7th Grade Science & Engineering Learning Expectations
Public Schools of Brookline

Overview

The Science & Engineering Learning Expectations (LEs) outline the content that students will learn and skills (practices) that students will be able to do from preK through Grade 8. They have been designed with careful consideration to how students will build their knowledge from grade to grade (learning progressions). As they progress through the grades, students will reinforce what they have learned before, continually learning certain overarching concepts in new ways and with increased sophistication.

Organization of the Learning Expectations

The Learning Expectations are organized into three strands: 1) Earth Science, 2) Life Science, and 3) Physical Science.

While the traditional Physical Science, Life Science, and Earth Science strands are referenced, it is important to be aware that none of these strands are totally separate. In fact, scientists often work in inter-disciplinary teams, across disciplines and/or alongside engineers to answer their questions and solve problems.

In addition, Science Practices (Inquiry and Nature of Science), Engineering and Environmental Education content has been woven throughout the Learning Expectations, illustrating the vital interconnections between these topics. This approach allows students to learn about these disciplines in the context of the science concepts they are learning, instead of as stand-alone, disconnected units.

Guide to This Document

This document shows the progression of Science concepts in the form of Big Ideas (left column) and Learning Expectations (right column). The Big Ideas identify the content that students will learn and the Learning Expectations illustrate what students will know and be able to do in order demonstrate that they have acquired this knowledge.

7th Grade Earth Science Learning Expectations

EARTH'S SYSTEMS	
Big Ideas	**Learning Expectations**
<u>Our Earth</u> • All earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and the earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. • Solid rocks can be formed by the cooling of molten rocks, the accumulation and consolidation of sediments (sometimes containing the remains of organisms), or the alteration of older rocks by heat, pressure and fluids.	• Pose and refine questions about Earth's internal processes which result in the cycling and changes of matter within Earth. • Plan and carry out investigations that demonstrate the chemical and physical processes that form rocks and cycle Earth materials. • Make a model to illustrate how energy and matter flows throughout Earth's system. Explain where the energy comes from and how it (and matter) is transformed.
<u>Changing Earth: Earth's History</u> • The geological time scale interpreted from rock strata provides a way to organize Earth's history. Earth has changed significantly since its formation along with the rest of the solar system 4.6 billion years ago. Major historical events include the formation of mountain chains and ocean basins, the evolution and extinction of particular living organisms, volcanic eruptions, periods of massive glaciation, and development of watersheds and rivers through glaciation and water erosion. • Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. • Sediments of sand and smaller particles (sometimes containing the remains of organisms) are gradually buried and are cemented together by dissolved minerals to form solid rock again. • Sedimentary rock buried deep enough may be re-formed by pressure and heat, perhaps melting and recrystallizing into different kinds of rock. These re-formed rock layers may be forced up again to become land surface and even mountains. Subsequently, this new rock too will erode. Rock bears evidence of the minerals, temperatures, and forces that created it. • Thousands of layers of sedimentary rock confirm the long history of the changing surface of the earth and the changing life forms whose remains are found in successive layers. The youngest layers are not always found on top, because of	• Recognize and analyze patterns in geologic evidence or representations of evidence (such as geologic cross-sections) to determine the relative ages of a sequence of events (i.e., sedimentary layering, formation of fossils, folding, faulting, igneous intrusion, erosion). • Develop and interpret models of the geologic time scale in order to organize major events in Earth's history. • Visually represent how Earth has changed throughout its history. • Explain how different geologic processes shape Earth's evolution over widely varying scales of space and time (e.g., meteor impacts are nearly instantaneous, mountain building can take many millions of years). • Gather evidence to support the claim that past geologic events have caused major extinctions of life forms on Earth and that these extinctions have subsequently allowed other life forms to flourish. • Write a story or create an illustration to show the major events that affected New England geology and how they influenced the types of living things present here over geological time. Explain how the geological conditions affected living things. • Pose and refine questions of the fossil and rock records to determine how the geosphere and biosphere systems interact and co-evolve. • Generate and revise causal explanations for how physical and

