

Kindergarten

Process Standards

The Nature of Science

Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.

- Use a scientific notebook to record predictions, questions and observations about data with pictures, numbers or in words.
- Conduct investigations that may happen over time as a class, in small groups, or independently.
- Generate questions and make observations about natural processes.
- Make predictions based on observations.
- Discuss observations with peers and be able to support your conclusion with evidence.
- Make and use simple equipment and tools to gather data and extend the senses.
- Recognize a fair test.

The Design Process

As citizens of the constructed world, students will participate in the design process. Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems.

- Identify a need or problem to be solved.
- Brainstorm potential solutions.
- Document the design throughout the entire design process.
- Select a solution to the need or problem.
- Select the materials to develop a solution.
- Create the solution.
- Evaluate and test how well the solution meets the goal.
- Communicate the solution with drawings or prototypes.
- Communicate how to improve the solution.

Standard 1: Physical Science

Core Standard:

Observe, manipulate, sort and generate questions about objects and their physical properties.

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K.1.1. Use all senses as appropriate to observe, sort and describe objects according to their composition and physical properties, such as size, color, and shape. Explain these choices to others and generate questions about the objects.

K.1.2 Identify and explain possible uses for an object based on its properties and compare these uses with other students' ideas.

Standard 2: Earth and Space Science

Core Standard:

Observe, record, and recognize patterns and generate questions about night/day and seasons.

K.2.1 Observe and record during each sunny day when the sun shines on different parts of the school building.

K.2.2 Describe and compare objects seen in the night sky and in the day sky.

K.2.3 Describe in words and pictures the changes in weather from month to month and over the seasons.

Standard 3: Life Science

Core Standard:

Observe living organisms, compare and contrast their characteristics, and ask questions about them.

K.3.1 Observe and draw physical features of common plants and animals.

K.3.2 Describe and compare living animals in terms of shape, texture of body covering, size, weight, color, and the way they move.

K.3.3. Describe and compare living plants in terms of growth, parts, shape, size, color, and texture.

Grade 1

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Standard 1: Physical Science

Core Standard:

Describe objects in terms of the materials that compose them and their physical properties.

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- 1.1.1 Use all senses as appropriate to identify the component parts of objects and the materials from which they are made.
- 1.1.2 Characterize materials as solid or liquid, investigate their properties, record observations and explain the choices to others based on evidence (e.g. physical properties).
- 1.1.3 Predict the results of, and experiment with methods (e.g., sieving, evaporation) for separating solids and liquids based on their physical properties.

Standard 2: Earth and Space Science

Core Standard:

Observe, describe, and ask questions about soil components and properties.

- 1.2.1 Observe and compare properties of sand, clay, silt and organic matter. Look for evidence of sand, clay, silt and organic matter as components of soil samples.
- 1.2.2 Choose, test, and use tools to separate soil samples into component parts.
- 1.2.3 Observe a variety of soil samples and describe in words and pictures the soil properties in terms of color, particle size and shape, texture, and recognizable living and nonliving items in the soil.
- 1.2.4 Observe over time the effect of organisms such as earthworms in the formation of soil from dead plants. Discuss the importance of earthworms in soil.

Standard 3: Life Science

Core Standard:

Observe, describe and ask questions about living things and their relationship to their environment.

- 1.3.1 Classify living organisms according to variations in specific physical features, such as body coverings or appendages, and describe how those features may provide an advantage for survival in different environments.
- 1.3.2 Observe organisms closely over a period of time in different habitats, such as terrariums, aquariums, lawns, and trees. Draw and write about observations.

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- 1.3.3 Observe and explain that plants and animals have basic needs for growth and survival: plants need to take in water and need light and animals need to take in water and food and have a way to dispose of waste.
- 1.3.4 Describe how animals' habitats, including plants, meet their needs for food, water, shelter, and an environment in which they can live.
- 1.3.5 Observe and describe ways in which animals and plants depend on one another for survival.

Standard 4: Science, Engineering and Technology

Core Standard:

Determine properties of natural and man-made materials and their most important uses.

