4th 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.

4th Grade Earth Science Learning Expectations

EARTH'S SYSTEMS [Future Geology/Earth Changes Unit and Future Changes in State Unit]	
Big Ideas	**Learning Expectations**
• Geology is the study of our planet: how it was made, what it is made of, and how it has changed over time. • Geologists study earth processes (landslides, volcanic eruptions, earthquakes, etc.), earth materials (rocks, minerals, fossils), and make claims about Earth's history based on available evidence (fossils, rock records, glacier data, etc.). They use many tools such as maps, models and various data collection tools to gather evidence that they use to make claims.	• Explain the different things geologists study and some of the tools they use.
Our Earth • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. • The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. • Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. Rainfall helps to shape the land and affects the types of living things found in a region. • Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. • Human activities affect Earth's systems and their interactions at its surface. • The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Earthquakes happen near or deep below Earth's surface, volcanoes are found on the continents and on the ocean floor, and major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features where people live and in other areas of Earth. • A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions, severe weather, floods, coastal erosion). Humans cannot eliminate natural hazards but can take steps to reduce their impacts. • People's lives change as technology changes. • Many technological systems have built-in controls to make them easier to use, or to protect people and property. • The development of new technologies has sometimes brought about changes in	• Create a model illustrating the major systems that make up the Earth (i.e., geosphere, hydrosphere, atmosphere, biosphere). • Provide evidence that oceans support a variety of ecosystems and organisms, shape landforms and influence climate. • Evaluate claims that the atmosphere, oceans and landforms interact with each other to produce weather and climate. • Using various types of maps, analyze the locations of a variety of Earth's features and map the geographic patterns that emerge (e.g., volcanoes are found on the continents and on the ocean floor, major mountain chains form inside continents or near their edges). Make claims based on this evidence. • Use maps and data to predict the likelihood of natural hazards occurring in an area and evaluate the possible effects on landforms and organisms. • Construct, test and refine collaboratively a design solution that mitigates the effects of a natural hazard.

the way people live and interact with one another and the environment.	
Changing Earth: Earth's History • The earth has changed over time. Understanding how landforms develop, are weathered (broken down into smaller pieces), and erode (get transported elsewhere) can help to infer the history of the current landscape. • All around us, we see visible evidence of the building up and breaking down of the Earth's surface. • Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. • The presence and location of certain fossil types indicate the order in which rock layers were formed and provide important evidence of how life and environmental conditions have changed. • The surface of the Earth changes due to processes such as erosion, weathering, landslides, volcanic eruptions and earthquakes. Wind, flowing water, and ice break down rocks into bits and pieces. • Patterns of tree rings and ice cores from glaciers can help reconstruct Earth's recent climate history. • Rocks are like a book that tell the story of life on Earth—hidden within many rocks (usually sedimentary rocks) are fossils, the remains of ancient plants and animals. • Fossils provide evidence about the types of organisms (both visible and microscopic), including dinosaurs, that lived long ago and also about the nature of their environments. Fossils can be compared with one another and to living organisms according to their similarities and differences.	• Identify the objects, processes or forces that weather and erode Earth's surface (e.g., ice, plants, animals, abrasion, gravity, water, wind). • Provide evidence from informational texts, maps, photographs/aerial photographs and other sources to show that Earth's surface is constantly changing. Explain what type of process(s) is the source of the change and how it may have occurred. • Make a model to illustrate how erosion (wind, waves, running water, gravity, or ice reshapes the Earth's surface. Explain. Give examples of local landforms that have been shaped in this way. • Describe two types of evidence that scientists use to study what the climate of Earth may have been in the past. • Evaluate the claim that the remains of organisms, including fossils, contribute to the formation of rocks and soil using a variety of evidence. • Gather evidence to support the claim that fossils provide evidence of the types of organisms that have lived on Earth and their environments, citing their similarities and differences to currently living species.
Changing Earth & Roles of Water on Earth • Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. • Water is found almost everywhere on Earth: as humidity; as fog or clouds in the atmosphere; as rain or snow falling from clouds; as ice, snow, and running water on land and in the ocean; and as groundwater beneath the surface. • Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. • The downhill movement of water as it flows to the ocean shapes the appearance of the land. • Soil is formed by weathering of rock by water and wind, and by the	• Using maps and other resources, provide evidence to illustrate the distribution of water on Earth—that water is found everywhere in the environment in a variety of forms • Give examples of the forms of water that are found on Earth (humidity in the air, fog, clouds, rain, snow, ice, running water, water in the ocean, and groundwater). • Carry out investigations to show that flowing water can shape the land (e.g., erosion and deposition form a river) and evaluate the effect of different variables (e.g., elevation, slope, flow rate) on erosion. Record the data and make claims based on evidence. • Use evidence to show that physical characteristics of an area are affected by both living things (e.g., plants' roots hold soil in place, beaver shelters and human-built dams alter the flow of water) and the natural processes of weathering and erosion.

