatment requires some basic steps:
  - Water collection
  - Coagulation, during which lime and alum are added to the water, causing particulates to clump together.
  - Next, the water is shaken to form larger clumps, called flocs.
  - During the sedimentation process water stands for approximately 24 hours, which allows the clumps to settle to the bottom.
  - The water is then filtered, disinfected (usually with chlorine) and aerated.

  The substances removed during the drinking water treatment process include suspended solids, bacteria, algae, viruses, fungi, minerals, and chemical pollutants.

- **that water is essential to life.** Water quality determines the sustenance of ecosystems, human activity such as agriculture, fishing, and recreation, as well as public health of human societies. Water quality supports healthy environments in which rich and varied communities of organisms can be found. The importance of monitoring and maintaining water quality cannot be overstated. Cultivating an awareness of their connection to North Carolina's hydrologic system is the first step towards developing stewardship skills and dispositions in students.

Earth History

Essential Standard and Clarifying Objectives

8.E.2 Understand the history of Earth and its life forms based on evidence of change recorded in fossil records and landforms.

8.E.2.1 Infer the age of Earth and relative age of rocks and fossils from index fossils and ordering of rock layers (relative dating and radioactive dating).

8.E.2.2 Explain the use of fossils, ice cores, composition of sedimentary rocks, faults, and igneous rock formations found in rock layers as evidence of the history of the Earth and its changing life forms.

Unpacking
What does this standard mean a child will know, understand and be able to do?

8.E.2.1

Students know:

- **that fossils provide important evidence of how life and environmental conditions have changed.** The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. Earth's history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.

- **that a *fossil* is the preserved remains or traces of an organism that lived in the past.** Fossils give clues to the diversity of living things over the history of Earth, give clues to past climate and surface changes on Earth, and give clues to changes that have occurred with organisms over time.

- **the formation process of mold, cast, petrified, preserved, carbonized, and trace fossils.**

- **the different types of fossils based on how they were formed.** The formation process of fossils varies depending on where and under what environmental conditions they formed.
    - ***Mold fossil* –** forms when sediments bury an organism and the sediments change into rock; the organism decays leaving a cavity in the shape of the organism.
    - ***Cast fossil* –** forms when a mold is filled with sand or mud that hardens into the shape of the organism.
    - ***Petrified fossil (permineralized fossil)* –** forms when minerals soak into the buried remains, replacing the remains, and changing them into rock.
    - ***Preserved fossil* –** forms when entire organisms or parts of organisms are prevented from decaying by being trapped in rock, ice, tar, or amber.

- *Carbonized fossil* – forms when organisms or parts, like leaves, stems, flowers, fish, are pressed between layers of soft mud or clay that hardens squeezing almost all the decaying organism away leaving the carbon imprint in the rock.
- *Trace fossil* – forms when the mud or sand hardens to stone where a footprint, trail, or burrow of an organism was left behind.

- **that the geologic time scale is a record of the major events and diversity of life forms present in Earth's history.** The geologic time scale began when Earth was formed and goes on until the present. At the end of each era a mass extinction occurred, many kinds of organisms died out, although there were other extinctions going on during each period of geologic time. Using the fossil record, paleontologists have created an idea of the different types of common organisms in each geologic period.
  - ***Precambrian Era***
    - The Precambrian Era is Earth's first era of time. It began with the creation of the Earth around 4.6 billion years ago.
    - 5 major events occurred during this era: (1) the formation of the Sun and light, (2) the creation of the Earth, (3) the creation of the atmosphere through volcanic out-gassing, (4) the creation of the oceans, and (5) the creation of life.
    - Began with simple life forms such as bacteria and simple algae.
    - There was a rise of simple organisms such as jellyfish and sea worms by the end of the era.
    - Few fossils because the life forms were soft-bodied and had no hard skeleton.
  - ***Paleozoic Era***
    - Began with the early invertebrates, such as trilobites and brachiopods; continued to develop early vertebrate fish, then arachnids and insects; later came the first amphibians, and near the era's end the reptiles became dominant.
    - Early land plants included simple mosses, ferns, and then cone-bearing plants.
    - By the end of the era, seed plants were common.
    - The mass extinction that ended the era caused most marine invertebrates as well as amphibians to disappear.
  - ***Mesozoic Era***
    - Reptiles were the dominant animals of this era, including the various dinosaurs.
    - Small mammals and birds also appeared.
    - Toward the end of the era, flowering plants appeared and the kinds of mammals increased.
    - The mass extinction that ended the era caused the dinosaurs to become extinct.
  - ***Cenozoic Era***
    - New mammals appeared while others became extinct.
    - The diversity of life forms increased.
    - Flowering plants became most common.
    - Humans are also part of the most recent period of this era.

- **that various models, diagrams, and pictures can be used to illustrate the vastness of time involved in geologic time and to show the**

diversity of life evident across geologic time. Through the illustrations, not only does the diversity of life-forms increase, but the complexity of those life-forms also increases.

