5th 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.

5th Grade Earth Science Learning Expectations [Future Sun, Earth & Moon System]

EARTH'S SYSTEMS	
Big Ideas	**Learning Expectations**
Changing Earth: Earth's History • 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.	• Evaluate claims 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.
Human Interactions with Earth [Social Studies Connection] • The Earth has changed over time and continues to change. • If Earth's global mean temperature continues to rise, the lives of humans and other organisms will be affected in many different ways. • 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, others are not. • Human activities in agriculture, industry, and everyday life have had major effects on living things, 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.	• Evaluate claims that the history of Earth's climate (e.g., drought, flooding, ice age), as determined by data (e.g., tree rings, ice cores) has affected organisms over time (e.g., species, population change). • Provide evidence that increases in Earth's temperature will affect humans and other organisms (e.g., loss of habitat for birds). • Analyze scientific data documenting the number and type of birds found in Massachusetts over time. Make claims based on this evidence. Compare these claims with the findings of local scientists. • Gather evidence to support the claim that some sources of energy are renewable (e.g., water, wind, geothermal, plants, solar) and some are not (e.g., fossil fuels, nuclear fuels) Compare and contrast the benefits, drawbacks and environmental impact of each. • Complete a carbon footprint based on his/her habits and energy use. • Identify steps that can be taken to decrease carbon footprints.
EARTH IN THE UNIVERSE	
Big Ideas	**Learning Expectations**
• Astronomy, one of the oldest sciences, is the study of celestial objects (like the sun, moon, planets, stars, comets, galaxies). • The Earth is part of the solar system, which includes the sun (a star), planets and many moons. All planets revolve around the sun. • The Sun is a star that appears larger and brighter than other stars because it is closer to Earth. Stars range greatly in their size and distance from Earth. • The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. • The orbits of Earth around the sun and of the moon around Earth, together with	• Using a proportional model of the solar system created on the school grounds (using common objects such as a pea and different sized balls), describe the components of our solar system. Explain why it is referred to as a system. • Provide evidence that the Sun is a star, similar to other stars, only much closer to Earth, and consequently appears much larger and brighter. • Gather evidence to support the claim that the Earth is a sphere and that the gravitational force of Earth acting on an object near the Earth's surface pulls that object toward the planet's center.

the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily and seasonal changes in the length and direction of shadows; phases of the moon; and different positions of the sun, moon, and stars at different times of the day, month, and year. • The moon is a sphere (like Earth), but its observable shape changes over the course of a month due to the relative positions of the Earth, Moon and Sun. • Planets in the night sky change positions and are not always visible from Earth as they orbit the sun. • Stars appear in patterns called constellations, which can be used for navigation and appear to move together across the sky because of Earth's rotation. • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. • A great deal of light travels through space to Earth from the sun and from distant stars. • Some objects in the solar system can be seen with the naked eye. • Astronomers can't perform experiments directly, but they observe using scientific tools and analyze data sent back to Earth from satellites and space probes. • Because lenses bend light beams, they can be used, singly or in combination, to provide magnified images of objects too small or too far away to be seen with the naked eye. • Lenses can be used to make eyeglasses, telescopes, or microscopes in order to extend what can be seen. The design of such instruments is based on understanding how the path of light bends the surface of a lens.	• Use a model of the solar system and Earth's motion (rotation and revolution around the Sun) to explain the apparent motion of stars, constellations and planets. • Use a model of the solar system and the relative positions and motion of the Earth, the Sun and the moon to explain patterns such as day and night, and daily and seasonal changes in the length and direction of shadows. • Use a model of the solar system to explain the pattern of lunar phases in terms of the relative positions of the Sun, Earth and Moon. • Provide evidence that the positions of stars and constellations have been used as navigation tools. Explain how they were used. • Carry out investigations to show that lenses bend light and provide evidence that lenses are used to magnify images in telescopes and microscopes or to correct vision. • Explain how devices such as the telescope have led to significant changes in our understanding of the universe, and that our understanding of physical phenomena such as light has led to the development of new technologies (e.g., lasers).