- 1.4.1 Use all senses as appropriate to sort objects as being composed of materials that are naturally-occurring or human-made, or a combination of the two.
- 1.4.2 Choose two animals that build shelters within their habitats and compare the shelters in terms of the materials and tools they use, and the type and purpose of shelter they provide.
- 1.4.3 Construct a simple shelter for an animal with natural and human-made materials taking care to use tools and materials safely and properly.

Grade 2

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Standard 1: Physical Science

Core Standard:

Observe and describe that the properties of materials can change, but not all materials respond in the same way to the same action.

Core Standard:

Observe and describe the motion of an object and how it changes when a force is applied to it.

- 2.1.1. Observe, describe, and measure ways in which the properties of a sample of water (including volume) change or stay the same as it is heated and cooled and is transformed into different states.
- 2.1.2. Predict the result of combining solids and liquids in pairs. Mix; observe, gather, record and discuss evidence that the result may be a material with different properties than the original materials.
- 2.1.3. Predict and experiment with methods (e.g. sieving, evaporation) to separate solids and liquids based on their physical properties.
- 2.1.4 Observe, sketch, demonstrate, and compare how objects can move in different ways (straight, zig-zag, back-and-forth, rolling, fast and slow).
- 2.1.5 Describe the position or motion of an object relative to a point of reference (background or another object).
- 2.1.6 Observe, demonstrate, sketch, and compare how applied force (push or pull) changes the motion of objects.
- 2.1.7 Investigate the motion of objects when they are acted upon by forces at a distance such as gravity and magnetism.

Standard 2: Earth Science

Core Standard:

Day to day and over the seasons observe, measure, record, recognize patterns and ask questions about features of weather.

Core Standard:

Investigate how the position of the sun and moon and the shape of the moon change in observable patterns.

- 2.2.1 Construct and use tools to observe and measure weather phenomena such as precipitation, changes in temperature, wind speed and direction.
- 2.2.2 Experience and describe wind (moving air) as motion of the air that surrounds us and takes up space.
- 2.2.3 Chart or graph weather observations such as cloud cover, cloud type, and type of precipitation on a daily basis over a period of weeks.

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- 2.2.4 Ask questions about charted observations and graphed data. Identify the patterns and cycles of weather day-to-day as well as seasonal time scales in terms of temperature and rainfall/snowfall amounts.
- 2.2.5 Ask questions and design class investigations on the effect of the sun heating the surface of the earth.
- 2.2.6 Learn about, report on, and practice severe weather safety procedures.
- 2.2.7 Investigate how the sun appears to move through the sky during the day by observing and drawing the length and direction of shadows.
- 2.2.8 Investigate how the moon appears to move through the sky during the day by observing and drawing its location at different times.
- 2.2.9 Investigate how the shape of the moon changes from day to day in a repeating cycle that lasts about a month.

Standard 3: Life Science

Core Standard:

Observe, ask questions about, and describe how organisms change their forms and behavior in the course of their life cycles.

- 2.3.1 Observing closely over a period of time, record in pictures and words the changes in plants and animals throughout their life cycles, including details of their body plan, structure and timing of growth, reproduction and death.
- 2.3.2 Compare and contrast details of body plan and structure within the life cycles of plants and animals.

Standard 4: Science, Engineering and Technology

Core Standard:

Describe how technologies have been developed to meet human needs.

- 2.4.1 Identify parts of the human body as tools, such as hands for grasping and teeth for cutting and chewing.
- 2.4.2 Identify technologies developed by humans to meet a human need and investigate the limitations of the technology and how it has improved quality of life.
- 2.4.3 Identify a need and design a simple tool to meet that need.

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- Make predictions and formulate testable questions.
- Design a fair test.
- Plan and carry out investigations as a class, in small groups or independently, often over a period of several class lessons.
- Perform investigations using appropriate tools and technology that will extend the senses.
- Use measurement skills and apply appropriate units when collecting data.
- Test predictions with multiple trials.
- Keep accurate records in a notebook during investigations and communicate findings to others using graphs, charts, maps and models through oral and written reports.
- Identify simple patterns in data and propose explanations to account for the patterns.
- Compare the results of an investigation with the prediction.