- **that millions of fossils have been collected and studied.** The *fossil record* gives important information about past life and environments on Earth. Certain fossilized organisms could only live in specific environments or under particular climate conditions. Extinction of life-forms as well as how and when new life-forms appeared is part of the fossil record.

- **that the *relative age* means the age of one object compared to the age of another object.** Relative age does not tell the exact age of an object. The relative age of rocks and fossils can be determined using two basic methods: ordering of rock layers and index fossils:
    - ***Ordering of Rock Layers*** Scientists read the rock layers knowing that each layer is deposited on top of other layers. The *law of superposition* states that each rock layer is older than the one above it. This law is used to read rock layers. Using this understanding of layering, scientists infer that the relative age of the rock or fossil in the rock is older if farther down in the rock layers. Relative dating is best used when the rock layers have been preserved in their original sequence. Over millions of years, tectonic plate motion can distort these layers. As a result of this, the youngest layers of rock are not always found on top, because of folding, breaking, and uplift of layers.

    - ***Index Fossils*** Certain fossils, called *index fossils*, can be used to help find the relative age of rock layers. To be an index fossil –an organism must have lived only during a short part of Earth's history; many fossils of the organism must be found in rock layers; the fossil must be found over a wide area of Earth; the organism must be unique.

      The shorter time period a species lived, the better an index it is. A key example of an organism used as an index fossil are *trilobites*, a group of hard-shelled animals whose body had three sections, lived in shallow seas, and became extinct about 245 million years ago. Therefore, if a trilobite is found in a particular rock layer, it can be compared with trilobites from other layers to estimate the age of the layer in which it was found.

- **that geologists use radiometric dating to estimate how long ago rocks formed, and to infer the ages of fossils contained within those rocks.** The universe is full of naturally occurring radioactive elements. Radioactive atoms are inherently unstable; over time, radioactive "parent atoms" decay into stable "daughter atoms." When molten rock cools, forming what are called igneous rocks, radioactive atoms are trapped inside. Afterwards, they decay at a predictable rate. By measuring the quantity of unstable atoms left in a rock and comparing it to the quantity of stable daughter atoms in the rock, scientists can estimate the amount of time that has passed since that rock formed. Absolute geologic dating and relative geologic dating are two methods by which scientists try to determine the age of geologic evidence. Carbon-14 dating is an example of absolute dating, and the law of superposition is an example of relative dating.

Teacher Note: It is not necessary for students to calculate radioactive decay.

8.E.2.2

Students know:

- **that a variety of artifacts are used to determine the geological history of the Earth, as well as how its life forms have changed over time.** *Ice cores* are cylinders of ice that are drilled out of glaciers and polar ice sheets. Ice cores play an important role in helping scientists to gain an understanding of the Earth's history, particularly how earth's climate has changed over time. When snow falls it carries with it the compounds that are in the air at the time. In areas where temperatures are rarely above freezing (ice sheets and glacial areas), this builds up layer upon layer of compacted snow which becomes ice. Within these ice layers there is a record of the atmosphere at the time that the snow creating the ice layers fell.

  Sedimentary rock makes up about 75% of the rocks on the Earth's surface. Sedimentary rocks form on the surface of the Earth, anywhere that sand, mud, or other types of sediment collect. Scientists can gain an understanding of Earth's climate, biological, and geologic history by examining the contents of different layers of sedimentary rock. Sedimentary rock layers can be disturbed by igneous rock. This happens when molten rock forces it way up through the layers above it. This forms igneous rock sections within and across the sedimentary layers. The sedimentary rock layers must be there first, therefore the igneous rock intrusions are younger than the layers it cuts through. Sometime the molten rock will force its way to the surface and erupt, creating a younger igneous layer at the surface. With time, more sedimentary layers can form on top of the igneous rock. Igneous rock is always younger than rock layers it cuts through.

- **that a fault is a break in the rocks that make up the Earth's crust that is formed due to the movement of rock on either side of the fault.** Generally, faults occur where there is movement (a slip) of tectonic plates. Sudden movement of this type is associated with earthquakes. Students know that the two main types of faults involve dip slips and strike slips. In a dip slip, two pieces of land change their vertical position compared to one another. Afterward, one side of the fault is higher than the other. In a strike slip, two pieces of land move horizontally.

Structures and Functions of Living Organisms

Essential Standard and Clarifying Objectives

8.L.1 Understand the structure and hazards caused by agents of disease that effect living organisms.

8.L.1.1 Summarize the basic characteristics of viruses, bacteria, fungi and parasites relating to the spread, treatment and prevention of disease.

8.L.1.2 Explain the difference between epidemic and pandemic as it relates to the spread, treatment and prevention of disease.

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.L.1.1

Students know that:

- **microbiology as a basic science explores microscopic organisms including viruses, bacteria, protozoa, parasites, and some fungi and algae.** These organisms lack tissue differentiation, are unicellular, and exhibit diversity of form and size.

