INTERNATIONAL
SCHOOL

SCIENCE CURRICULUM STANDARDS ORGANIZED BY GRADE LEVEL

Curriculum standards are divided into five strands:

- Physical Science
- Life Science
- Earth and Space Science
- Scientific Inquiry
- History and Nature of Science

The curriculum standards in this document were based on AERO (American Education Reaches Out) in the United States and were revised to fit ISE's student population. More information about the AERO Standards can be found at: http://www.projectaero.org/

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Science
Vision Statement

Science permeates our lives and is a way of exploring and understanding the natural world. Science has had a profound influence on human history and has important ethical implications.

The science program emphasizes an inquiry-based, hands-on, real world approach that makes connections across disciplines.

The science program recognizes that scientific problem solving, critical and creative thinking skills, communication, and collaboration prepare students for an ever-changing world.

We believe:

- Science encourages responsible and ethical decision makers in a global community.
- Science helps students become successful global decision-makers and gives them an educational foundation.
- Science gives students the skills to critically analyze data.
- Science encourages the natural curiosity of learners at all levels.
- Science increases scientific literacy and the application of science to everyday life.
- Students construct new knowledge for themselves through research, reading, exploration, and discussion in science.

Science incorporates:

Physical Science
Life Science
Earth and Space Science
Scientific Inquiry
History and Nature of Science

Pre-Kindergarten Science Curriculum

Science Strand: Scientific Inquiry

Curriculum Standards	Learner Outcomes
The students will begin to develop inquiry skills including problem-solving and decision-making.	• Ask questions about objects, organisms, and events in their environment. • Make observations and predictions. • Conduct simple explorations through active play.

Science Strand: History and Nature of Science

Curriculum Standards	Learner Outcomes
The students will begin to develop an understanding of and types of resources as it relates to their immediate environment.	• Develop sensitivity to the needs of living things and the environment.

Science Strand: Physical Science

Curriculum Standards	Learner Outcomes
The students will begin to develop an understanding of the concepts that explain the physical world.	• Sort, classify and describe properties of objects and materials, including size, shape, color, texture, weight, and temperature. • Observe simple changes in matter (eg. The block of ice turning into water.)

Science Strand: Life Science

Curriculum Standards	Learner Outcomes
The students will observe and investigate the properties of objects, both living and nonliving.	• Identify differences between living and non-living things. • Understand that living things have specific needs (eg. water, air, food, shelter).

Kindergarten Science Curriculum

Strand: Forces & Motion

Curriculum Standards	Learner Outcomes
Students will plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. Students will analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.	• Pushes and pulls can have different strengths and directions. • Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. • When objects touch or collide, they push on one another and can change motion. • A bigger push or pull makes things speed up or slow down more quickly. • A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.

Strand: Energy

Curriculum Standards	Learner Outcomes
Students will make observations to determine the effect of sunlight on the Earth's surface. Students will use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.	• Sunlight warms Earth's surface.

Strand: Earth and Human Activity

Curriculum Standards	Learner Outcomes
Students will use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.	• Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. • Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. • Asking questions, making observations, and gathering information are helpful in

Students will ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. Students will communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment	thinking about problems. • Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

Grade One Science Curriculum

Strand: Waves and Their Applications

Curriculum Standards	Learner Outcomes
Students will plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. Students will plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light. Students will use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.	• Sound can make matter vibrate, and vibrating matter can make sound. • Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.) • People also use a variety of devices to communicate (send and receive information) over long distances.

Strand: From Molecules to Organisms: Structures & Processes

Curriculum Standards	Learner Outcomes
Students will use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. Students will read texts and use media to determine patterns in behaviour of parents and offspring that help offspring survive.	• All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. • Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviours that help the offspring to survive. • Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviours that help them survive. Plants also respond to some external inputs.

Strand: Earth's Place in the Universe

Curriculum Standards	**Learner Outcomes**
Students will use observations of the sun, moon, and stars to describe patterns that can be predicted. Students will make observations at different times of year to relate the amount of daylight to the time of year.	• Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. • Seasonal patterns of sunrise and sunset can be observed, described, and predicted.