The Design Process:

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- Evaluate and test the design using measurement.
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Standard 1: Physical Science

Core Standard:

Observe and describe how sound is produced by vibrations.

Core Standard:

Observe and describe how light travels from point to point.

- 3.1.1 Generate sounds using different materials, objects and techniques; record; discuss and share results.
- 3.1.2 Investigate how the loudness and pitch of sound changes when the rate of vibrations changes.
- 3.1.3 Investigate and recognize that sound moves through solids, liquids and gases (air).
- 3.1.4 Investigate how light travels through the air and tends to maintain its direction until it interacts with some other object or material.
- 3.1.5 Observe and describe how light is absorbed, changes its direction, is reflected back, or passes through objects. Observe and describe that when light cannot pass through an object a shadow results.
- 3.1.6 Describe evidence to support the idea that light and sound are forms of energy.

Standard 2: Earth Science

Core Standard:

Observe, describe, and identify rocks and minerals by their specific properties.

Core Standard:

Observe and describe how natural materials meet the needs of plants and animals, including humans.

- 3.2.1 Examine the physical properties of rock samples and sort them into categories based on size using simple tools such as sieves.
- 3.2.2 Observe the detailed characteristics of rocks and minerals and identify rocks as being composed of different combinations of minerals.
- 3.2.3 Observe, classify, and identify minerals by their physical properties of hardness, color, luster, and streak.

- 3.2.4 Observe fossils and describe how they provide evidence about the plants and animals that lived long ago and the nature of their environment at that time.
- 3.2.5 Describe natural materials and give examples of how they sustain the lives of plants and animals.
- 3.2.6 Describe how the properties of earth materials make them useful to humans in different ways and describe ways that humans have altered these resources to meet their needs for survival.

Standard 3: Life Science

Core Standard:

Observe, describe, and ask questions about plant growth and development.

- 3.3.1 Observe and identify the common structures of a plant including roots, stems, leaves, flowers, fruits, and seeds, and describe their functions.
- 3.3.2 Investigate plant growth over time, take measurements in SI units, record the data and display them in graphs. Examine factors that might influence plant growth.

Standard 4: Science, Engineering and Technology

Core Standard:

Define a real world problem and list criteria for a successful solution.

- 3.4.1 Choose and use the appropriate tools to estimate and measure length, mass and temperature in SI units.
- 3.4.2 Define the uses and types of simple machines and utilize simple machines in the solution to a real world problem.

Grade 4

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- Test predictions with multiple trials.
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- Compare the results of an investigation with the prediction.

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Standard 1: Physical Science

Core Standard:

Provide evidence that heat and electricity are forms of energy.

Core Standard:

Design and assemble electric circuits that provide a means of transferring energy from one form or place to another.

- 4.1.1 Describe and investigate the different ways in which heat can be generated.
- 4.1.2 Investigate the variety of ways that heat can be generated and move from one place to another and explain the direction in which the heat moves.
- 4.1.3 Construct a complete circuit through which an electrical current can pass as evidenced by the lighting of a bulb or ringing of a bell.
- 4.1.4 Experiment with materials to identify conductors and insulators of heat and electricity.
- 4.1.5 Demonstrate that electrical energy can be transformed into heat, light, and sound.

Standard 2: Earth Science

Core Standard:

Observe, investigate and give examples of ways that the shape of the land changes over time.

Core Standard:

Describe how the supply of natural resources is limited and investigate ways that humans protect and harm the environment.

- 4.2.1 Demonstrate and describe how smaller rocks come from the breakage and weathering of larger rocks in a process that occurs over a long period of time.
- 4.2.2 Demonstrate and describe how wind, water and glacial ice shape and reshape earth's land surface by eroding rock and soil in some areas and depositing them in other areas in a process that occurs over a long period of time.
- 4.2.3 Demonstrate and describe how earthquakes, volcanoes, and landslides suddenly change the shape of the land.
- 4.2.4 Investigate earth materials that serve as natural resources and gather data to determine which are in limited supply.