- **viruses, bacteria, fungi and parasites may infect the human body and interfere with normal body functions.** Some kinds of bacteria or fungi may infect the body to form colonies in preferred organs or tissues.
  - ***Viruses***
    - Viruses are non-living particles composed of a nucleic acid (DNA or RNA) and a protein coat.
    - Viruses need a host cell to reproduce.
    - Viruses invade healthy cells and use the enzymes and organelles of the host cell to make more viruses, usually killing those cells in the process.
    - Viral diseases are among the most widespread illnesses in humans. These illnesses range from mild fevers to some forms of cancer and include several other severe and fatal diseases. Transmission of these illnesses varies; some are transmitted by human contact, while others are transmitted through water or an insect bite.
    - Vaccines and some anti-viral drugs are used to control and prevent the spread of viral diseases.
  - ***Bacteria***
    - Bacteria are prokaryotic single-celled organisms.
    - Bacteria can live in a variety of places (with oxygen, without oxygen, extreme hot, extreme cold).
    - Bacteria reproduce through binary fission, a form of asexual reproduction. Under optimal conditions, bacteria can grow and divide extremely rapidly, and bacterial populations can double very quickly.

- Antibiotics are used to inhibit the growth of bacteria. Because antibiotics have been overused, many diseases that were once easy to treat are becoming more difficult to treat. Antibiotic resistance in bacteria occurs when mutant bacteria survive an antibiotic treatment and give rise to a resistant population.

- ***Fungi***
  - Fungi are eukaryotic, nonphotosynthetic organisms, and most are multicellular heterotrophs.
  - Most fungi reproduce both sexually and asexually (producing spores). This provides an adaptive advantage. When the environment is favorable, rapid asexual reproduction ensures an increased spread of the species. During environmental stress, sexual reproduction ensures genetic recombination, increasing the likelihood that offspring will be better adapted to the new environmental conditions.
  - Fungi can sometimes attack the tissues of living plants and animals and cause disease. Fungal disease is a major concern for humans because fungi attack not only us but also our food sources, making fungi competitors with humans for nutrients.
  - Mold spores can cause mild to serious allergies in some people. Billions of mold spores can become airborne and may then be inhaled, triggering an allergic reaction.
- ***Parasites***
  - A parasite is an organism that feed on another individual, known as the host. They either live on or in their host's body.
  - Natural selection favors adaptations that allow a parasite to efficiently exploit its host. Parasites are usually specialized anatomically and physiologically. Tapeworms are so specialized for a parasitic lifestyle that they do not even have a digestive system. They live in the small intestine of their host and absorb nutrients directly through their skin.
  - Infectious disease may also be caused by animal parasites, which may take up residence in the intestines, bloodstream, or tissues.

Teacher Note: It is not necessary for students to know specific diseases or disorders caused by microorganisms.

8.L.1.2

Students know that:

- **a disease outbreak happens when a disease occurs in greater numbers than expected in a community or region, or during a season.** An outbreak may occur in one community or even extend to several countries. It can last from days to years. Sometimes a single case of a contagious disease is considered an outbreak. This may be true if it is an unknown disease, is new to a community, or has been absent from a population for a long time. An outbreak can be considered as an *epidemic* or *pandemic*.

- **epidemic and** pandemic **are similar terms that refer to the spread of infectious diseases among a population.** There are two main differences between epidemic and pandemic. The term *pandemic* normally is used to indicate a far higher number of people affected than an epidemic. *Pandemic* also refers to a much larger region being affected. In the most extreme case, the entire global population would be affected by a pandemic.

- **the terms *epidemic* and *pandemic* usually refer to the rate of infection, the area that is affected or both.** An epidemic is defined as an illness or health-related issue that is showing up in more cases than would normally be expected. It occurs when an infectious disease spreads rapidly to many people. In 2003, the severe acute respiratory syndrome (SARS) epidemic took the lives of nearly 800 people worldwide.

- **in the case of a pandemic, even more of the population is affected than in an epidemic.** A pandemic typically is in a widespread area (usually worldwide) rather than being confined to a particular location or region and affect global populations. An epidemic is not worldwide. For example, malaria can reach epidemic levels in regions of Africa but is not a threat globally. Whereas a flu strain can begin locally (epidemic) but eventually spread globally (pandemic). This is not unusual for a new virus, because if people have not been exposed to the virus before, their immune systems are not ready to fight it off, and more people become ill. Swine flu started in Mexico city where it was feared to lead to epidemic proportions in North America, now that the flu has been found in New Zealand, Israel, Scotland and many other countries, it has become pandemic. The 1918 Spanish flu and the Black Plague are extreme examples of pandemics. Keep in mind, though, that a pandemic doesn't necessarily mean millions of deaths-it means a geographically widespread epidemic.

- **influenza pandemics have occurred more than once.** Spanish influenza killed 40-50 million people in 1918. The Asian influenza killed 2 million people in 1957. The Hong Kong influenza killed 1 million people in 1968. An influenza pandemic occurs when: A new subtype of virus arises. This means humans have little or no immunity to it; therefore, everyone is at risk. The virus spreads easily from person to person, such as through sneezing or coughing. The virus begins to cause serious illness worldwide. With past flu pandemics, the virus reached all parts of the globe within six to nine months. With the speed of air travel today, public health experts believe an influenza pandemic could spread much more quickly. A pandemic can occur in waves. And all parts of the world may not be affected at the same time.

