

## Minnesota Academic Standards Science

The grade level designations in the Minnesota Academic Standards for Science are strongly recommended. However, school districts may place the (K-2, 3-5, 6-8) standards at grade levels that accommodate their particular curriculum. The standards should be mastered by the end of the highest grade in the band.

### ORGANIZATION OF THIS DOCUMENT

The Minnesota Academic Standards in Science are organized into four general *strands*: 1) History and Nature of Science, 2) Physical Sciences, 3) Earth and Space Science and 4) Life Science. One or more categories or *sub-strands* of standards are listed under each strand. For example, the History and Nature of Science strand includes the sub-strands of Scientific World View, Scientific Inquiry, Scientific Enterprise and Historical Perspectives.

Each *standard* is a summary description regarding what it is that students should know and/or be able to do within a particular discipline. (Content standards serve to organize an academic subject domain through a *manageable number* of generally stated goals for student learning.) Content standards can address two kinds of knowledge: 1) declarative knowledge (what student should "know"), and/or procedural knowledge (what students should "do"). Examples of declarative knowledge include facts, concepts, principles, generalizations, and over-arching themes. Examples of procedural knowledge include skills, processes, and strategies.

A *benchmark* is a clear, specific description of knowledge or skill that students should acquire by a particular point in their schooling. (Benchmarks should be specific enough to be clear about the learning it should entail. Ideally, benchmarks are placed at the grade at which a student is not only developmentally ready to acquire the understanding or skill described, but also at the point in time at which the student has received all prior instruction necessary to learn the new material.)

The strands are identified by Roman numerals (I, II, III) and the sub-strands by upper case letters (A, B, C, etc.). The standards are noted by the word "Standard" and are followed by a list of benchmarks identified by ordinal numbers (1, 2, 3, etc.). The example below illustrates the relationship between a strand, sub-strand, standard and benchmarks.

#### Example

#### *Kindergarten*

<i>Strand</i>	<b>IV. LIFE SCIENCE</b>
<i>Sub-strand</i>	<b>B. Diversity of Organisms</b>
<i>Standard</i>	<u>Standard</u> : The student will understand that there are living and nonliving things.
<i>Benchmarks</i>	The student will:  <ol style="list-style-type: none"><li>1. Compare and contrast living and nonliving things.</li><li>2. Know simple ways that living things can be grouped.</li></ol>

The next page outlines the organization of the Science standards for all grade levels.

## **FRAMEWORK FOR THE K-12 SCIENCE STANDARDS GRADE LEVELS (K-2, 3-5, 6-8, 9-12)**

### **I. HISTORY AND NATURE OF SCIENCE**

#### **A. Scientific World View**

Standard statement

1. Benchmark
2. Benchmark, etc.

#### **B. Scientific Inquiry**

Standard statement

1. Benchmark
2. Benchmark, etc.

#### **C. Scientific Enterprise**

Standard statement

1. Benchmark
2. Benchmark, etc.

#### **D. Historic Perspectives**

Standard statement

1. Benchmark
2. Benchmark, etc.

### **II. PHYSICAL SCIENCE**

#### **A. Structure of Matter**

Standard statement

1. Benchmark
2. Benchmark, etc.

#### **B. Chemical Reactions**

Standard statement

1. Benchmark
2. Benchmark, etc.

#### **C. Energy Transformations**

Standard statement

1. Benchmark
2. Benchmark, etc.

#### **D. Motion**

Standard statement

1. Benchmark
2. Benchmark, etc.

#### **E. Forces of Nature**

Standard statement

1. Benchmark
2. Benchmark, etc.

### **III. EARTH AND SPACE SCIENCE**

#### **A. Earth Structure and Processes**

Standard statement

1. Benchmark
2. Benchmark, etc.

**B. The Water Cycle, Weather and Climate**

Standard statement

1. Benchmark
2. Benchmark, etc.

**C. The Universe**

Standard statement

1. Benchmark
2. Benchmark, etc.

**IV. LIFE SCIENCE**

**A. Cells**

Standard statement

1. Benchmark
2. Benchmark, etc.

**B. Diversity of Organisms**

Standard statement

1. Benchmark
2. Benchmark, etc.

**C. Interdependence of Life**

Standard statement

1. Benchmark
2. Benchmark, etc.

**D. Heredity**

Standard statement

1. Benchmark
2. Benchmark, etc.

**E. Biological Populations Change over Time**

Standard statement

1. Benchmark
2. Benchmark, etc.

**F. Flow of Matter and Energy**

Standard statement

1. Benchmark
2. Benchmark, etc.

**G. Human Organism**

Standard statement

1. Benchmark
2. Benchmark, etc.

## KINDERGARTEN

### I. HISTORY AND NATURE OF SCIENCE

#### B. Scientific Inquiry

Standard: The student will raise questions about the natural world.

The student will:

1. Observe and describe common objects using simple tools.

### III. EARTH AND SPACE SCIENCE

#### B. The Water Cycle, Weather and Climate

Standard: The student will observe weather changes.

The student will:

1. Describe daily and seasonal changes in weather.

### IV. LIFE SCIENCE

#### B. Diversity of Organisms

Standard: The student will understand that there are living and nonliving things.

The student will:

1. Compare and contrast living and nonliving things.
2. Know simple ways that living things can be grouped.

#### G. Human Organism

Standard: The student will understand that people have five senses that can be used to learn about the environment.

The student will:

1. Observe and describe the environment using the five senses.

## GRADE 1

### I. HISTORY AND NATURE OF SCIENCE

#### B. Scientific Inquiry

Standard: The student will raise questions about the natural world, make careful observations, and seek answers.