4.2.5 Describe methods that humans currently use to extend the use of natural resources.

4.2.6 Describe ways in which humans have changed the natural environment that have been detrimental or beneficial.

Standard 2: Life Science

Core Standard:

Observe, describe, and ask questions about structures of organisms and how they affect their growth and survival.

4.3.1 Observe and describe how offspring are very much, but not exactly, like their parents or one another. Describe how these differences in physical characteristics among individuals in a population may be advantageous for survival and reproduction.

4.3.2 Observe, compare, and record the physical characteristics of living plants or animals from widely different environments, and describe how each is adapted to its environment.

4.3.3 Design an investigation to explore how organisms meet some of their needs by responding to stimuli from their environment.

4.3.4 Describe a way that a given plant or animal might adapt to changes arising from human or non-human impact on the environment.

Standard 4: Science, Engineering and Technology

Core Standard:

Design a moving system and measure its motion.

4.4.1 Investigate transportation systems and devices that operate on or in land, water, air and space and recognize the forces (lift, drag, friction, thrust and gravity) that affect their motion.

4.4.2 Make appropriate measurements to compare the speeds of objects in terms of distance traveled in a given amount of time or time required to travel a given distance.

4.4.3 Investigate how changes in speed or direction are caused by forces; the greater the force exerted on an object, the greater the change.

4.4.4 Define a problem in the context of motion and transportation and propose a solution to this problem by evaluating, reevaluating and testing the design, gathering evidence

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about how well the design meets the needs of the problem, and documenting the design so that it can be easily replicated.

Grade 5

Process Standards

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- Design a fair test.
- Plan and carry out investigations as a class, in small groups or independently, often over a period of several class lessons.
- Perform investigations using appropriate tools and technology that will extend the senses.
- Use measurement skills and apply appropriate units when collecting data.
- Test predictions with multiple trials.
- Keep accurate records in a notebook during investigations and communicate findings to others using graphs, charts, maps and models through oral and written reports.
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- Communicate how to improve the solution.

Standard 1: Physical Science

Core Standard:

Describe weight and volume and measure weight and volume of various objects.

Core Standard:

Demonstrate that mass is conserved even when a substance has undergone changes in state.

- 5.1.1 Describe and measure the volume and weight of a sample of a given material.
- 5.1.2 Describe the difference between weight and mass, with the understanding that weight is dependent on gravity and mass is the amount of matter in a given substance/material.
- 5.1.3 Demonstrate that regardless of how parts of an object are assembled, the weight of the whole object is identical to the sum of the weight of the parts, but the volume can differ from the sum of the volumes.
- 5.1.4 Determine if matter has been added or lost by comparing weights when melting, freezing, or dissolving a sample of a substance.

Standard 2: Earth Science

Core Standard:

Observe, describe, and ask questions about patterns in the sun- moon-earth system.

- 5.2.1 Recognize that our earth is part of the solar system in which the sun, an average star, is the central and largest body. Observe that our solar system includes the sun, moon, seven other planets and their moons, and many other smaller objects, such as asteroids and comets.
- 5.2.2 Observe and use pictures to record how the sun appears to move across the sky in the same general way every day but rises and sets in different places as the seasons change.
- 5.2.3 In monthly intervals, observe and draw the length and direction of shadows cast by the sun at several chosen times during the day. Use the recorded data as evidence to explain how shadows are affected by the relative position of the earth and sun.
- 5.2.4 Use a calendar to record observations of the shape of the moon and the rising and setting times over the course of a month. Based on the observations, describe patterns in the moon cycle.

Standard 3: Life Science

Core Standard:

Observe, describe, and ask questions about how changes in one part of an ecosystem create changes in other parts of the ecosystem.

- 5.3.1 Observe and classify common Indiana organisms as producers, consumers, decomposers, predator and prey based on their relationships and interactions with other organisms in their ecosystem.
- 5.3.2 Investigate the action of different decomposers and compare the role they play in an ecosystem with that of producers and consumers.

Standard 4: Science, Engineering and Technology

Core Standard:

Design a prototype that replaces a function of a human body part and evaluate using selected criteria.