Teacher Note: It is not necessary for students to know specific examples of epidemics and pandemics. Examples provided are for teaching purposes only.

Essential Standard and Clarifying Objectives

8.L.2 Understand how biotechnology is used to affect living organisms.

8.L.2.1 Summarize aspects of biotechnology including:

- Specific genetic information available
- Careers

- Economic benefits to North Carolina
- Ethical issues
- Implications for agriculture

Unpacking
What does this standards mean a child will know and be able to do?

8.L.2.1

Students know that:

- **technology is essential to science for such purposes as sample collection and treatment, measurement, data collection and storage, computation, and communication of information.**

- **traditional biotechnology was (and still is) the use of living organisms to solve problems and make useful products.** Domesticating crop plants and farm animals through selective breeding, and using yeast to make bread rise and produce wine are examples of traditional biotechnology. New biotechnology involves the use of living cells and their molecules to solve problems and make useful products.

- **biotechnology is not just one technology, but many.** Biotechnology is a toolbox filled with many different kinds of living cells and their component molecules, and different ways to use them. Because there are millions of different species of plants, animals, and microorganisms in the world, each having cells and molecules with unique characteristics, there are a lot of potential tools in this toolbox. This is why biotechnology is so powerful and can be applied in so many different ways. There are three basic kinds of biotechnology tools: working with cells, working with proteins, and working with genes.

- **many industries are finding uses for the new tools provided by biotechnology.** The health care industry is developing better ways to diagnose, treat, and prevent disease. The food and agriculture industries are rapidly adopting the tools of biotechnology. The "third wave" of biotechnology applications is just beginning to emerge in energy and the environment, where living cells and their molecules can help us develop new methods to clean up our environment, detect environmental contamination, and reduce our dependence on petroleum.

- **the microbial world has led to the emerging field of biotechnology which has given us many advances and new careers in medicine, agriculture, genetics, and food science.** Biotechnology, while it has benefited North Carolina in many ways, has also raised many ethical issues for an informed community to consider. As we increase our knowledge and make advances in technology we are able to reduce the threat of microbial hazards.

- **biotechnology affects us in every area of our lives: our food, water, medicine and shelter.** Uses of modern biotechnology include: making medicine in large quantities (e.g. penicillin) and human insulin for the treatment of diabetes, combating crime through DNA testing and forensic testing, removing pollution from soil and water (bioremediation), and improving the quality of agricultural crops and livestock products. Some new areas such as Genetic Modification (GM) and cloning are controversial.

Ecosystems

Essential Standard and Clarifying Objectives

8.L.3 Understand how organisms interact with and respond to the biotic and abiotic components of their environment.

8.L.3.1 Explain how factors such as food, water, shelter, and space affect populations in an ecosystem.

8.L.3.2 Summarize the relationships among producers, consumers, and decomposers including the positive and negative consequences of such interactions including:

- coexistence and cooperation
- competition (predator/prey)
- parasitism
- mutualism

8.L.3.3 Explain how the flow of energy within food webs is interconnected with the cycling of matter (including water, nitrogen, carbon dioxide, and oxygen).

Unpacking
What does this standard mean a child will know, understand and be able to do?

8.L.3.1

Students know that:

- **ecosystems are complex, interactive systems that include both biological communities (biotic) and physical (abiotic) components of the environment.** Organisms and populations of organisms are dependent on their environmental interactions both with living and nonliving factors. As with individual organisms, a hierarchal structure exists; groups of the same organisms (species) form populations, different populations interact to form communities, communities live within an ecosystem, and all of the ecosystems on Earth make up the biosphere. Like individual organisms, ecosystems are sustained by the continuous flow of energy.

- **ecosystems are dynamic in nature; their characteristics can vary over time.** Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.

- **a *population* is a group of organisms belonging to the same species that live in a particular area.** Populations can be described based on their size, density, or distribution.

- **population density measures the number of individual organisms living in a defined space.** Regulation of a population is affected by limiting factors that include density-dependent, density-independent, abiotic and biotic factors.
    - ***Density-dependent factors*** Limiting factors that are density-dependent are those that operate more strongly on large populations than on small ones. Density-dependent limiting factors include competition (for food, water, shelter & space), predation, parasitism, and disease. These limiting factors are triggered by increases in population density (crowding).
    - ***Density-independent factors*** Limiting factors that are density-independent are those that occur regardless of how large the population is and reduce the size of all populations in the area in which they occur by the same proportion. Density-independent factors are mostly abiotic (such as weather changes), human activities (such as pollution), and natural disasters (such as fires).
    - ***Abiotic and biotic factors*** Limiting factors can change within an ecosystem and may affect a population.
        - *Abiotic factors* are nonliving things in an ecosystem and may be chemical or physical. Some examples are water, nitrogen, oxygen, salinity, pH, soil nutrients and composition, temperature, amount of sunlight, and precipitation.
        - *Biotic factors* include all of the living components of an ecosystem. Some examples are bacteria, fungi, plants, and animals.