Grade Two Science Curriculum

Strand: Matter and Its Interactions

Curriculum Standards	Learner Outcomes
Students will plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. Students will analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. Students will make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. Students will construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.	• Different kinds of matter exist and many of them can be either solid, liquid or gas, depending on temperature. Matter can be described and classified by its observable properties. • Different properties are suited to different purposes. • A great variety of objects can be built up from a small set of pieces. • Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.

Strand: Ecosystems: Interactions, Energy and Dynamics

Curriculum Standards	Learner Outcomes
Students will plan and conduct an investigation to determine if plants need sunlight and water to grow. Students will develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.	• Plants depend on water and light to grow. • Plants depend on animals for pollination or to move their seeds around. • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

Strand: Earth's Systems

Curriculum Standards	Learner Outcomes
Students will compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. Students will develop a model to represent the shapes and kinds of land and bodies of water in an area. Students will obtain information to identify where water is found on Earth and that it can be solid or liquid.	• Wind and water can change the shape of the land. • Because there is always more than one possible solution to a problem, it is useful to compare and test designs. • Maps show where things are located. One can map the shapes and kinds of land and water in any area. • Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.

Grade Three Science Curriculum

Strand: Motion and Stability: Forces and Interactions

Curriculum Standards	Learner Outcomes
Students will plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. Students will make observations and/ or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. Students will ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. Students will define a simple design problem that can be solved by applying scientific ideas about magnets.	• Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) • Objects in contact exert forces on each other. • 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. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) • Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. 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.

Strand: From Molecules to Organisms: Structures & Processes

Curriculum Standards	Learner Outcomes
Students will develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	• Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.

Strand: Biological Evolution: Unity & Diversity

Curriculum Standards	Learner Outcomes
Students will analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. Students will use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. Students will construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. Students will make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.	• 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. • Some kinds of plants and animals that once lived on Earth are no longer found anywhere. • Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. • Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. • For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. • Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

Grade Four Science Curriculum

Strand: Energy

Curriculum Standards	Learner Outcomes
Students will use evidence to construct an explanation relating the speed of an object to the energy of that object. Students will make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. Students will ask questions and predict outcomes about the changes in energy that occur when objects collide. Students will apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	• The faster a given object is moving, the more energy it possesses. • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. • Energy is present whenever there are moving objects, sound, light, or heat. 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. • Light also transfers energy from place to place. • 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 with by transforming the energy of motion into electrical energy. • When objects collide, the contact forces transfer energy so as to change the object's motions. • The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

Strand: Waves and Their Application

Curriculum Standards	Learner Outcomes
Students will develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. Students will generate and compare multiple solutions that use patterns to transfer information.	• 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; there is no net motion in the direction of the wave except when the water meets a beach. • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). • An object can be seen when light reflected from its surface enters the eyes. • Digitized information can be 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. • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.

Strand: Earth & Human Activity

Curriculum Standards	Learner Outcomes
Students will obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. Students will generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.	• 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. • A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. • Testing a solution involves investigating how well it performs under a range of likely conditions.

Grade Five Science Curriculum

Strand: Matter and Its Interactions

Curriculum Standards	Learner Outcomes
Students will develop a model to describe that matter is made of particles too small to be seen. Students will measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. Students will make observations and measurements to identify materials based on their properties. Students will conduct an investigation to determine whether the mixing of two or more substances results in new substances	• 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. 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 and the effects of air on larger particles or objects. • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. • Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) • When two or more different substances are mixed, a new substance with different properties may be formed. • No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)

Strand: Earth's Place in the Universe

Curriculum Standards	Learner Outcomes
Students will support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth. Students will represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of stars.	• The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.

Strand: Earth's Systems

Curriculum Standards	Learner Outcomes
Students will develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. Students will describe and graph the amounts of saltwater and freshwater in various reservoirs to provide evidence about the distribution of water on 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. • 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.

Middle School (Grade 6-8) Science Curriculum: Physical Science

Strand: Matter and Its Interactions

Curriculum Standards	Learner Outcomes
Students will create molecular models. Students will predict changes in particle motion and temperature. Students will balance chemical equations.	• Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. • The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. • The total number of each type of atom is conserved, and thus the mass does not change.