folding, breaking, and uplift of layers. • The evolution of life is shaped by Earth's varying geologic conditions. Sudden changes in these conditions (e.g., meteor impacts, major volcanic eruptions) have caused mass extinctions. However these changes, as well as more gradual ones, have also allowed other existing or new life forms to flourish. The evolution and proliferation of living things over geological time have in turn changed the rates of weathering and erosion of land surfaces, altered the composition of Earth's soils and atmosphere, and affected the distribution of water in the hydrosphere. • Physical and chemical interactions among rocks, sediments, water, air and plants produce soil. • Surface-related geologic processes create natural resources needed by humans and cause natural hazards that pose challenges to human society (e.g., landslides and coastal erosion).	chemical interactions among rocks, sediments, water, air and organisms contribute to the weathering and erosion of rocks and the formation of soil. • Ask questions to better explain why surface water and mineral resources are distributed unevenly around the planet, based on evidence of current and past geologic processes. • Explain how scientists gather information to learn about Earth's history and give examples to show that this information is continuously changing based on new discoveries and the availability of new tools. • Explain the formation of different types of rocks and their characteristics (composition, conditions under which they form, time to form). Give examples of why it is important to know this. • Given a rock sample, provide evidence of the conditions under which it formed, what it is comprised of, and how it may have changed over time. • Interpret aerial photographs, topographic maps and remote sensing data to identify surface features and explain how they formed.
Changing Earth: Plate Tectonics • The top part of the mantle, along with the crust, forms structures known as tectonic plates. Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geological history. • Plate movements are responsible for most continental and ocean floor features and for the distribution of most rocks and minerals within Earth's crust. • Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. • There are worldwide patterns to major geological events (such as earthquakes, volcanic eruptions, and mountain building) that coincide with plate boundaries. • Some natural hazards, such as volcanic eruptions, are preceded by phenomena that allow for reliable predictions. Others, such as earthquakes, occur suddenly and with no notice, and thus they are not yet predictable. However, mapping the history of earthquakes in a region and an understanding of related geological forces can help forecast the locations and likelihoods of future events. • Humans depend on Earth's interior for many different resources. Mineral and energy resources are limited, and many are not renewable or replaceable over	• Using fossil evidence, evidence from rock formations, continent shapes and seafloor structures, develop and use models of ancient land and ocean basin patterns to explain past and current plate motions. • Manipulate models and provide evidence to support the theory of plate tectonics--continental and ocean-floor features are the result of past plate motions. Illustrate how plate movements affect the distribution of rocks and minerals and the Earth's surface. • Explain how the theory of plate tectonics developed and gradually became a widely accepted way of thinking (as more and more evidence was discovered). • Construct explanations for how the patterns of distributions of Earth's mineral and energy resources, which are limited and often non-renewable, are a result of past and current geologic processes. • Analyze and interpret data about natural hazards in a region, derived from new and/or improved technologies, to identify the patterns that allow for predictions or forecasts of future events (e.g., volcanoes, earthquakes, tsunamis).

human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.	
<u>Human Interactions with Earth [Social Studies Connection]</u> • Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geological processes. • Humans have become one of the most significant agents of change in the near-surface Earth system. Human activities have significantly altered the biosphere, geosphere, hydrosphere and atmosphere. • As human populations and per-capita consumption of natural resources increase, so do the impacts on Earth's systems unless the activities and technologies involved are engineering otherwise. • Continued monitoring of the changes to Earth's surface provides a deeper understanding of the way in which human activities are impacting Earth's systems, providing the basis for social policies and regulations that can reduce these impacts. • Some methods of growing food are more or less sustainable. • Each person's lifestyle has a measurable impact on an ecosystem (ecological footprint).	• Explain what sustainability means in the context of food production. • Give examples to show how some food sources are more sustainable than others. Explain why. • Describe what contributes to a person's ecological footprint and list several ways that a person's ecological footprint can be reduced. • Design a sustainable food growing system and evaluate its level of sustainability. • Create a timeline for the last 100 years that shows the changes in Brookline's environment based on research. [Social Studies Connection]