decomposition of plant and animal remains. • Living things affect the physical characteristics of their regions (e.g., plants' roots hold soil in place, beaver shelters and human-built dams alter the flow of water, plants' respiration affects the air).	• Make a cartoon illustrating a process by which rock is broken down to make soil.
Changing Earth: Rocks & Minerals • Minerals (not rocks) can be identified using several physical properties, such as hardness, luster, color, streak, and cleavage. • Most rocks are mixtures made up of two or more minerals. • Many types of rocks and minerals are formed from the remains of organisms or are altered by their activities. • Most rocks come from other rocks—forces on and below the Earth's surface constantly make new rocks out of old ones. • Rocks are classified by their mineral and chemical composition, the texture of their particles and the processes that formed them (igneous, sedimentary and metamorphic). • Igneous rocks are formed when hot, melted rock from deep in the Earth (magma) cools and becomes solid. • Sedimentary rocks are formed when layers of sand, mud, plants, shells that form on the bottom of lakes, rivers and oceans (sediments) are compacted (squeezed together) to make solid rock. • Metamorphic rocks are formed when any rock type (igneous, sedimentary or metamorphic) is subjected to intense temperatures and pressures deep in the Earth.	• Use the naked eye, a magnifying glass and/or loupe, and a stereomicroscope to observe and describe the physical properties of rocks. Compare and contrast their properties, and use this data to make claims about how the rocks formed. • Observe and record evidence showing that rocks are made of smaller parts called minerals (e.g., granite is made of quartz, feldspar and mica). • Write a story or make a model describing how the three types of rock (igneous, metamorphic, sedimentary) may have formed in Massachusetts. • Illustrate or make a model showing the life cycle of a rock. • Observe, record and discuss the properties of minerals (color, hardness, reflectivity, response to magnets, electrical conductor versus insulator, melting point) to identify them.
Human Interactions with Earth [Social Studies Connection] • Humans, like all other organisms, obtain living and nonliving resources from their environments. • All materials, energy, and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. • Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. For example, they are treating sewage, reducing the amounts of materials they use, and regulating sources of pollution such as emissions from factories and power plants or the runoff from agricultural activities. • Invasive plants can be transferred intentionally or accidently by humans, animals or forces of nature to areas where they do not belong. They damage the lands	• Provide evidence that human activity can produce changes in Earth's systems (e.g., overgrazing can convert grassland to desert, logging can change a forest ecosystem). • Design and evaluate technological solutions (e.g., water filtration system) collaboratively based on criteria and constraints (e.g., cost, energy use) to minimize unwanted outcomes of human activity (e.g., pollution). • Gather evidence to demonstrate how people obtain living and nonliving resources from the environment. • Describe how invasive plants may be transferred to new areas and the effects they have on the local environment. • Give examples of invasive plants in Brookline/Massachusetts and describe what is being done to eradicate them. • Analyze data to show the effect that paper recycling has on world tree

and waters that native plants and animals need to survive.	populations. • Explain what happens to paper recycled in Brookline and the types of products that it may be reused in.