Strand: Energy

Curriculum Standards	Learner Outcomes
Students will describe the relationships of kinetic energy to the mass of an object and to the speed of an object. Students will describe that when the arrangement of objects interacting at a distance changes, different amount of potential energy are stored in the system.	• Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. • A system of objects may also contain stored (potential) energy, depending on their relative positions. • When the motion energy of an object changes, there is inevitably some other change in energy at the same time. • When two objects interact, each one exerts a force on the other.

Strand: Waves and Their Applications in Technologies for Information Transfer

Curriculum Standards	Learner Outcomes
Students will relate the amplitude of a wave to its energy. Students will describe how waves are reflected, absorbed, or transmitted.	• A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. • A sound wave needs a medium through which it is transmitted. When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. • The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.

Middle School (Grade 6-8) Science Curriculum: Life Science

Strand: From Molecules to Organisms: Structures and Processes

Curriculum Standards	Learner Outcomes
Students will relate how structure is related to function in a cell. Students will explain how environmental and genetic factors affect growth in organisms. Students will describe the flow of energy within an organism.	• All living things are made up of cells, which is the smallest unit that can be said to be alive. • Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. • Genetic factors as well as local conditions affect the growth of the adult plant 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. • 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.

Strand: Ecosystems: Interactions, Energy, and Dynamics

Curriculum Standards	Learner Outcomes
Students will relate resource availability effect on populations. Students will describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	• Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. • Growth of organisms and population increases are limited by access to resource.

Strand: Heredity: Inheritance and Variation of Traits

Curriculum Standards	Learner Outcomes
Students will describe how changes to a chromosome affects an organism. Students will compare sexual and asexual reproduction.	• 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 affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. • Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.

Middle School (Grade 6-8) Science Curriculum: Earth Science

Strand: Earth's Place in the Universe

Curriculum Standards	Learner Outcomes
Students will model and describe the Sun-Earth-Moon system. Students will describe Earth's geologic time scale.	• The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth . • The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.

Strand: Earth's Systems

Curriculum Standards	Learner Outcomes
Students will describe the cycling of Earth's materials and the flow of energy that drive the cycling. Students will describe the processes that create climate on Earth.	• 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 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. • Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.

Strand: Earth & Human Activity

Curriculum Standards	Learner Outcomes
Students will describe how increases in human population and per-capita consumption of natural resources impact Earth's systems. Students will describe factors that have caused the rise in global temperatures over the past century.	• Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise **.** • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.

High School (Grade 9) Science Curriculum: Physical Science

Strand: Matter and Its Interactions

Curriculum Standards	Learner Outcomes
Students will use a periodic table to predict the properties of elements. Students will explain that atoms, and therefore mass, are conserved during chemical reactions. Students will explore how the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	• Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. • A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. • Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.

Strand: Motion and Stability: Forces and Interactions

Curriculum Standards	Learner Outcomes
Students will explore Newton's Second Law of Motion. Students will use Newton's Law of Gravitation and Coulomb's lab to predict forces between objects.	• Newton's second law accurately predicts changes in the motion of macroscopic objects. • Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces.

Strand: Energy

Curriculum Standards	Learner Outcomes
Students will calculate the change of energy in a system. Students will model the electric or magnetic fields of two objects and the changes in energy due to the interaction.	• Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. • Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.

High School (Grade 10) Science Curriculum: Biology

Strand: From Molecules to Organisms: Structures and Processes

Curriculum Standards	Learner Outcomes
Students will relate how the structure of DNA creates proteins. Students will describe the steps of mitosis. Students will describe the process of photosynthesis. Students will describe the formation of macromolecules. Students will describe the steps of cell respiration.	• All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. • The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. • Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.

Strand: Ecosystems: Interactions, Energy, and Dynamics

Curriculum Standards	Learner Outcomes
Students will analyze factors determining carrying capacity. Students will analyze factors determining biodiversity and population. Students will describe the cycling of matter and the flow of energy. Students will evaluate the impact of human activity on ecosystems.	• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. • A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Strand: Heredity: Inheritance and Variation of Traits

Curriculum Standards	Learner Outcomes
Students will explain the relationship between DNA, chromosomes, and the coding for proteins. Students will explain how genetic variation may result from meiosis, errors during replication, and mutations. Students will explain the variation and distribution of expressed traits in a population.	• Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved. in regulatory or structural functions, and some have no as-yet known function. • In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. • Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.