7th Grade Life Science Learning Expectations

Big Ideas	Learning Expectations
Characteristics of Living Things & Classification • All living things are made up of cells, which are the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). • Unicellular organisms (microorganisms), like multicellular organisms, need food, water, a way to dispose of waste, and an environment in which they can live. • Cells come in many different shapes and sizes but they all share basic parts, processes, and needs. Each cell is a system. • Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. • In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.	• Give evidence to support the claim that all living things are made up of cells. Explain how we know this. • Gather and present evidence to support the claim that the structure of cells in both unicellular and multicellular organisms is related to how cells function. • Use data to show that unicellular and multicellular organisms obtain food, water, and places for waste disposal from the environment to survive. • Create a cell analogy model that illustrates understanding of the function of basic cell structures (e.g., cell membrane, cell wall, nucleus, chloroplasts, mitochondria, etc.) and how they work together as a system. • Explain how the cell membrane maintains a stable internal environment by controlling what enters and leaves the cell. • Compare and contrast a plant cell and an animal cell. Provide details on their basic parts and processes. • Construct models and representations of body systems to show multiple interacting subsystems and structures.
Ecosystems: Flow of Matter & Energy in the Biosphere • Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or 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 need oxygen. • Food webs are 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—	• Develop an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth. • Develop and use models of the cycling of matter among living and nonliving parts of ecosystems • Use models to explore the transfer of energy into, out of, and within ecosystems. • Construct and communicate models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem. • Provide evidence to explain that the total amount of matter in the environment stays the same even though its form and location change (i.e., matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web). • Use evidence from credible sources to support the claim that changing a component of an ecosystem affects the species in the

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 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. • As in all material systems, the total amount of matter in the environment remains constant, even though its form and location change. • 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.	ecosystem.
Biodiversity • Biodiversity is the wide range of existing life forms that have adapted to the variety of conditions on Earth, from terrestrial to marine ecosystems. • Biodiversity includes genetic variation within a species, in addition to species variation in different habitats and ecosystem types (e.g., forests, grasslands, wetlands). • The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. • Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.	• Use evidence to make claims about the role of genetic variation within a species as an essential component of biodiversity. • Use models or other representations to explain why scientists use biodiversity as an indicator of ecosystem health. • Explain the implications of biodiversity and ecosystem health on humans.
Adaptations & Natural Selection • Fossils are mineral replacements, preserved remains, or traces of organisms that lived in the past. 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 those 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 on 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	• Analyze and interpret patterns of change in fossils over time that provide evidence of the history of life on Earth and relationships between organisms. • Use credible evidence to make a claim about the anatomical similarities and differences between organisms living today and organisms in the fossil records, as it relates to evolutionary history and descent from a common ancestor. • Give several logical explanations for why the remains of most individual organisms do not form fossils. • Recognize, compare and record patterns in the general characteristics of embryological development across species to show relationships not evident in the fully formed anatomy.

between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. • Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy. • Genetic variations among individuals in a population give some individuals an advantage in surviving and reproducing in their environment. This is known as natural selection. It leads to the predominance of certain traits in a population and the suppression of others. • Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. In separated populations with different conditions, the changes can be large enough that the populations, provided they remain separated (a process called reproductive isolation), evolve to become separate species. • Being part of a group helps animals obtain food, defend themselves and cope with challenges. Groups may serve different functions and vary dramatically in size. • Groups may form because of genetic relatedness, physical proximity, or other recognition mechanisms (which may be species-specific). They engage in a variety of signaling behaviors to maintain the group's integrity or to warn of threats. Groups often dissolve if they no longer function to meet individuals' needs, if dominant members lose their place, or if other key members are removed from the group through death, predation, or exclusion by other members.	• Give examples illustrating how the development of new technologies (and subsequent gathering of additional evidence) has changed scientific ideas regarding evolution and biodiversity over time. • Create and communicate claims based on credible evidence for how genetic variations in a population give some individuals an advantage over others to survive and reproduce in a specific environment, resulting in these genetic traits becoming more common in that population. • Use mathematical models to explain that natural selection over generations results in changes within species in response to environmental conditions that lead to the predominance or suppression of certain traits in a population. • Evaluate data and make claims about how separated populations in different environmental conditions may evolve to become separate species. • Pose questions about patterns in social interactions and grouping behaviors of animals that contribute to a survival advantage across many species.
Genetics and Heredity • Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. • Animals engage in characteristic behaviors that increase the odds of reproduction. • Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features (such as attractively colored flowers) for reproduction. Plant growth can continue throughout the plant's life through production of plant matter in photosynthesis. • Genetic factors as well as local conditions affect the size of the adult plant. The growth of an animal is controlled by genetic factors, food intake, and interactions with other organisms, and each species has a typical adult size range. • Hereditary information is contained in genes, which are passed down from parents to their offspring.	• Gather evidence to support claims of how environmental and genetic factors affect the growth of organisms. • Investigate and present evidence supporting the claim that plant growth continues throughout the plant's life through production of plant matter by photosynthesis. • Gather evidence and make claims explaining how specialized plant structures and specific animal behaviors (e.g., placement of stamen and bees gathering nectar, hard shells on pine nuts, squirrels burying nuts, etc.) are related to successful reproduction of plants. • Identify and evaluate the impact of characteristic behaviors (e.g., birds building nests to protect young, brown trout spawning in late fall when predators are less active) of animals on their odds of successfully reproducing.

• Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. • Each distinct gene chiefly controls the production of specific proteins, which in turn affect the traits of the individual (e.g., human skin color results from the actions of proteins that control the production of the pigment melanin). • Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. • Sexual reproduction provides for transmission of genetic information to offspring through egg and sperm cells. These cells, which contain only one chromosome of each parent's chromosome pair, unite to form a new individual (offspring). Thus offspring possess one instance of each parent's chromosome pair (forming a new chromosome pair). Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited or (more rarely) from mutations. • In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. • In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. • In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. We can choose desired parental traits determined by genes, which are then passed on to offspring.	• Using data, explain how changes (mutations) to genes, which are located on chromosomes, affect specific inherited traits resulting in harmful, beneficial or neutral effect. • Use models and/or simulations to explain how the genetic contribution from each parent in sexual reproduction contributes to variation in individuals. • Communicate explanations of ways technologies enable humans to influence the inheritance of certain traits in plants and animals (e.g., breeds of cattle for various purposes, disease resistant crops, genetically modified organisms).

7th Grade Physical Science Learning Expectations

MATTER	
Big Ideas	**Learning Expectations**
Properties of Matter • All matter (living and nonliving things on Earth) is made from about 100 different atoms (elements), which combine with one another in various ways. • Atoms form molecules that range in size from two to thousands of atoms. • Pure substances are made from a single type of atom or molecule; each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). • The change of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. • A substance has characteristic properties such as density, melting point, freezing point and solubility, all of which are independent of the amount of the substance and can be used to identify it.	• Describe and give examples to show that atoms and molecules are the building blocks of matter (e.g., cell parts, nutrients, minerals). • Identify and/or describe the elements that are most common in both living and nonliving things on Earth. • Categorize or classify a set of minerals according to characteristic properties. • Design a working model of the transfer of matter and energy through a system that includes living and nonliving things. • Classify rocks according to physical and chemical properties.
Cycles of Matter • Matter is cycled through nature (carbon, nitrogen, water). 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. • The idea of atoms explains the conservation of matter: If the number of atoms stays the same no matter how the same atoms are rearranged, then their total mass stays the same.	• Create a visualization of the carbon cycle and nitrogen cycle. • Compare and contrast photosynthesis and respiration.
FORCE & MOTION	
Big Ideas	**Learning Expectations**
• The Engineering Design Process can be used to solve a variety of problems, including those that affect human safety during natural hazard events.	• Describe the forces that act on a structure during an earthquake. • Build a model earthquake resistant structure (using the Engineering

• Many variables (materials, forces, earth composition, structural design) determine the stability of a structure. • Many forces interact on a structure and cause change during an earthquake. • Forces on an object can change its shape or orientation. • Science and Engineering, although different in some ways, are closely interconnected. • Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.	Design Process) and evaluate its stability. Explain how the model is the same and different from an actual building • When testing the structure, identify evidence of forces (tension, compression, shear, torsion, gravity, normal force, bending, etc.) interacting in the system • Evaluate the properties and suitability of materials used to build the model structures • Explain how Engineering and Science are interconnected and depend on each other
ENERGY	
Big Ideas	**Learning Expectations**
Energy Transfer • Energy flows through all dynamic systems on Earth. • Energy exists in many forms. It is neither created nor destroyed, but is transformed from one form to another. • Energy is stored in many different forms. • The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. • Both the burning of fuel and cellular digestion in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.	• Obtain and communicate information to support claims that when combining simpler molecules (e.g., H_2O and CO_2) into complex molecules (e.g., sugars) or breaking down complex molecules to simpler molecules, energy can be used, stored or released. • Develop a model to represent the movement of matter and energy in the cycling of carbon (e.g. carbon in the atmosphere and carbon in living things). • Provide evidence to show that the total amount of matter in the Earth's system stays the same even though its form and location change. • Give examples of different ways in which energy is stored within the Earth system.
Energy Transfer: Waves (Geology) • Vibrations in materials set up wavelike disturbances that spread away from the source (e.g., sound and seismic waves). These and other waves move at different speeds in different materials. • Geologists use seismic waves and their reflection at interfaces between layers to gather information about structures and materials deep in the planet.	• Explain how geologists gather evidence to find out more about the Earth's interior. • Demonstrate or provide data to show how seismic waves provide useful information to geologists.