4th Grade Life Science Learning Expectations [Plant Explorers Unit]

Big Ideas	Learning Expectations
Characteristics of Living Things (Organisms) • Scientists sort (classify) living things based on features they share in order to learn more about them. • Living things (plants and animals) share certain characteristics (e.g., they grow and reproduce) • All plants share certain features • Plants include trees, flowering plants, bushes, ferns, grasses, mosses and green algae	• Use evidence to show that animals and plants can be classified based on their features (e.g., vertebrates have backbones, mammals have hair, insects have six legs, , plants have flowers, make cones or have spores). • Design several ways to classify a group of plants, seeds and/or leaves based on the features they share. Explain. • Provide evidence to show that a pine tree and a dandelion are plants.
Structure & Function of Living Things (Organisms) • Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. • Each part of a plant has a role in the survival of the plant: roots anchor the plant and absorb water and minerals, stems and trunks hold the flowers, fruit and leaves. They also carry water from the roots to the leaves. Flowers are the parts that produce the seeds and/or fruit necessary for reproduction. Leaves are the green, food-making parts of the plant. • These structures (e.g., leaves, fruit, etc.) can look similar or different depending on the living thing and where it lives.	• Draw and label the parts of a tree and a flowering plant; explain the role of each part in the plant's survival. • Use models to analyze how internal and external structures and systems in humans allow them to grow, survive and reproduce. • Compare/contrast the needs and structures of plants & animals. • Design and construct a technological solution that uses an internal or external structure of an organism as a model to solve a problem (e.g., Velcro based on a cocklebur).
Needs of Living Things (Organisms) • All living things have needs that must be met for them to stay alive. • Plants need light, air, water, space to grow, minerals, and the right temperature in order to live and grow. • Plants make their own food; they get the materials they need for growth mainly from air and water, and their energy comes from the sun. • Different plants survive better in different places because they have varied needs for sunlight, water, and minerals.	• Provide evidence to support the claim that plants get the material they need to grow from air and water, using energy from the sun. • Plan and carry out investigations collaboratively to determine the role of light in plant growth and the production of food. • Explain (in very basic terms) how a plant makes its own food. Compare with how animals get their food.
Ecosystems • Organisms can survive only in environments in which their particular needs are met. • Plants (like all living things) depend on other living things and the environment for survival • Animals can move around, but plants cannot. Plants often depend on animals for pollination or to move their seeds around. • When the environment changes in ways that affect a place's physical	• Provide evidence to show how plants in different habitats depend on animals (e.g., pollination, seed dispersal, etc.). • Identify organisms that capture the sun's energy in a desert, woodland, meadow and ocean ecosystem. Explain how they are used by other organisms to survive. • Explain what happens when the habitat of a certain plant changes (e.g., extra water in a normally dry area, pollution, fire, drought, shade where there was availability of light). and the plant can no longer get

characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. • Plants are the key to life on Earth—without them many other living things on Earth could not survive. The food of almost any kind of animal can be traced back to plants. • Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil for plants to use. • A healthy ecosystem is one in which multiple species of different types are able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.	what it needs to survive and grow. • Provide evidence to support the claim that life on Earth depends on plants. • Make a labeled diagram that shows the role decomposers play in creating soil. • Gather evidence to support the claim that the introduction of invasive plants can damage the balance of other living things.
Adaptations • Plants have features that help them survive in their environment. [These features include physical adaptations (e.g., seed size/shape, etc.) and behavioral adaptations (e.g., seedlings grow toward light some trees shed leaves in the fall, etc.). • Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	• Draw and give examples of evidence of plant adaptations observed on the school grounds. • Compare the basic structures of a cactus and an oak tree. Explain how they are alike, how they are different, and how each are adapted to survive in its environment. • Describe the features of plants that allow them to live in places others cannot (e.g., kelp, saguaro cactus, oak tree, baobab tree, etc.). • Give examples of behavioral adaptations that allow plants to increase their chances of survival. • Provide evidence to support the claim that different types of seeds have adapted to increase their chances of survival (e.g., dispersal by wind, water, and/or animals).
Growth & Development • Reproduction is essential to the continued existence of every kind of living thing (organism). Plants and animals have unique and diverse life cycles that include a beginning (birth for animals, germination for plants), growing, developing into adults, reproduction, and eventually dying. • Pollinators (insects, bats, birds, etc.) play a very important role in plant reproduction and subsequently the production of many foods that we eat (nuts, fruits, vegetables).	• Compare/contrast the life cycle of an apple tree, a sunflower, and an insect. • Identify at least two pollinators and explain what they do to help plants.
Biodiversity & Evolution • Fossils provide evidence about the types of organisms (both visible and microscopic) that lived long ago and also about the nature of their environments. Fossils can be compared with one another and to living organisms according to their similarities and differences.	• Compare plant fossils to one another and to living plants (seeds too). Explain how they are alike and how they are different. • Observe photos of fossils to make claims about the nature of the organisms and the type of environment where they lived, and their similarities to organisms that are alive today.