      A change in an abiotic or biotic factor may decrease the size of a population if it cannot acclimate or adapt to or migrate from the change. A change may increase the size of a population if that change enhances its ability to survive, flourish or reproduce.

Teacher Note: It is not essential for students to calculate population growth patterns or population density.

8.L.3.2

Students know:

- **that organisms in an ecosystem constantly interact.** These interactions among the organisms:
    - generate stability within ecosystems.
    - can facilitate or restrain growth.
    - can enhance or limit the size of populations, maintaining the balance between available resources and those who consume them.
    - can change both biotic and abiotic characteristics of the environment.

- **that an *ecosystem* is defined as a community (all the organisms in a given area) and the abiotic factors (such as water, soil, or climate) that affect them.** A *stable ecosystem* is one where
    - the population numbers of each organism fluctuate at a predictable rate.

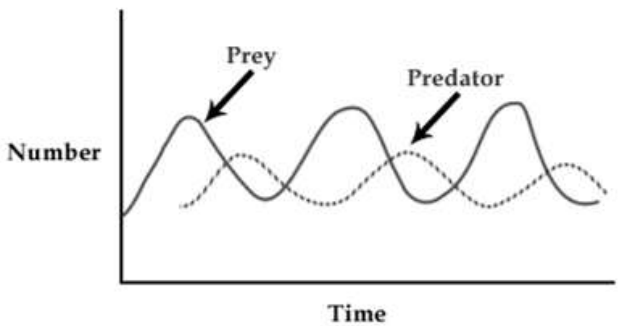
- the supply of resources in the physical environment fluctuates at a predictable rate.
- energy flows through the ecosystem at a fairly constant rate over time.

These fluctuations in populations and resources ultimately result in a stable ecosystem.

Predation is an interaction between species in which one species (the *predator*) eats the other (the *prey*). This interaction helps regulate the population within an ecosystem thereby causing it to become stable. Fluctuations in predator–prey populations are predictable. At some point the prey population grows so numerous that they are easy to find.

A graph of predator–prey density over time shows how the cycle of fluctuations results in a stable ecosystem.

- As the prey population increases, the predator population increases.
- As the predator population increases, the prey population decreases.



- **that in any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources.**
  - ***Competition*** is a relationship that occurs when two or more organisms need the same resource at the same time. Competition can be among the members of the same or different species and usually occurs with organisms that share the same niche.
    - An ecological *niche* refers to the role of an organism in its environment including type of food it eats, how it obtains its food and how it interacts with other organisms.
    - Two species with identical ecological niches cannot coexist in the same habitat.
  - Competition usually results in a decrease in the population of a species less adapted to compete for a particular resource.
  - A ***symbiotic relationship*** exists between organisms of two different species that live together in direct contact. The balance of the ecosystem is adapted to the symbiotic relationship. If the population of one or other of the symbiotic organisms becomes unbalanced,

the populations of both organisms will fluctuate in an uncharacteristic manner. Symbiotic relationships include parasitism, mutualism, and commensalism.

- ***Parasitism*** is a symbiotic relationship in which one organism (the parasite) benefits at the expense of the other organism (the host). In general, the parasite does not kill the host.
  - Some parasites live within the host, such as tape worms, heartworms, or bacteria.
  - Some parasites feed on the external surface of a host, such as aphids, fleas, or mistletoe.
  - The parasite-host populations that have survived have been those where neither has a devastating effect on the other.
  - Parasitism that results in the rapid death of the host is devastating to both the parasite and the host populations. It is important that the host survive and thrive long enough for the parasite to reproduce and spread.
- ***Mutualism*** is a symbiotic relationship in which both organisms benefit. Because the two organisms work closely together, they help each other survive. For example,
  - bacteria, which have the ability to digest wood, live within the digestive tracts of termites;
  - plant roots provide food for fungi that break down nutrients the plant needs.

8.L.3.3

Students know that the sun is the ultimate source of energy.

- Energy entering ecosystems as sunlight is transferred by producers into chemical energy through the process of photosynthesis.
- Energy then passes from organisms to organisms.
- Energy can change from one form to another in living things. Animals get energy from oxidizing their food, releasing some of its energy as heat.
- Almost all food energy comes originally from sunlight.

Students know that food provides molecules that serve as fuel and building material for all organisms. Plants, algae (including phytoplankton), and many microorganisms use the energy in light to make sugars (food) from carbon dioxide and from the atmosphere and water through the process of photosynthesis, which also releases oxygen. This food can be used immediately for fuel or materials or it may be stored for later use. Animals obtain food from eating plants or eating other animals. Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy;. In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to provide energy and produce waste carbon dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not require oxygen. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.

Students know that over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.