- 5.4.1 Investigate technologies that mimic human or animal musculoskeletal systems in order to meet a need.
- 5.4.2 Investigate the purpose of prototypes and models when designing a solution to a problem and how limitations in cost and design features might affect their construction.
- 5.4.3 Design a solution to a problem in the context of musculoskeletal body systems. Using suitable tools, techniques and materials, draw or build a prototype or model of a proposed design.

Grade 6

Process Standards

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- Make predictions and develop testable questions based on research and prior knowledge.
- Plan and carry out investigations as a class, in small groups or independently often over a period of several class lessons.
- Collect quantitative data with appropriate tools or technologies and use appropriate units to label numerical data.
- Incorporate variables that can be changed, measured or controlled.
- Use the principles of accuracy and precision when making measurement.
- Test predictions with multiple trials
- Keep accurate records in a notebook during investigations.
- Analyze data, using appropriate mathematical manipulation as required, and use it to identify patterns and make inferences based on these patterns.
- Evaluate possible causes for differing results (valid data).
- Compare the results of an experiment with the prediction.
- Communicate findings using graphs, charts, maps and models through oral and written reports.

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- Select a solution to the need or problem.
- Select the most appropriate materials to develop a solution that will meet the need.
- Create the solution through a prototype.
- Test and evaluate how well the solution meets the goal.
- Evaluate and test the design using measurement.
- Present evidence using mathematical representations (graphs, data tables).

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- Communicate the solution including evidence using mathematical representations (graphs, data tables), drawings or prototypes.
- Redesign to improve the solution based on how well the solution meets the need.

Standard 1: Physical Science

Core Standard

Explain that all objects and substances in the natural world are composed of matter in different states with different properties.

Core Standard

Understand that there are different forms of energy with unique characteristics.

- 6.1.1 Understand that the properties and behavior of matter can be explained by a model which depicts particles representing atoms or molecules in motion.
- 6.1.2 Explain the properties of solids, liquids and gases using drawings and models that represent matter as particles in motion whose state can be represented by the relative positions and movement of the particles.
- 6.1.3 Using a model in which matter is composed of particles in motion, investigate that when substances undergo a change in state, mass is conserved.
- 6.1.4 Recognize that objects in motion have kinetic energy and objects at rest have potential energy.
- 6.1.5 Describe with examples that potential energy exists in several different forms (gravitational potential energy, elastic potential energy, and chemical potential energy, among others).
- 6.1.6 Compare and contrast potential and kinetic energy and how they can be transformed within a system from one form to another.
- 6.1.7 Explain that energy may be manifested as heat, light, electricity, mechanical motion, and sound and is often associated with chemical reactions.

Standard 2: Earth and Space Science

Core Standard

Understand the relationships between celestial bodies and the force that keeps them in regular and predictable motion.

- 6.2.1 Describe and model how the position, size and relative motions of the earth, moon, and sun cause day and night, solar and lunar eclipses and phases of the moon.
- 6.2.2 Recognize that gravity is a force that keeps celestial bodies in regular and predictable motion, holds objects to earth's surface, and is responsible for ocean tides.
- 6.2.3 Understand that the sun, an average star where nuclear reactions occur, is the central and largest body in the solar system.
- 6.2.4 Compare and contrast the planets of the solar system with one another and with asteroids and comets with regard to their size, composition, distance from sun, surface features and ability to support life.
- 6.2.5 Demonstrate that the seasons in both hemispheres are the result of the inclination of the earth on its axis which in turn causes changes in sunlight intensity and length of day.

Standard 3: Life Science

Core Standard

Describe that all organisms, including humans, are part of complex systems found in all biomes (freshwater, marine, forest, desert, grassland, tundra).

Core Standard

Understand that the major source of energy for ecosystems is light produced by major nuclear reactions in the sun.