The student will:

1. Observe, describe, measure, compare and contrast common objects, using simple tools including but not limited to ruler, thermometer and balance.

### II. PHYSICAL SCIENCE

#### A. Structure of Matter

Standard: The student will understand that objects have physical properties.

The student will:

1. Describe objects in terms of color, size, shape, weight, texture, flexibility and attraction to magnets.

#### E. Forces of Nature

Standard: The student will understand that forces can act at a distance.

The student will:

1. The student will know that magnets can be used to make some things move without direct contact.
2. The student will know that things near the Earth fall to the ground unless something holds them up.

### III. EARTH AND SPACE SCIENCE

#### B. The Water Cycle, Weather and Climate

Standard: The student will investigate weather cycles.

The student will:

1. Observe, record and describe characteristics in daily weather and seasonal cycles.

#### C. The Universe

Standard: Student will recognize the changes that occur in the sky in a 24-hour day.

The student will:

1. Observe and describe the changes in the position of the sun and the moon.

#### **IV. LIFE SCIENCE**

##### **B. Diversity of Organisms**

Standard: The student will observe plant and animal life cycles.

The student will:

1. Observe and describe how plants and animals grow and change.

##### **D. Heredity**

Standard: The student will understand that there is variation among individuals of one kind within a population.

The student will:

1. Describe ways in which many plants and animals closely resemble but are not identical to their parents.
2. Match adult animals and plants to their offspring.

##### **F. Flow of Matter and Energy**

Standard: The student will understand that organisms have basic needs.

The student will:

1. Know that animals need air, water and food and that plants require air, water, nutrients and light.

##### **G. Human Organism**

Standard: The student will know that the human body is made up of parts.

The student will:

1. Observe and describe major parts of the body including, but not limited to, eyes, nose, heart, skin, arms, legs and muscles.

##### **G. Human Organism**

Standard: The student will learn that some diseases are caused by germs.

The student will:

1. Know that diseases caused by germs can be spread from person to person; the number of germs can be reduced by personal behavior.

## GRADE 2

### I. HISTORY AND NATURE OF SCIENCE

#### A. Scientific World View

Standard: The student will understand that science is a human endeavor practiced throughout the world.

The student will:

1. Recognize that repeating a scientific investigation will lead to very similar results.
2. Recognize that scientific investigations generally work the same way in different places.
3. Give examples of scientific advances throughout history.
4. Recognize that everyone can do science and invent things and ideas.

#### B. Scientific Inquiry

Standard: The student will raise questions about the natural world, make careful observations and seek answers.

The student will:

1. Use appropriate tools to gather and organize data.
2. Recognize and describe patterns in data.

### II. PHYSICAL SCIENCE

#### A. Structure of Matter

Standard: The student will understand that objects can be sorted and classified based on their properties.

The student will:

1. Sort and classify objects in terms of color, size, shape, weight, texture, flexibility and attraction to magnets.
2. Classify a substance as a solid, liquid or gas.
3. Know that solids have a definite shape and that liquids take the shape of their container.
4. Observe that water can be a solid or liquid and can change from one state to the other.

#### D. Motion

Standard: The student will know that objects move in various ways.

The student will:

1. Observe and describe how objects move in a variety of ways, including, but not limited to, a straight line, a curve, a circle, back and forth and at different speeds.

2. Observe that push and pull forces can make objects move.

### **III. EARTH AND SPACE SCIENCE**

#### **A. Earth Structure and Processes**

Standard: The student will recognize basic Earth materials.

The student will:

1. Observe and describe rocks, soils, water and air.

### **IV. LIFE SCIENCE**

#### **B. Diversity of Organisms**

Standard: The student will recognize that plants and animals have life cycles.

The student will:

1. Describe life cycles of plants and animals.

#### **C. Interdependence of Life**

Standard: The student will understand that organisms live in different environments.

The student will:

1. The student will observe and describe some features of plants and animals that allow them to live in specific environments.

#### **E. Biological Populations Change Over Time**

Standard: The student will understand that biological populations change over time.

The student will:

1. Know that some kinds of organisms that once lived on Earth are now extinct, including, but not limited to, dinosaurs, trilobites, mammoths, giant tree ferns and horsetail trees.

#### **F. Flow of Matter and Energy**

Standard: The student will investigate feeding relationships among organisms.

The student will:

1. Observe and describe predator and prey relationships.
2. Compare and contrast plant eaters and meat eaters.

#### **G. Human Organism**

Standard: The student will recognize that people have basic needs.

The student will:

1. Know that people need water, food, air, waste removal and a particular range of temperature in their environment, just like other animals.

## GRADE 3

### I. HISTORY AND NATURE OF SCIENCE

#### A. Scientific World View

Standard: The student will understand the use of science as a tool to examine the natural world.

The student will:

1. Explore the use of science as a tool that can help investigate and answer questions about the environment.

#### B. Scientific Inquiry

Standard: The student will understand the nature of scientific investigations.

The student will:

1. Ask questions about the natural world that can be investigated scientifically.
2. Participate in a scientific investigation using appropriate tools.
3. Know that scientists use different kinds of investigations depending on the questions they are trying to answer.

### II. PHYSICAL SCIENCE

#### C. Energy Transformations

Standard: The student will explore the characteristics and properties of sound and light.

The student will:

1. Investigate how sounds are made when objects vibrate.
2. Know that light tends to maintain its direction of motion until it is absorbed, refracted, or reflected by an object.