Students know that the flow of energy through ecosystems can be described and illustrated in food chains, food webs, and pyramids (energy, number, and biomass). These are all models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers as the three groups interact- primarily for food- within an ecosystem. Transfers of matter into and out of the physical environment occur at every level, for example when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately so are waste products, such as fecal material. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.

Students know how the flow of energy is interconnected with the cycling of matter.

- A ***food chain*** is the simplest path that energy takes through an ecosystem. Energy enters an ecosystem from the Sun. Each level in the transfer of energy through an ecosystem is called a *trophic level*. The organisms in each trophic level use some of the energy in the process of cellular respiration, lose energy due to heat loss, and store the rest.
    - The first trophic level consists of *producers* (green plants or other *autotrophs*).
        - Primary producers capture the Sun's energy during photosynthesis, and it is converted to chemical energy in the form of simple sugars.
        - The autotroph uses some of the simple sugars for energy and some of the simple sugars are converted to organic compounds (carbohydrates, proteins, and fats) as needed for the structure and functions of the organism.
        - Examples of primary producers include land plants and phytoplankton in aquatic environments.
    - The second trophic level consists of *primary consumers (heterotrophs).*
        - Primary consumers that eat green plants are called *herbivores*.
        - The herbivore uses some of the organic compounds for energy and some of the organic compounds are converted into the proteins, carbohydrates and fats that are necessary for the structure and functions of the herbivore. Much of the consumed energy is lost as heat.
        - Examples of primary consumers include grasshoppers, rabbits and zooplankton.
    - The third trophic level, or any higher trophic level, consists of *consumers*.
        - Consumers that eat primary consumers are called *carnivores*; consumers that eat both producers and primary consumers are called *omnivores*.
        - The carnivores or omnivores use some of the organic compounds for energy and some of the organic compounds are converted into the proteins, carbohydrates and fats that are necessary for their body structures and functions. Much of the consumed energy is lost as heat.
        - Examples of consumers include humans, wolves, frogs, and minnows.

- A heterotroph that breaks down organic material and returns the nutrients to soil, water, and air making the nutrients available to other organisms is called a *decomposer*.
- The energy available for each trophic level in an ecosystem can be illustrated with a food chain diagram.

- A ***food web*** represents many interconnected food chains describing the various paths that energy takes through an ecosystem. The energy available in an ecosystem can be illustrated with a food web diagram.

- ***Ecological pyramids*** are models that show how energy flows through ecosystems. Pyramids can show the relative amounts of energy, biomass, or numbers of organisms at each trophic level in an ecosystem. The base of the pyramid represents producers. Each step up represents a different level of consumer. The number of trophic levels in the pyramid is determined by the number of organisms in the food chain or food web.

  - An *energy pyramid* represents the energy available for each trophic level in an ecosystem.
    - The energy needs of organisms are greater from level to level in an ecosystem.
    - Therefore, the total amount of energy available at each level decreases in an ecosystem.
    - Each successive level in an ecosystem can support fewer numbers of organisms than the one below. With each level of the pyramid, only 10% of the energy available is used by organisms while there is an energy loss of about 90% to the environment.
  - A *number pyramid* represents the number of individual organisms available for energy at each trophic level in an ecosystem. It can be used to examine how the population of a certain species affects another.
    - The autotrophic level is represented at the base of the pyramid. This represents the total number of producers available to support the energy needs of the ecosystem.
    - The total numbers of individual organisms tend to decline as one goes up trophic levels.
  - A *biomass pyramid* represents the total mass of living organic matter (biomass) at each trophic level in an ecosystem.
    - Since the number of organisms is reduced in each successive trophic level, the biomass at each trophic level is reduced as well.
    - Even though a biomass pyramid shows the total mass of organisms available at each level, it does not necessarily represent the amount of energy available at each level. For example, the skeleton and beak of a bird will contribute to the total biomass but are not available for energy.

Evolution and Genetics
Essential Standard and Clarifying Objectives
8.L.4 Understand the evolution of organisms and landforms based on evidence, theories and processes that impact the Earth over time. 8.L.4.1 Summarize the use of evidence drawn from geology, fossils, and comparative anatomy to form the basis for biological classification systems and the theory of evolution. 8.L.4.2 Explain the relationship between genetic variation and an organism's ability to adapt to its environment.
Unpacking What does this standard mean a child will know, understand and be able to do?
8.L.4.1 **Students know that:** • life on Earth, as well as the shape of Earth's surface, has a history of change that is called ***evolution.*** • the evidence that organisms and landforms change over time is scientifically described using the ***Theory of Evolution***, the ***Plate Tectonics Theory****, and the* ***Law of Superposition*****.** • ***biological evolution*** **accounts for the diversity of species developed through gradual processes over many generations.** Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment. Similarities among organisms can infer the degree of relatedness: homologous structures—anatomical and cellular, analogous structures--anatomical and cellular, embryological similarities—anatomical and cellular, human developmental patterns are similar to those of other vertebrates. • ***fossils*** (mineral replacements, preserved or traces of organisms that lived in the past) **can be compared to one another and to living organisms according to their similarities and differences.** Many thousands of layers of sedimentary rock provide evidence for the long history of the earth and for the long history of changing life forms whose remains are found in the rocks. Sediments, sand and smaller particles (sometimes containing the remains of organisms) are gradually buried and cemented together to form solid rock again. More recently deposited rock layers are more likely to contain fossils resembling existing species. Thousands of layers of sedimentary rock not only provide evidence of the history of Earth itself, but also of changes in organisms whose fossil remains have been found in these layers. The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are

found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life in Earth. Because of the conditions necessary for their preservation, not all types of organisms that existed in the past have left fossils that can be retrieved. Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.