5th Grade Life Science Learning Expectations [BirdSleuths 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 • All birds share certain features.	• Gather 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, birds have feathers, plants have flowers, make cones or have spores). • Describe the common features of birds apply this knowledge when sorting animal photo cards into birds and other animals. • Compare birds with plants and mammals. Explain how they are similar and how they are different.
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. • These structures (e.g., feet, tails, etc.) can look similar or different depending on the living thing and where it lives. • Animals have sense receptors that are specialized to gather certain kinds of information, which may then be processed and integrated by an animal's brain, with some information stored as memories. Animals are able to use their perceptions and memories to guide their actions. Some responses to information are instinctive—that is, animals' brains are organized so that they do not have to think about how to respond to certain stimuli.	• Draw and label the basic structures of a bird; explain the role of each part in the bird's survival. • Use models to analyze how internal and external structures in humans allow them to grow, survive and reproduce (reproductive system) [Health Connection] • 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., bird's wing to design airplanes). • Gather evidence to show that animals respond to information detected by their senses through instinct or memory (e.g., birds sensing when to migrate). • Compare/contrast the basic structures of birds and mammals. Identify similar structures based on their function.
Needs of Living Things (Organisms) • All living things have needs that must be met for them to stay alive. • Like other animals, birds need food, water, air, a space to live in and raise young (shelter), and the right temperature in order to live and grow. • Animals and plants alike generally need to take in air and water, animals must take in food, and plants need light and minerals. Food provides animals with the materials they need for body repair and growth and is digested to release the energy they need to maintain body warmth and for motion.	• Describe the basic needs of birds and explain how those needs are met in their environment. • Compare the needs of plants and birds, demonstrating how these needs are alike and how they are different.
Ecosystems • Like other living things, birds live in places that can provide the things they need to live and grow (habitats). • Birds (like all living things) depend on other living things and the environment for	• Provide evidence to show how birds in different habitats depend on plants and other animals. • Create a model of a food web for a certain type of bird. Compare this with food web models for other birds that live in different habitats.

survival. • 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. • Food and fuel release energy when they are burned or digested. The energy released by burning fuel or digesting food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, water and minerals from the environment and release waste matter (gas, liquid, or solid) back into the environment. • 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. • Populations of organisms live in a variety of habitats, and change in those habitats affects the organisms living there. • When the environment changes in ways that affect a place's physical 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.	Identify similarities and differences. • Using the particle model of matter (matter is made of tiny particles too small to be seen), explain how matter in one organism becomes matter in another organism in a food web and how matter cycles between organisms and the environment. • Explain what happens when the habitat of a certain bird changes (e.g., pollution, fire, drought,) and the bird can no longer get what it needs to survive and grow. . Give examples of how and where this has happened in the past. • Provide evidence to support the claim that all life on Earth depends on plants. • Gather evidence to support the claim that the introduction of invasive species can damage the balance of other living things. • Use models to represent the boundaries that define a particular ecosystem (e.g., edges of a lake or meadow), inputs to (e.g., sunlight, precipitation) and outputs from (e.g., through fishing and hunting, logging, oxygen produced) of that ecosystem. • Construct a model that tracks energy flow through an ecosystem as energy enters, is used in the production of food and fuel (including fossil fuels) and is released as food is digested and fuel is burned.
Adaptations • Birds have features that help them survive in their environment. [These features include physical adaptations (e.g., beaks, feathers, feet, eggs, protective coloration, etc..) and behavioral adaptations (e.g., migration, territorial behaviors, mating behaviors, etc.). • Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. • Groups can be collections of equal individuals, hierarchies with dominant members, small families, groups of single or mixed gender, or groups composed of individuals similar in age. Some groups are stable over long periods of time; others are fluid, with members moving in and out. Some groups assign specialized tasks to each member; in others, all members perform the same or a similar range of functions.	• Draw and give examples of evidence of bird adaptations observed on the school grounds. • Illustrate and explain how birds are adapted to survive in their environment (desert, tropical forest, temperate forest, grassland, arctic tundra, wetlands, rivers, oceans, mountains). • Compare the adaptations of a roadrunner and an egret. Explain how they are alike, how they are different, and how each are adapted to live in its environment. • Explain the factors that trigger the migration of a population of birds from one place to another. • Give examples of bird behaviors that help them survive in their environment. • Explain how being part of a group can help birds obtain food, defend themselves and cope with changes.
Growth & Development	• Compare the life cycle of a bird and a human.