### III. EARTH AND SPACE SCIENCE

#### B. The Water Cycle, Weather and Climate

Standard: The student will investigate weather conditions.

The student will:

1. Measure, record, and describe weather conditions using common instruments.
2. Identify cumulus, cirrus and stratus clouds.

#### C. The Universe

Standard: The student will understand the characteristics and relationships of objects in the solar system.

The student will:

1. Recognize the difference between rotation and revolution and their connection to day, night, seasons and the year.
2. Identify the planets in the solar system and their relative sizes, distances and basic characteristics.
3. Observe that the sun supplies heat and light to the Earth.
4. Know that planets look like stars, but over time they move differently than stars.

#### **IV. LIFE SCIENCE**

##### **B. Diversity of Organisms**

Standard: The student will recognize that plants and animals have different structures that serve various functions.

The student will:

1. Describe the structures that serve different functions in growth, survival and reproduction for plants and animals.
2. Know that plants have different structures from animals that serve the same necessary functions in growth, survival and reproduction.

##### **C. Interdependence of Life**

Standard: The student will understand that an organism's patterns of behavior are related to the nature of its environment.

The student will:

1. Know that organisms interact with one another in various ways besides providing food.
2. Know that changes in a habitat can be beneficial or harmful to an organism.

##### **D. Heredity**

Standard: The student will understand that many characteristics of an organism are inherited from its parents, but that other characteristics result from an individual's interactions with the environment.

The student will:

1. Observe and differentiate between characteristics of organisms that are inherited and characteristics that are acquired.
2. Identify similarities and differences between parent and offspring.

## GRADE 4

### I. HISTORY AND NATURE OF SCIENCE

#### A. Scientific World View

Standard: The student will understand how science is used to investigate interactions between people and the natural world.

The student will:

1. Explore the uses and effects of science in our interaction with the natural world.
2. Discuss the responsible use of science.
3. Recognize the impact of scientific and technological activities on the natural world.

#### B. Scientific Inquiry

Standard: The student will participate in a controlled scientific investigation.

The student will:

1. Recognize when comparisons might not be fair because some conditions are not kept the same.
2. Collect, organize, analyze and present data from a controlled experiment.
3. Recognize that evidence and logic are necessary to support scientific understandings.

### II. PHYSICAL SCIENCE

#### A. Structure of Matter

Standard: The student will know that heating and cooling may cause changes to the properties of a substance.

The student will:

1. Observe that heating and cooling can causes changes in state.
2. Describe the changes in the properties of a substance when it is heated or cooled.
3. Compare and contrast the mass, shape and volume of solids, liquids and gases.

#### C. Energy Transformations

Standard: The student will understand basic electricity and its application in everyday life.

The student will:

1. Explore simple electrical circuits using components such as wires, batteries and bulbs.
2. Investigate static electricity.
3. Identify objects and materials that conduct electricity and those that are insulators.

**E. Forces of Nature**

Standard: The student will understand that a relationship exists between electricity and magnetism.

The student will:

1. Demonstrate how a wire and magnet can be used to generate an electric current.
2. Demonstrate how an electric current can make an iron object magnetic.

**III. EARTH AND SPACE SCIENCE**

**A. Earth Structure and Processes**

Standard: The student will investigate the impact humans have on the environment.

The student will:

1. Identify and investigate environmental issues and potential solutions.

**B. The Water Cycle, Weather and Climate**

Standard: The student will recognize that water on Earth cycles and exists in many forms.

The student will:

1. Describe the water cycle involving the processes of evaporation, condensation, precipitation and collection.
2. Identify where water exists on Earth.

**C. The Universe**

Standard: The student will identify the patterns and movements of celestial objects.

The student will:

1. Recognize that the stars in the sky appear to slowly move from east to west.
2. Identify the sun as an average-sized star and that the other stars are so far away that they look like points of light.
3. Know that telescopes magnify distant objects in the sky and dramatically increase the number of stars we can see.

**IV. LIFE SCIENCE**

**A. Cells**

Standard: The student will know that all organisms are composed of cells, which are the fundamental units of life.

The student will:

1. Recognize that cells are very small, and that all living things consist of one or more cells.

2. Recognize that cells need: food, water and air, a way to dispose of waste, and an environment in which they can live.

#### **IV. LIFE SCIENCE**

##### **B. Diversity of Organisms**

Standard: The student will know that living things can be sorted into groups in many ways according to their varied characteristics, structures and behaviors.

The student will:

1. Classify plants and animals according to their physical characteristics.
2. Learn that the characteristics used for grouping depend on the purpose of the grouping.

##### **G. Human Organism**

Standard: The student will know the structures that serve various functions in the human body, including protection from disease.

The student will:

1. Understand that humans have structures that serve functions in growth, survival and reproduction.
2. Know that germs entering the body can cause disease, and that the body has defenses against these germs.
3. Know that there are many diseases that can be prevented by vaccination.

## GRADE 5

### I. HISTORY AND NATURE OF SCIENCE

#### A. Scientific World View

Standard: The student will understand that communication is essential to science.

The student will:

1. Know that current scientific knowledge and understanding guide scientific investigation.
2. Recognize that clear communication of methods, findings and critical review is an essential part of doing science.

#### B. Scientific Inquiry

Standard: The student will understand the process of scientific investigations.

The student will:

1. Perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
2. Observe that when a science investigation or experiment is repeated, a similar result is expected.

#### C. Scientific Enterprise

Standard: The student will recognize that science and technology involve different kinds of work and engages men and women of all backgrounds.