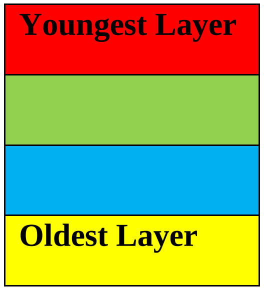
- **most species that have lived on the earth are now extinct.** Extinction of species is common. Extinction of species occurs when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment. Some organisms that lived long ago are similar to existing organisms, but some are quite different. Extinction of organisms is apparent in the fossil record.

- ***biological classification*** is a system which is used to organize and codify all life on Earth. There are a number of goals to biological classification, in addition to the obvious need to be able to precisely describe organisms. Creating a system of classification allows scientists to examine the relationships between various organisms, and to construct evolutionary trees to explore the origins of life on Earth and the relationship of modern organisms to historical examples. Biological classification is also referred to as ***taxonomy.*** Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy.

Theory of Evolution: The theory states that species change over time. Living things evolve in response to changes in their environment. Charles Darwin is widely known as the "Father of Evolution". His theory of evolution is the widely held notion that all life is related and has descended from a common ancestor. As random genetic mutations occur within an organism's genetic code, the beneficial mutations are preserved because they aid survival -- a process known as *natural selection.* These beneficial mutations are passed on to the next generation. Over time, beneficial mutations accumulate and the result is an entirely different organism (not just a variation of the original, but an entirely different creature).

Plate Tectonics Theory: The movements of Earth's continental and oceanic plates have caused mountains and deep ocean trenches to form and continually change the shape of Earth's crust throughout time. These same movements have caused these plates to pass through different climatic ones. Natural processes and human activities result in environmental challenges. Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas and shaped the surface of land. Sea level changes as plate tectonics cause the volume of the oceans and the height of land to change, as ice caps on land melt or enlarge and/or as sea water expands when ocean water warms and cools. The processes responsible for changes we observe today are similar to the processes that have occurred throughout Earth's history. The evolution of Earth's living things is strongly linked to the movements of the lithospheric plates. The movements of the plates cause changes in climate, in geographic features such as mountains, and in the types of living things in particular places.

Law of Superposition: Many thousands of layers of sedimentary rock provide evidence for the long history of the earth and for the long history of changing life forms whose remains are found in the rocks (fossils). More recently deposited rock layers are more likely to contain fossils resembling existing species.



The Law of Superposition states that in any undisturbed sequence of rocks deposited in layers, the youngest layer is on top and the oldest on bottom, each layer being younger than the one beneath it and older than the one above it.

8.L.4.2

Students know that:

- **within every population, variation exists within the inherited traits of the individuals.** Variation exists in the phenotypes (body structures and characteristics) of the individuals within every population. An organism's phenotype may influence its ability to find, obtain, or utilize its resources (food, water, shelter, etc.) and also might affect the organism's ability to reproduce.

- **in any particular environment, the growth and survival of organisms depend on physical conditions.** Changes in environmental conditions can affect the survival of individual organisms and entire species. If an environment changes, organisms that have characteristics which are well-suited to the new environment will be able to survive and reproduce at higher rates than those with less favorable traits. Therefore, the alleles associated with favorable phenotypes increase in frequency and become more common and increase the chances of survival of the species.

- **individual organisms with certain traits (those that are "favored" in the environment) are more likely than others to survive, reproduce and pass these "favorable" traits (such as courting behaviors, coloration or odors in plants and animals, competitive strength) to their offspring.** Those organisms that do not interact well with the environment are more likely to die or produce fewer offspring than those organisms having "favored" traits.

- **within a species there is a variability of phenotypic traits leading to diversity among the organisms of the species. The greater the diversity, the greater the chances are for that species to survive during environmental changes.**

Molecular Biology

Essential Standard and Clarifying Objectives

8.L.5 Understand the composition of various substances as it relates to their ability to serve as a source of energy and building materials for growth and repair of organisms.

8.L.5.1 Summarize how food provides the energy and the molecules required for building materials, growth and survival of all organisms (to include plants).

8.L.5.2 Explain the relationship among a healthy diet, exercise, and the general health of the body (emphasis on the relationship between respiration and digestion).

Unpacking
What does this standard mean a child will know, understand and be able to do?

8.L.5.1

Students know that:

- **food provides molecules that serve as fuel and building material for all organisms.** Plants use the energy in light to make sugars out of carbon dioxide and water. This food can be used immediately for fuel or materials or it may be stored for later use. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.