- 6.3.1 Describe specific relationships (predator/prey, consumer/producer or parasite/host) between organisms and determine whether these relationships are competitive or mutually beneficial.
- 6.3.2 Describe how changes caused by organisms in the habitat where they live can be beneficial or detrimental to themselves or the native plants and animals.
- 6.3.3 Describe how certain biotic and abiotic factors, such as predators, quantity of light and water, range of temperatures, and soil composition, can limit the number of organisms that an ecosystem can support.
- 6.3.4 Recognize that plants use energy from the sun to make sugar (glucose) by the process of photosynthesis.

- 6.3.5 Describe how all animals, including humans, meet their energy needs by consuming other organisms, breaking down their structures, and using the materials to grow and function.
- 6.3.6 Recognize that food provides the energy for the work that cells do and is a source of the molecular building blocks that can be incorporated into a cell's structure or stored for later use.

Standard 4
Science, Engineering and Technology

Core Standard

Apply a form of energy to design and construct a simple mechanical device.

- 6.4.1 Understand how to apply potential or kinetic energy to power a simple device.
- 6.4.2 Construct a simple device that uses potential or kinetic energy to perform work.
- 6.4.3 Describe the transfer of energy amongst energy interactions.

Grade 7

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- Plan and carry out investigations as a class, in small groups or independently often over a period of several class lessons.
- Collect quantitative data with appropriate tools or technologies and use appropriate units to label numerical data.
- Incorporate variables that can be changed, measured or controlled.
- Use the principles of accuracy and precision when making measurement.
- Test predictions with multiple trials
- Keep accurate records in a notebook during investigations.
- Analyze data, using appropriate mathematical manipulation as required, and use it to identify patterns and make inferences based on these patterns.
- Evaluate possible causes for differing results (valid data).
- Compare the results of an experiment with the prediction.
- Communicate findings using graphs, charts, maps and models through oral and written reports.

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- Select a solution to the need or problem.
- Select the most appropriate materials to develop a solution that will meet the need.
- Create the solution through a prototype.
- Test and evaluate how well the solution meets the goal.
- Evaluate and test the design using measurement.
- Present evidence using mathematical representations (graphs, data tables).

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- Communicate the solution including evidence using mathematical representations (graphs, data tables), drawings or prototypes.
- Redesign to improve the solution based on how well the solution meets the need.

Standard 1: Physical Science

Core Standard

Explain that energy cannot be created or destroyed but only changed from one form into another or transferred from place to place.

Core Standard

Describe and investigate how forces between objects can act at a distance or by means of direct contact between objects.

- 7.1.1 Explain that when energy is transferred from one system to another, the total quantity of energy does not change.
- 7.1.2 Describe and give examples of how energy can be transferred from place to place and transformed from one form to another through radiation, convection and conduction.
- 7.1.3 Recognize and explain how different ways of obtaining, transforming, and distributing energy have different environmental consequences.
- 7.1.4 Recognize and provide evidence how light, sound and other waves have energy and how they interact with different materials.
- 7.1.5 Describe and investigate how forces between objects can act at a distance, such as magnetic, electrical or gravitational forces, or by means of direct contact between objects.
- 7.1.6 Explain that forces have magnitude and direction and those forces can be added to determine the net force acting on an object.
- 7.1.7 Demonstrate and describe how an object's speed or direction of motion changes when a force acts upon it. Demonstrate and describe that an object's speed and direction of motion remain unchanged if the net force acting upon it is zero.

Standard 2: Earth and Space Systems

Core Standard

Describe how earth processes have shaped the topography of the earth and have made it possible to measure geological time.

- 7.2.1 Describe how the earth is a layered structure composed of lithospheric plates, a mantle and a dense core.
- 7.2.2 Recognize that the earth possesses a magnetic field that is detectable at the surface with a compass.
- 7.2.3 Characterize the immensity of geologic time and recognize that it is measured in eras and epochs.
- 7.2.4 Explain how convection currents in the mantle cause lithospheric plates to move causing fast changes like earthquakes and volcanic eruptions, and slow changes like creation of mountains and formation of new ocean floor.
- 7.2.5 Describe the origin and physical properties of igneous, metamorphic and sedimentary rocks and how they are related through the rock cycle.
- 7.2.6 Describe physical and chemical characteristics of soil layers and how they are influenced by the process of soil formation, including the action of bacteria, fungi, insects, and other organisms.
- 7.2.7 Use geological features such as karst topography and glaciation to explain how large-scale physical processes have shaped the land.
- 7.2.8 Compare and contrast fossils with living organisms in a given location to explain how earth processes have changed environments over time.