The student will:

1. Describe different kinds of work done in science and technology.
2. Identify men and women of various backgrounds and ages who have been involved in science and technology, both past and present.

### II. PHYSICAL SCIENCE

#### D. Motion

Standard: The student will understand that changes in speed or direction of motion are caused by forces.

The student will:

1. Investigate the use of a lever, inclined plane and wheel and axle to move objects.
2. Demonstrate that the greater the force applied, the greater the change in motion.

### **III. EARTH AND SPACE SCIENCE**

#### **A. Earth Structure and Processes**

Standard: The student will explore the structures and functions of Earth systems.

The student will:

1. Recognize the natural processes that cause rocks to break down into smaller pieces and eventually into soil.
2. Investigate the formation, composition and properties of soil.
3. Describe how waves, wind, water and ice shape and reshape the Earth's surface.
4. Describe the impact of floods, tornadoes, earthquakes and volcanoes on the Earth.
5. Explore the interaction of the lithosphere, atmosphere, biosphere, hydrosphere and space.

### **IV. LIFE SCIENCE**

#### **E. Biological Populations Change Over Time**

Standard: The student will know that biological populations change over time.

The student will:

1. Recognize that individuals of the same species differ in their characteristics and that sometimes the differences give individuals an advantage in surviving and reproducing.
2. Recognize that extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival.
3. Compare the structure of fossils to one another and to living organisms.

#### **F. Flow of Matter and Energy**

Standard: The student will know that matter and energy flow into, out of, and within a biological system.

The student will:

1. Recognize that organisms need energy to stay alive and grow, and that this energy originates from the sun.
2. Use food webs to describe the relationships among producers, consumers, and decomposers in an ecosystem in Minnesota.
3. Recognize that organisms are growing, dying and decaying, and that their matter is recycled.

## GRADE 6

### I. HISTORY AND NATURE OF SCIENCE

#### A. Scientific World View

Standard: The student will understand that science is a way of knowing about the world that is characterized by empirical criteria, logical argument and skeptical review.

The student will:

1. Distinguish between scientific evidence and personal opinion.
2. Explain why scientists often repeat investigations to be sure of the results.
3. Recognize that scientists assume that the laws of nature are the same everywhere and that they are understandable and predictable.
4. Define scientific facts, laws and theories.

### I. HISTORY AND NATURE OF SCIENCE

#### B. Scientific Inquiry

Standard: The student will understand that scientific inquiry is used in systematic ways to investigate the natural world.

The student will:

1. Identify questions that can be answered through scientific investigation and those that cannot.
2. Distinguish among observation, prediction and inference.
3. Use appropriate tools and Système International (SI) units for measuring length, time, mass, volume and temperature with suitable precision and accuracy.
4. Present and explain data and findings from controlled experiments using multiple representations including tables, graphs, physical models and demonstrations.

#### C. Scientific Enterprise

Standard: The student will know that science and technology are human efforts that both influence and are influenced by society.

The student will:

1. Describe the types of questions asked, the products, and the methods of investigation used to distinguish science from technology.
2. Explain why scientists may work in teams or work alone, can collaborate and, at times, compete.

## II. PHYSICAL SCIENCE

### A. Structure of Matter

Standard: The student will understand that matter is made of small particles and this explains the properties of matter.

The student will:

1. Know that there are more than 100 different elements with unique properties.
2. Use evidence to explain that matter is made of small particles called atoms or molecules that are too small to see.
3. Know that the mass of a substance remains constant whether it is together, in parts or in a different state.
4. Describe the states of matter in terms of the space between particles.
5. Distinguish between volume, mass and density.
6. Use the characteristic properties of density, melting point, boiling point and solubility to identify and distinguish mixtures and pure substances.
7. Know that atoms are the smallest unit of an element that maintains the characteristics of the element.

### B. Chemical Reactions

Standard: The student will differentiate between chemical and physical changes.

The student will:

1. Define chemical and physical changes.
2. Observe that substances react chemically with other substances to form new substances with different characteristic properties.
3. Give examples and classify substances as mixtures or pure substances.

### C. Energy Transformations

Standard: The student will understand that energy exists in many forms and can be transferred in many ways.

The student will:

1. Compare and contrast heat, chemical, mechanical and electrical energy and identify transformations of energy from one form to another in everyday situations.
2. Recognize that heat is transferred by convection, conduction and radiation from warmer objects to cooler ones until both reach the same temperature.
3. Demonstrate that visible light from the sun or reflected by objects may be made up of a mixture of many different colors of light.

4. Recognize the relationship between light and heat.
5. Describe waves in terms of speed, frequency and wavelength.
6. Recognize that vibrations such as sound and earthquakes move in waves and that waves move at different speeds in different materials.

**D. Motion**

Standard: The student will describe the motion of objects.

The student will:

1. Use a frame of reference to describe the position, speed, and acceleration of an object.
2. Measure and graph the positions and speed of an object.
3. Recognize that unbalanced forces acting on an object change the object's speed and/or direction.

**E. Forces of Nature**

Standard: The student will understand that a variety of forces govern the structure and motion of objects in the universe.

The student will:

1. Know that electric currents and magnets can exert a force on certain objects and each other.
2. Know that there are positive and negative charges and that like charges repel one another and opposite charges attract.

## GRADE 7

### I. HISTORY AND NATURE OF SCIENCE

#### A. Scientific World View

Standard: The student will understand that science is a way of knowing about the world that is characterized by empirical criteria, logical argument and skeptical review.