• 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.	
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. • 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.	• Observe photos of fossil birds and their ancestors 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. • Give examples of how scientists have used fossils as evidence to make claims about birds that lived long ago. Explain how these ideas change as more evidence and/or new tools become available. • Predict the number of different kinds of birds found on the school grounds. Gather evidence to show the diversity of birds on the school grounds in different seasons. Graph the results. • Based on research using informational texts, gather evidence and make claims on the different types and numbers of birds 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. • Offspring acquire a mix of traits from their biological parents. Different organisms vary in how they look and function because they have different inherited information. In each kind of organism there is variation in the traits themselves, and different organisms may have different versions of the trait. • The environment also affects the traits that an organism develops—differences in where they grow or in the food they consume may cause organisms that are related to end up looking or behaving differently. • Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates and reproducing.	• Gather evidence to show that the characteristics of organisms can be inherited from parents (e.g., feather color), caused by the environment (e.g., migration patterns) or a result from a combination of both. • Obtain and communicate information to show that individuals of a species may inherit different versions of single traits (e.g., eye color in humans, flower color in some plants) that can lead to variations in appearance and function. • Use evidence to support the claim that some characteristics that vary among individuals in a single species can provide them an advantage in surviving, finding mates, and reproducing in a particular environment (e.g., more colorful feathers attract mates, a faster flyer may more easily escape a predator, being more resistant to a disease can help a bird survive illness).

5th Grade Physical Science Learning Expectations

FORCE & MOTION [Future Sun, Earth & Moon System Unit]	
Big Ideas	**Learning Expectations**
• The force of gravity of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	• Provide evidence to support the claim that gravity is a force that pulls all things on Earth toward the Earth's center. • Explain how life on Earth would be different without gravity.
ENERGY [Existing Light/Sound Unit, Future Energy Unit (Electricity, Waves and Energy Transfer Added)]	
Big Ideas	**Learning Expectations**
Energy Transfer • Energy is present whenever there are moving objects, sound, light, or heat. • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. • When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. • The faster a given object is moving, the more energy it possesses. • When objects collide, the contact forces transfer energy so as to change the objects' motions. • Magnets can exert forces on other magnets or on magnetizable materials, causing energy transfer between them (e.g., leading to changes in motion) even when the objects are not touching. • Electric, magnetic and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. Magnets can exert forces on other magnets or on magnetizable materials, thereby transferring energy (e.g., in the form of motion) even when the objects are not touching. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. • "Produce energy" typically refers to conversion of stored energy into a desired form for practical use (e. g., the stored energy of water behind a dam is released so that it flows downhill and drives a turbine generator to produce electricity.) • It is important to be able to concentrate energy so that it is available for use where and when it is needed (e.g., batteries).	• Observe and give examples of situations in which energy is present (moving objects, sound, light, heat, electric current) (e.g., pendulums, heat from an incandescent light bulb, battery to light a bulb, sound coming from a vibrating object such as a tuning fork). • Investigate and provide evidence to support the claim that energy is transferred from place to place by moving objects or through sound, light and electric currents. • Perform investigations to provide evidence that energy is transferred when magnets interact and objects collide. • Give three examples to illustrate how engineers have designed technologies to store energy so that it is available for our use when and where we need it. [Engineering Connection] • Collaborating with others, design a technological solution (e.g., flashlight, windmill, watermill, alarm circuit, doorbell) that converts energy to produce motion, sound, heat or light. [Engineering Connection] • Make observations, collect data, and identify patterns of the forces that magnets and magnetized materials exert on each other and the resulting motion of those objects. • Design and refine technological solutions to a problem that use magnetized materials (e.g., moving a metal ball through a maze with a magnet) as a tool to produce or control motion. Share solutions. • Using magnets, demonstrate that magnets push or pull at a distance. Explain how electrical and gravitational forces behavior in a similar way.
Energy Transfer: Waves	• Ask questions about waves, observing their creation by disturbing the

• Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it doesn't move in the direction of the wave—observe, for example, a bobbing cork or seabird—except when the water meets the beach. • Water, sound and light waves are a repeating pattern of motion that transfer energy from place to place. All waves have some features in common. • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. • By understanding wave properties, scientists and engineers can design systems for transferring information across long distances and storing information. • Digitized information (e.g., the pixels of a picture) can be stored for future recovery or transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa.	surface of water and sharing observations about patterns in the waves. • Using a physical model (e.g., rope, slinky), analyze the characteristics of waves (e.g., amplitude, wavelength). • Carry out investigations to show that waves affect the motion of objects and transfer energy to objects (e.g., corks bobbing up and down) as a wave passes. • Compare and contrast water, light and sound waves. • Carry out investigations to provide evidence that waves can add or cancel each other as they cross (e.g., the pattern of waves created by two pebbles dropped in water) depending on the relative phase of the wave (i.e., relative position of peaks and troughs of the waves). • Carry out investigations to provide evidence that waves will pass through each other and emerge unaffected (e.g., waves created by two pebbles dropped in water). • Observe and share evidence that waves exist in nature (e.g., ocean waves, sound waves, seismic waves) and transfer energy (e.g., coastal erosion, earthquake damage). • Design, refine and evaluate a device that uses a mechanical wave to transmit both analog and digital information (e.g., drums can send information through sound waves either as patterns that have specific meaning-analog- or as high and low notes that represent ones and zeros—digital). [Engineering Connection] • Explain why it is important to understand wave properties.
Forms of Energy: Light • Like moving objects, sound, and electric currents, light transfers energy from place to place. For example, energy radiated from the sun is transferred to the earth by light. When this light is absorbed, it warms Earth's land, air, and water and facilitates plant growth. • A great deal of light travels through space to Earth from the sun and from distant stars. • Humans and animals see an object when light emitted by or reflected by its surface enters the eye, which sends an electrical signal to the brain. The color people see depends on the color of the available light sources as well as the properties of the surface. • An object can be seen when light reflected from its surface enters the eyes; the color people see depends on the color of the available light sources as well as the	• Illustrate how light transfers energy from the sun to heat the Earth and explain the impact of this process. • Provide evidence to show that light travels through space to Earth from other parts of the solar system. Explain. • Draw a diagram or make a model that includes a light source, an object, and the eye to illustrate how humans and other animals see. Explain. Note what would happen if the light cannot reach the eye. • Carry out investigations to show that the color of light and properties of the surface influence what is seen (e.g., illuminating different objects with different colors of light). • Give examples of ways that lenses can be used to magnify images to small or too far away to be seen with the naked eye. Explain how they work.

properties of the surface. • Because lenses bend light beams, they can be used, singly or in combination, to provide magnified images of objects too small or too far away to be seen with the naked eye. • Lenses can be used to make eyeglasses, telescopes, or microscopes in order to extend what can be seen. The design of such instruments is based on understanding how the path of light bends at the surface of a lens.	• Illustrate how lenses have affected our ideas about the world and our solar system.
Forms of Energy: Sound • Like moving objects, light and electricity, sound transfers energy from place to place. • Sound is produced by vibration. All objects that make sound vibrate or cause surrounding objects or materials to vibrate.	• Provide evidence from first-hand investigations to back up the claim that sound is produced by vibrating objects and transfers energy. • Explain how a model of the eardrum works and describe how it is similar/different to a real eardrum.
Forms of Energy: Electricity • Like moving objects, light and sound, energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin by transforming the energy of motion into electrical energy (e.g., moving water driving a spinning turbine which generates electric currents).	• Build a simple circuit and demonstrate how electric currents can be used to produce motion, sound, heat and light. Explain. • Give examples of ways in which electrical currents can produce light, heat, motion, and sound in our everyday lives. • Describe three ways in which electrical current may be produced from different sources of energy, including from energy of motion.