- **cells carry on the many functions needed to sustain life.** They grow and divide (mitosis or meiosis), thereby producing more cells. This requires that they take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs. The way in which all cells function is similar in all living organisms. Within cells many of the basic functions of organisms, such as releasing energy from food and getting rid of waste, are carried out by different cell elements.

- **matter is transferred among organisms in an ecosystem when organisms eat, or are eaten by others for food.** Matter is transferred from organisms to the physical environment when molecules from food react with oxygen to produce carbon dioxide and water in a process called cellular respiration. Through the process of cellular respiration, cells convert energy (glucose) to a usable form of energy (ATP). The energy stored in ATP provides the means by which cells are able to carry out their functions such as growth, development, and repair of organisms, locomotion and transportation of molecules across cell membranes.

- **in plants and animals, molecules from food (a) react with oxygen to provide energy that is needed to carry out life functions, (b)**

build and become incorporated into the body structure, or (c) are stored for later use. (Also in Matter and Energy)

- **matter moves within individual organisms through a series of chemical reactions in which food is broken down and rearranged to form new molecules.**
- **plants use the energy from light to make sugars (food) from carbon dioxide and water. This process transforms light energy from the sun into stored chemical energy.**
- **minerals and other nutrients from the soil are not food (they don't provide energy), but they are needed for plants to make complex molecules from the sugar they make.**
- **chemical energy is transferred from one organism in an ecosystem to another as the organisms interact with each other for food.**
- **the atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.** Over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.
- **energy can change from one form to another in living things. Animals get energy from oxidizing their food, releasing some of its energy as heat. Almost all food energy comes originally from sunlight.**

Teacher Notes:

1) The term *food* is commonly known as whatever nutrients plants and animals must take in if they are to grow and survive. In scientific terms, *food* refers only to those substances, such as carbohydrates, proteins, and lipids, from which organisms derive the energy they need to grow and operate and the material of which they are made. It is also important to emphasize that the sugars that plants make out of water and carbon dioxide are their only source of food. Water and minerals dissolved in it are not sources of energy for plants or for animals.

2) *It is not essential for students to know the structural components of proteins, lipids, and carbohydrates.*

8.L.5.2

Students know that:

- **A balanced diet combined with regular exercise aid in the overall general health of the body.** Humans require energy to function. The total energy used by an individual depends on the type and intensity of the activity and the energy required for basic life processes. The amount of energy required to maintain minimum essential life functions is called *basal metabolic rate*, or BMR. Humans obtain the energy required to carry out basic life processes from the food they consume. Food energy is measured in calories. The amount of food energy (calories) a person requires varies with body weight, age, sex, activity level, and natural body efficiency.

- **For the body to use food (proteins, lipids, carbohydrates) for energy and building materials, the food must first be digested into molecules that are absorbed and transported to cells.**

- **Metabolism is the set of chemical reactions involved in storing fuel (food) molecules and converting fuel (food) molecules into energy.** In order for the body to use the fuel energy stored in food, the food must first be digested and combined with oxygen (oxidized).

- **Three factors contribute to the overall metabolic rate of the body.** The Basal Metabolic Rate (BMR) accounts for about 60% of all energy used by the body. Daily physical activities such as walking and moving around account for another 30% of the energy used by the body. Finally, 10% of the energy used by the body is used to digest and process (oxidize) food.

- **If one consumes more calories than the body uses, the excess is stored and weight is gained. Weight loss occurs when fewer calories are taken in than the body needs.**

- **To burn food for the release of energy stored in it, oxygen must be supplied to cells, and carbon dioxide removed**. The heart /lung system work together to deliver oxygen rich blood to all of the organs, tissues and cells of the body. Lungs take in oxygen for the combustion of food and they eliminate the carbon dioxide produced. The circulatory system moves all these substances to or from cells where they are needed or produced, responding to changing demands.

- **In order for systems to work properly, energy from the cells must be transformed into a useable form for cells and ultimately, organs, to perform work.** These systems work together in order for the body to function properly and maintain a balance. Regular exercise is important to maintain a healthy heart/lung system, good muscle tone, and bone strength. Regular exercise and physical activity increases the heart rate providing more oxygen for the body to use for processing food. A healthy body requires a delicate balance between a healthy diet and physical activity.

- **In order for energy balance to occur, Energy In = Energy Out.** This means that caloric intake equals caloric output. Food components (protein, fat, and carbohydrate) taken into the body have the following fates: they can be used to fuel metabolic activities and physical activities, they can be incorporated into growing body tissues, and they can be stored as fat.

- **There are two important concepts of energy balance for adolescents. First, to allow for normal body growth, more food energy must be consumed than can be accounted for solely on the basis of energy required for metabolic and physical activities. Second, insufficient energy intake may affect cellular metabolic activities, body weight, growth, tissue formation, and health.**

Teacher Note: It is not essential for students to know how to calculate calories and BMI or to know the USDA food pyramid/plate.