The student will:

1. Recognize how scientific knowledge is subject to change as new evidence becomes available, or as new theories cause scientists to look at old observations differently.
2. Explain natural phenomena by using appropriate physical, conceptual and mathematical models.

#### B. Scientific Inquiry

Standard: The student will design and conduct scientific investigations.

The student will:

1. Formulate a testable hypothesis based on prior knowledge.
2. Recognize that a variable is a condition that may influence the outcome of an investigation and know the importance of manipulating one variable at a time.
3. Write a specific step-by-step procedure for a scientific investigation.
4. Explain how classroom scientific investigations relate to established scientific principles.

#### C. Scientific Enterprise

Standard: The student will know that science and technology are human efforts that both influence, and are influenced by, society.

The student will:

1. Give examples of the development of technology influencing scientific knowledge, and investigation and scientific knowledge influencing the development of technology.

#### D. Historic Perspectives

Standard: The student will understand how scientific discovery, culture, societal norms and technology have influenced one another in different time periods.

The student will:

1. Cite examples of individuals throughout history who made discoveries and contributions in science and technology.
2. Cite examples of how culture influences scientific and technological advances.

#### **IV. LIFE SCIENCE**

##### **A. Cells**

Standard: The student will understand that all organisms are composed of cells that carry on the many functions needed to sustain life.

The student will:

1. Know that cells are the fundamental units of life.
2. Distinguish between single-cellular and multi-cellular organisms.
3. Distinguish between plant and animal cells.
4. Recognize that cells repeatedly divide for growth and repair.
5. Recognize that cells convert energy from food for the production of molecules necessary for life, and for life processes including cell growth and cell division.
6. Recognize that specialized cells in multi-cellular organisms perform specialized functions.

##### **B. Diversity of Organisms**

Standard: The student will understand that living systems, at every level of organization, demonstrate the complementary nature of structure and function.

The student will:

1. Explain that individuals are composed of specialized cells, tissues, organs and organ systems that perform specialized functions.
2. The student will recognize that an organism's body plan and its ability to regulate its internal environment enable it to make or find food, grow and reproduce in a constantly changing environment.
3. The student will recognize that behavioral responses of organisms may be determined by heredity and past experience.
4. The student will use and create dichotomous keys.
5. The student will use the characteristics of an organism to identify the kingdom to which it belongs.

##### **C. Interdependence of Life**

Standard: The student will understand that within ecosystems, complex interactions exist between organisms and the physical environment.

The student will:

1. Provide examples of the potentially irreversible effects of human activity on ecosystems.
2. Define a population as all individuals of a species that exist together at a given place and time.

3. Define an ecosystem as all populations living together and the physical factors with which they interact.
4. Explain the factors that affect the number and types of organisms an ecosystem can support, including available resources, abiotic and biotic factors and disease.

**D. Heredity**

Standard: The student will understand that heredity information is contained in genes which are inherited through both sexual and asexual reproduction.

The student will:

1. Recognize that inherited traits result from information contained in genes, which are located on chromosomes of each cell.
2. Recognize that each gene carries a single unit of information and can influence more than one trait.
3. Explain how inherited traits can be determined by one or many genes.
4. Comprehend that interactions with the environment affect some inherited traits.
5. Comprehend that reproduction is essential for the continuation of a species.
6. Compare and contrast the advantages and disadvantages of sexual and asexual reproduction.

**E. Biological Populations Change Over Time**

Standard: The student will understand how biological evolution provides a scientific explanation for the fossil record of ancient life forms, as well as for the striking similarities observed among the diverse species of living organisms.

The student will:

1. Recognize extinction is a common event.
2. Describe how the fossil record documents the appearance and diversification of many life forms.
3. Explain how biological adaptations in structure, function and behavior enhance the reproductive success and survival of a species in a particular environment.
4. Recognize that scientific evidence can be used to infer common ancestry among some organisms.
5. Explain how diversity of species develops through gradual processes over generations.

**F. Flow of Matter and Energy**

Standard: The student will understand how the flow of energy and the recycling of matter contribute to a stable ecosystem.

The student will:

1. Know that plants use the energy in light to make sugars out of carbon dioxide and water.
2. Explain how energy is transferred through food chains and food webs in an ecosystem.
3. Explain how the amount of useable energy available to organisms decreases as it passes through a food chain and/or food web.
4. Know that the total amount of matter in a closed system remains the same as it is transferred between organisms and the physical environment even though its location or form changes.
5. Compare and contrast predator/prey, parasite/host and producer/consumer/decomposer relationships.

**G. Human Organism**

Standard: The student will understand human body systems and their relationship to disease.

The student will:

1. Recognize that disease can be caused by genetics, infection by other organisms, exposure to environmental factors or a combination of these.
2. Identify risks associated with natural, chemical and biological hazards.
3. Describe the structure and function of systems for digestion, respiration, reproduction, circulation, excretion, movement, control and coordination and for protection from disease, in the human organism.

## GRADE 8

### I. HISTORY AND NATURE OF SCIENCE

#### A. Scientific World View

Standard: The student will understand that science is a way of knowing about the world that is characterized by empirical criteria, logical argument and skeptical review.

The student will:

1. Explain and give examples of how science can be used to make informed ethical decisions by identifying likely consequences of particular actions.
2. Explain the development, usefulness and limitations of scientific models in the explanation and prediction of natural phenomena.

#### B. Scientific Inquiry

Standard: The student will understand that scientific inquiry is used by scientists to investigate the natural world in systematic ways.