Standard 3: Life Science

Core Standard

Understand the cellular structure of living organisms, both single-celled and multicellular.

- 7.3.1 Explain that all living organisms are composed of one or more cells and that the many functions needed to sustain life are carried out within such cells.
- 7.3.2 Understand that water is a major component within all cells and is required to carry out many cellular functions.
- 7.3.3 Explain that although the way cells function is similar in all living organisms, multicellular organisms also have specialized cells whose specialized functions are directly related to their structure.

- 7.3.4 Compare and contrast similarities and differences between specialized subcellular components within plant and animal cells, including organelles and cell walls that perform essential functions and give a cell its shape and structure.
- 7.3.5 Explain that cells in multicellular organisms repeatedly divide to make more cells for growth and repair.
- 7.3.6 Explain that after fertilization, a small cluster of cells divides to form the basic tissues of an embryo which further develops into all the specialized tissues and organs within a multicellular organism.
- 7.3.7 Describe how various organs and tissues serve the needs of cells for nutrient and oxygen delivery and waste removal.

Standard 4: Science, Engineering and Technology

Core Standard:

Design and construct a device that converts energy from one form to another to perform work.

- 7.4.1 Understand that energy is the capacity to do work.
- 7.4.2 Explain that energy can be used to do work using many processes, for example generation of electricity by harnessing wind energy.
- 7.4.3 Explain that power is the rate that energy is converted from one form to another.
- 7.4.4 Explain that power systems are used to provide propulsion for engineered products and systems.

Grade 8

Process Standards

The Nature of Science

Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.

- Make predictions and develop testable questions based on research and prior knowledge.
- Plan and carry out investigations as a class, in small groups or independently often over a period of several class lessons.
- Collect quantitative data with appropriate tools or technologies and use appropriate units to label numerical data.
- Incorporate variables that can be changed, measured or controlled.
- Use the principles of accuracy and precision when making measurement.
- Test predictions with multiple trials
- Keep accurate records in a notebook during investigations.
- Analyze data, using appropriate mathematical manipulation as required, and use it to identify patterns and make inferences based on these patterns.
- Evaluate possible causes for differing results (valid data).
- Compare the results of an experiment with the prediction.
- Communicate findings using graphs, charts, maps and models through oral and written reports.

The Design Process:

As citizens of the constructed world, students will participate in the design process. Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems.

- Identify a need or problem to be solved.
- Brainstorm potential solutions.
- Document the design throughout the entire design process so that it can be replicated in a portfolio/notebook with drawings including labels.
- Select a solution to the need or problem.
- Select the most appropriate materials to develop a solution that will meet the need.
- Create the solution through a prototype.
- Test and evaluate how well the solution meets the goal.
- Evaluate and test the design using measurement.
- Present evidence using mathematical representations (graphs, data tables).

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- Communicate the solution including evidence using mathematical representations (graphs, data tables), drawings or prototypes.
- Redesign to improve the solution based on how well the solution meets the need.

Standard 1: Physical Science

Core Standard

Describe how atomic structure determines chemical properties and how atoms and molecules interact.

- 8.1.1 Explain that all matter is composed of particular arrangements of atoms of approximately one hundred elements.
- 8.1.2 Understand that elements are organized on the periodic table based on atomic number.
- 8.1.3 Explain how the arrangement of atoms and molecules determines chemical properties of substances.
- 8.1.4 Describe the structure of an atom and relate the arrangement of electrons to how that atom interacts with other atoms.
- 8.1.5 Explain that atoms join together to form molecules and compounds and illustrate with diagrams the relationship between atoms and compounds and/or molecules.
- 8.1.6 Explain that elements and compounds have characteristic properties such as density, boiling points and melting points that remain unchanged regardless of the sample size.
- 8.1.7 Explain that chemical changes occur when substances react and form one or more different products, whose physical and chemical properties are different from those of the reactants.
- 8.1.8 Demonstrate that in a chemical change, the total numbers of each kind of atom in the product are the same as in the reactants and that the total mass of the reacting system is conserved.