• There are many different types of plants and animals on Earth, but only certain types are found naturally at a certain place. • Populations of organisms live in a variety of habitats, and change in those habitats affects the organisms living there. Humans, like all other organisms, obtain living and nonliving resources from their environments.	• Give examples of how scientists have used fossils as evidence to make claims about plants that lived long ago. • Predict the number of different kinds of plants that exist on the school grounds or in a nearby park. Gather evidence to show the diversity and number of certain types of plants found on the school grounds. Graph the results. • Based on research using informational texts, gather evidence and make claims on the different types and numbers of plants living in different habitats throughout the world.
Heredity • Many characteristics of organisms are inherited from their parents. Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. • Individuals of the same kind of plant or animal are recognizable as similar by can also vary in many ways. • Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates and reproducing.	• Construct an argument that the characteristics of plants can be inherited from parents (e.g., flower color), caused by the environment (e.g., stunted growth) or a result from a combination of both. • On the school grounds, compare two different trees of the same type and explain how they are alike and how they are different. Do the same thing for two different dandelion plants. Based on this evidence, make a claim about which tree or dandelion plant has the best advantages for surviving and reproducing. • Explain or illustrate the types of traits that can be inherited by plants. Compare with characteristics that result from interactions with the environment.

4th Grade Physical Science Learning Expectations

MATTER [Future Changes in State Unit and Future Geology/Earth Changes Unit]	
Big Ideas	**Learning Expectations**
Properties of Matter • Matter occupies space and has weight. One physical property of matter is its state. • Matter may exist in different states (gas, liquid, solid). • Changes of state are physical and reversible. They occur when matter is heated or cooled. Various factors affect the rate of change of state. • Changes of state affect our daily lives. • Air is a material that surrounds us and takes up space—we feel its movement as wind • Water left in an open container appears to "disappear," but water in a closed container does not. When liquid water appears to "disappear," it turns into a gas in the air. It can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water. • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means (e.g., by weighing or by observing its effects on other objects). For example, a model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations including: the inflation and shape of a balloon; the effects of air on larger particles of objects (e.g. leaves in the wind, dust suspended in air); and the appearance of visible scale water droplets in condensation, fog, and, by extension, also in clouds or the contrails of a jet. • The physical properties of matter may change form, but the total amount (weight) of material remains the same, even if it seems to vanish (e.g., sugar in solution, evaporation in a closed container).	• Explain everyday phenomena (e.g., inflating a balloon, effect of air on larger objects, smell of baking cookies) using the particle model (e.g., matter is made of particles too small to be seen). • Compare the properties of gases, liquids, and solids and give examples of each. • Describe, using first-hand observational data, how heating and cooling of water and other materials can change the material's physical properties. • Explain, using examples, how changes of state are reversible. • Give examples of how changes of state affect our lives. • Explain factors that may affect the rate of change of state using evidence gathered during investigations. • Provide evidence to show that the properties of a material may change after phase change, but the total amount of material remains the same. • Provide physical evidence to show that air takes up space (e.g., balloon filled with air, air-filled packing pillows, etc.). • Observe and record what happens when water is left in an open container and the same amount is left in a closed container. Make a claim based on evidence gathered. • Provide evidence to show that water exists in the air. • Explain how their model of the water cycle can be used to understand the basic concepts of how water cycles through our atmosphere. • Based on observations of a model of the water cycle (terrarium), explain how the water cycle is a series of changes of state driven by changes in temperature. • Explain how the model water cycle in the terrarium is similar to and different from the water cycle that occurs in our environment. • Gather evidence to support the claim that changing the size or shape of an object does not change the weight of the object.

ENERGY [Future Geology/Earth Changes Unit]	
Big Ideas	**Learning Expectations**
Energy Transfer	• Illustrate or describe how seismic waves form.

• Earthquakes cause seismic waves, which are waves of motion in Earth's crust.	• Explain how scientists know that seismic waves move through the Earth's crust.