The student will:

1. Know that scientific investigations involve the common elements of systematic observations, the careful collection of relevant evidence, logical reasoning and innovation in developing hypotheses and explanations.
2. Describe how scientists can conduct investigations in a simple system and make generalizations to more complex systems.

#### B. Scientific Inquiry

Standard: The student will use multiple skills to design and conduct scientific investigations.

The student will:

1. Specify variables to be changed, controlled and measured.
2. Use sufficient trials and adequate sample size to ensure reliable data.
3. Use appropriate technology and mathematics skills to access, gather, store, retrieve and organize data.

#### C. Scientific Enterprise

Standard: The student will know that science and technology are human efforts that both influence and are influenced by civilizations and cultures worldwide.

The student will:

1. Evaluate the credibility and validity of scientific and technological information from various sources.

#### **D. Historic Perspectives**

Standard: The student will understand how scientific discovery, culture, societal norms and technology have influenced one another in different time periods.

The student will:

1. Relate personal experiences in scientific investigation to the experiences of scientists throughout history.
2. Cite examples of how science and technology contributed to changes in agriculture, manufacturing, sanitation, medicine, warfare, transportation, information processing or communication.

### **III. EARTH AND SPACE SCIENCE**

#### **A. Earth Structure and Processes**

Standard: The student will identify Earth's composition, structure and processes.

The student will:

1. Explain how earthquakes, volcanoes, sea-floor spreading and mountain building are evidence of the movement of crustal plates.
2. Describe how features on the Earth's surface are created and constantly changing through a combination of slow and rapid processes of weathering, erosion, sediment deposition, landslides, volcanic eruptions and earthquakes.
3. Describe the various processes and interactions of the rock cycle.
4. Interpret successive layers of sedimentary rocks and their fossils to document the age and history of the Earth.
5. Recognize that constructive and destructive Earth processes can affect the evidence of Earth's history.
6. Classify and identify rocks and minerals using characteristics including but not limited to density, hardness and streak.

#### **A. Earth Structure and Processes**

Standard: The student will investigate the impact humans have on the environment.

The student will:

1. Identify and research an environmental issue and evaluate its impact.

#### **B. The Water Cycle, Weather and Climate**

Standard: The student will investigate how the atmosphere interacts with the Earth system.

The student will:

1. The student will define radiation, conduction and convection and explain their effects on weather and climate.

2. The student will identify the forces that create currents and layers in the Earth's atmosphere and water systems.
3. The student will describe the effect of Earth's rotation on the winds and ocean currents.
4. The student will collect and use data to predict the weather.
5. The student will identify the composition and structures of the atmosphere
6. The student will describe climate changes that have occurred over time.

### **C. The Universe**

Standard: The student will compare objects in the solar system and explain their interactions with the Earth.

The student will:

1. Recognize that the sun is the principal energy source for the solar system and that this energy is transferred in the form of radiation.
2. Explain how the combination of the Earth's tilted axis and revolution around the sun causes the progression of seasons and weather patterns.
3. Compare and contrast the planets, taking into account their composition, mass and distance from the sun and recognize the conditions that have allowed life to flourish on Earth.
4. Use the predictability of the motions of the Earth, and sun to explain the length of day, length of year, phases of the moon, eclipses, tides and shadows.

### **C. The Universe**

Standard: The student will describe the composition and structure of the universe.

The student will:

1. Recognize that the universe consists of many billions of galaxies, each containing many billions of stars and that there are vast distances that separate these galaxies and stars from one another.
2. Recognize that the sun is a medium-sized star and is the closest star to Earth. It is the central and largest body in the solar system and is one of billions of stars in the Milky Way Galaxy.

## GRADES 9–12

### I. HISTORY AND NATURE OF SCIENCE

#### A. Scientific World View

Standard: The student will understand the nature of scientific ways of thinking and that scientific knowledge changes and accumulates over time.

The student will:

1. Be able to distinguish among hypothesis, theory and law as scientific terms and how they are used to answer a specific question.
2. Be able to explain how scientific and technological innovations as well as new evidence can challenge portions of or entire accepted theories and models including but not limited to cell theory, atomic theory, theory of evolution, plate tectonic theory, germ theory of disease and big bang theory.
3. Recognize that in order to be valid, scientific knowledge must meet certain criteria including that it: be consistent with experimental, observational and inferential evidence about nature; follow rules of logic and reporting both methods and procedures; and, be falsifiable and open to criticism.
4. Explain how traditions of ethics, peer review, conflict and general consensus influences the conduct of science.
5. Recognize that some scientific ideas are incomplete, and opportunity exists in these areas for new advances.

#### B. Scientific Inquiry

Standard: The student will design and conduct a scientific investigation.

The student will:

1. Design and complete a scientific experiment using scientific methods by determining a testable question, making a hypothesis, designing a scientific investigation with appropriate controls, analyzing data, making conclusions based on evidence and comparing conclusions to the original hypothesis and prior knowledge.
2. Distinguish between qualitative and quantitative data.
3. Apply mathematics and models to analyze data and support conclusions.
4. Identify possible sources of error and their effects on results.
5. Know that professional scientists and engineers have ethical codes.
6. Give examples of how different domains of science use different bodies of scientific knowledge and employ different methods to investigate questions.

### **C. Scientific Enterprise**

Standard: The student will understand the relationship between science and technology and how both are used.

The student will:

1. Compare and contrast the purposes and career opportunities of engineering, technology and science.
2. Provide an example of a need or problem identified by science and solved by engineering or technology.
3. Provide an example of how technology facilitates new discoveries and the development of scientific knowledge.
4. Know that technological changes and scientific advances are often accompanied by social, political, environmental and economic changes.
5. Recognize that science and technology are influenced by cultural backgrounds and beliefs and by social needs, attitudes, values and limitations.

### **D. Historic Perspectives**

Standard: The student will recognize the historical and cultural context of scientific endeavors and how they influence each other.

The student will:

1. Be able to trace the development of a scientific advancement, invention or theory and its impact on society.
2. Provide examples of scientific advancements contributed by other civilizations and cultures.
3. Compare and contrast the differences between scientific theories and theories from other bodies of knowledge, and the importance of each in a science discussion.

## **II. PHYSICAL SCIENCE**

### **A. Structure of Matter**

Standard: The student will understand the nature of matter including its forms, properties and interactions.

The student will:

1. Identify protons, neutrons and electrons as the major components of the atom, their mass relative to one another, their arrangement and their charge.
2. Be able to explain the relationship of an element's position on the periodic table to its atomic number and atomic mass.
3. Compare and contrast the properties of an element and its isotopes, and describe how isotopes can be used in research, medicine and industry.

4. Use the periodic table to identify regions, families, groups and periods.
5. Explain how neutral atoms become ions.
6. Be able to explain how atoms form compounds through bonding.
7. Compare and contrast the states of matter in terms of interactions between particles.
8. Differentiate between an atom and a molecule.
9. Differentiate between an element and compound.
10. Be able to explain how scientific and technological innovations as well as new evidence can challenge portions of or entire accepted theories and models including, but not limited to, atomic theory.

### **B. Chemical Reactions**

Standard: The student will describe chemical reactions and the factors that influence them.

The student will:

1. Describe chemical reactions using words and symbolic equations.
2. Explain the influence of temperature, surface area, agitation and catalysts on the rate of a reaction.
3. Distinguish between a chemical reaction and a nuclear reaction.
4. Explain how the rearrangement of atoms and molecules in a chemical reaction illustrates conservation of mass.
5. Describe how combining acids and bases produce a neutral solution.

### **C. Energy Transformations**

Standard: The student will understand energy forms, transformations and transfers.

The student will:

1. Know that potential energy is stored energy and is associated with gravitational or electrical force, mechanical position or chemical composition.
2. Differentiate between kinetic and potential energy and identify situations where kinetic energy is converted into potential energy and vice versa.
3. Differentiate between AC and DC current.
4. Describe the production, storage and transmission of electricity.
5. Be able to describe physical and chemical changes in terms of the law of conservation of energy.

6. Compare and contrast the amount of energy released through chemical reactions and nuclear fission and fusion.
7. Describe the risks and benefits of fossil fuels, renewable sources and nuclear power as sources of usable energy.
8. Describe applications of the different wavelengths of the electromagnetic spectrum.
9. Describe energy, work and power both conceptually and quantitatively.

#### **D. Motion**

Standard: The student will understand the nature of force and motion.

The student will:

1. Use Newton's three laws of motion to qualitatively and quantitatively describe the interaction of objects.
2. Describe the effect of friction and gravity on the motion of an object.

#### **E. Forces of Nature**

Standard: The student will understand the forces of nature and their application.

The student will:

1. Recognize the factors that affect the presence and magnitude of gravitational, electromagnetic, weak and strong nuclear forces.
2. Identify the dominant force or forces in a variety of interactions.

### **III. EARTH AND SPACE SCIENCE**

#### **A. Earth Structure and Processes**

Standard: The student will understand that the interactions of the atmosphere, biosphere, lithosphere, hydrosphere and space have resulted in ongoing change of the Earth system over geologic time.

The student will:

1. Identify the internal and external sources of energy for the Earth.
2. Apply the laws of thermodynamics to explain the cycling of materials and transfer of energy in the Earth system.
3. Illustrate how biological processes have played significant roles in determining the character of the atmosphere, biosphere, hydrosphere and lithosphere over time.
4. Use the theory of plate tectonics to analyze relationships among earthquakes, volcanoes, mountains fossil deposits, rock layers and ocean features.
5. Describe how glaciers, gravity, wind, temperature changes, waves and rivers cause weathering and erosion.

6. Describe the rock cycle and compare and contrast the processes responsible for the formation of igneous, sedimentary and metamorphic rocks.
7. Use evidence found in fossils, rock layers, ice cores, radiometric dating and globally gathered data to explain how Earth has changed over short and long periods of time.
8. Be able to explain how scientific and technological innovations as well as new evidence can challenge portions of or entire accepted theories and models, including, but not limited to, plate tectonic theory and big bang theory.

**A. Earth Structure and Processes**

Standard: The student will investigate the impact humans have on the environment.

The student will:

1. Identify and research an environmental issue and evaluate its impact.

**B. The Water Cycle, Weather and Climate**

Standard: The student will explain the causes and effects of the Earth's atmospheric and hydrologic processes.

The student will:

1. Explain how the transfer of energy and motions of the Earth contribute to global climatic processes including wind, waves and ocean currents.
2. Trace the cyclical movement of carbon and water through the lithosphere, hydrosphere, atmosphere and biosphere.
3. Demonstrate the effect of the Earth's tilt, rotation and revolution on the seasons, day length and tides.
4. Identify, predict and investigate the factors that influence the quality of water and how it can be reused, recycled and conserved.
5. Discuss the impact of the use of natural resources and other human activities on the Earth's climate.

**C. The Universe**

Standard: The student will relate the formation and components of our solar system to the conditions necessary for life.

The student will:

1. Explain how the sun, Earth and solar system formed.
2. Compare the characteristics of Earth with the characteristics and movement patterns of the other planets, their satellites and other objects in our solar system.

3. Compare and contrast the environmental parameters that make life possible on Earth with conditions found on the other planets of our solar system.

### **C. The Universe**

Standard: The student will use astronomical data to reveal the structure, scale, and changes in the stars, galaxies and universe over time.

The student will:

1. Identify different types of stars and galaxies and describe how stars, galaxies and the universe change over time.
2. Explain how nuclear fusion produces energy and other elements.
3. Describe the evidence from current technologies that has been used to understand the composition and the early history of the universe.
4. Explain how Doppler evidence indicates our universe is expanding in all directions.

## **IV. LIFE SCIENCE**

### **A. Cells**

Standard: The student will comprehend that all living things are composed of cells, and that the life processes in a cell are based on molecular interactions.

The student will:

1. Relate cellular structures to their functions.
2. Compare and contrast the structures found in typical plant, animal and bacterial cells.
3. Explain the role of the cell membrane as a highly selective barrier in diffusion, osmosis and active transport.
4. Describe the role of enzymes as catalysts in metabolism and cellular synthesis of new molecules.
5. Differentiate between the processes of photosynthesis and respiration in terms of energy flow, reactants and products.
6. Describe and compare the processes of mitosis and meiosis and their roles in the cell cycle.

### **B. Diversity of Organisms**

Standard: The student will classify, compare and contrast the diversity of organisms on Earth and their modes of accommodating the requirements for life.

The student will:

1. Relate the structure, complexity and organization of organ systems to the methods of obtaining, transforming, releasing and eliminating the matter and energy used to sustain the organism.

2. Recognize that organisms have both innate and learned behavioral responses to internal and external stimuli, including the tropic responses in plants.
3. Use scientific evidence, including the fossil record, homologous structures, embryological development or biochemical similarities, to classify organisms in order to show probable evolutionary relationships and common ancestry.

### **C. Interdependence of Life**

Standard: The student will describe how the environment and interactions between organisms can affect the number of species and the diversity of species in an ecosystem.

The student will:

1. Describe the factors related to matter and energy in an ecosystem that both influence fluctuations in population size and determine the carrying capacity of a population.
2. Explain how adaptations of species and co-evolution with other species are related to success in an ecosystem.
3. Identify examples of mutualism, commensalism, and parasitism in a stable ecosystem.
4. Predict and analyze how a change in an ecosystem, resulting from natural causes, changes in climate, human activity or introduction of invasive species, can affect both the number of organisms in a population and the biodiversity of species in the ecosystem.

### **D. Heredity**

Standard: The student will explain how inherited characteristics are encoded by genes.

The student will:

1. Explain that the instructions for the characteristics of all organisms are carried in nucleic acids.
2. Define the relationship between DNA, genes and chromosomes.
3. Describe the structure and function of DNA and distinguish between replication, transcription and translation.
4. Know that different species of multicellular organisms have a characteristic number of chromosomes, and that in typical humans there are 22 autosomal pairs and 2 sex chromosomes.
5. Describe how genetic information is transmitted from parents to offspring through the processes of meiosis and fertilization as they relate to chromosome recombination and sexual reproduction.
6. Use Mendel's laws of segregation and independent assortment to determine the genotype and phenotype of a monohybrid cross.
7. Differentiate between dominant, recessive, co-dominant, incompletely dominant, polygenic and sex-linked traits.

### **E. Biological Populations Change Over Time**

Standard: The student will understand how biological evolution provides a scientific explanation for the fossil record of ancient life forms, as well as for the striking molecular similarities observed among the diverse species of living organisms.

The student will:

1. Understand that species change over time and the term biological evolution is used to describe this process. The student will be able to explain how scientific and technological innovations as well as new evidence can challenge portions of or entire accepted theories and models including, but not limited to, cell theory, theory of evolution and germ theory of disease.
2. Use the principles of natural selection to explain the differential survival of groups of organisms as a consequence of:
  - The potential for a species to increase its numbers;
  - The genetic variability of offspring due to mutation and recombination of genes;
  - A finite supply of the resources required for life; and,
  - The ensuing selection based on environmental factors of those offspring better able to survive and produce reproductively successful offspring.
3. Describe how genetic variation between populations is due to different selective pressures acting on each population, which can lead to a new species.
4. Use biological evolution to explain the diversity of species.

### **F. Flow of Matter and Energy**

Standard: The student will describe and explain the cycling of matter and flow of energy through an ecosystem's living and non-living components.

The student will:

1. Explain the relationship between abiotic and biotic components of an ecosystem in terms of the cycling of water, carbon, oxygen and nitrogen.
2. Know that all matter tends to become more disorganized over time, and that living systems require a continuous input of energy in order to maintain their chemical and physical organizations and prevent death.
3. Explain that sunlight is transformed into chemical energy by photosynthetic organisms.
4. Explain that respiration releases chemical energy through the breakdown of molecules.
5. Understand that matter and energy flow through different levels of organization of living systems, from cells to communities, as well as between living systems and the physical environment as chemical elements are recombined in different ways. Each recombination results in both storage and dissipation of energy.

**G. Human Organism**

Standard: The student will understand how all organ systems, including the nervous system, interact to maintain homeostasis.

The student will:

1. Understand and describe the basic anatomy and physiology of the nervous system and sense organs.
2. Describe how the functions of individual organ systems are integrated to maintain a homeostatic balance in the body.