Standard 2: Earth and Space Systems

Core Standard

Explain how the sun's energy heats the air, land, and water driving the processes that result in wind, ocean currents, and the water cycle.

Core Standard

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Describe how human activities have changed the land, water, and atmosphere.

- 8.2.1 Recognize and demonstrate how the sun's energy drives convection in the atmosphere and in bodies of water, which results in ocean currents and weather patterns.
- 8.2.2 Describe and model how water moves through the earth's crust, atmosphere, and oceans in a cyclic way, as liquid, vapor, and solid.
- 8.2.3 Describe the characteristics of ocean currents and identify their effects on weather patterns.
- 8.2.4 Describe the physical and chemical composition of the atmosphere at different elevations.
- 8.2.5 Describe the conditions that cause Indiana weather and weather-related events such as tornadoes, lake effect snow, blizzards, thunderstorms, and flooding.
- 8.2.6 Identify, explain, and discuss some effects human activities have on the biosphere, such as air, soil, light, noise and water pollution.
- 8.2.7 Recognize that some of Earth's resources are finite and describe how recycling, reducing consumption and the development of alternatives can reduce the rate of their depletion.
- 8.2.8 Explain that human activities, beginning with the earliest herding and agricultural activities, have drastically changed the environment and have affected the capacity of the environment to support native species. Explain current efforts to reduce and eliminate these impacts and encourage sustainability.

Standard 3: Life Science

Core Standard

Understand the predictability of characteristics being passed from parents to offspring.

Core Standard

Explain how a particular environment selects for traits that increase the likelihood of survival and reproduction by individuals bearing those traits.

- 8.3.1 Explain that reproduction is essential for the continuation of every species and is the mechanism by which all organisms transmit genetic information.
- 8.3.2 Compare and contrast the transmission of genetic information in sexual and asexual reproduction.

- 8.3.3 Explain that genetic information is transmitted from parents to offspring mostly by chromosomes.
- 8.3.4 Understand the relationship between deoxyribonucleic acid (DNA), genes, and chromosomes.
- 8.3.5 Identify and describe the difference between inherited traits and physical and behavioral traits that are acquired or learned.
- 8.3.6 Observe anatomical structures of a variety of organisms and describe their similarities and differences. Use the data collected to organize the organisms into groups and predict their relatedness.
- 8.3.7 Recognize and explain that small genetic differences between parents and offspring can accumulate in successive generations so that descendants may be different from their ancestors.
- 8.3.8 Examine traits of individuals within a population of organisms that may give them an advantage in survival and reproduction in a given environments or when the environment changes.
- 8.3.9 Describe the effect of environmental changes on populations of organisms when their adaptive characteristics put them at a disadvantage for survival. Describe how extinction of a species can ultimately result.
- 8.3.10 Recognize and describe how new varieties of organisms have come about from selective breeding.

Standard 4
Science, Technology and Engineering

Core Standard

Identify the appropriate materials to be used to solve a problem based on their specific properties and characteristics.

- 8.4.1 Understand how the strength of attractive forces between particles in a material helps to explain many physical properties of the material, such as why different materials exist as gases, liquids or solids at a given temperature.
- 8.4.2 Rank the strength of attractions between the particles of room-temperature materials.
- 8.4.3 Investigate the properties (mechanical, chemical, electrical, thermal, magnetic, and optical) of natural and engineered materials.

Integrated Chemistry and Physics

The Nature of Science

Students should understand that scientific knowledge is gained from observation of natural phenomena and experimentation, by designing and conducting investigations guided by theory, and by evaluating and communicating the results of those investigations according to accepted procedures. Thus, scientific knowledge is scientists' best explanations for the data from many investigations. Further, ideas about objects in the microscopic world that we cannot directly sense are often understood in terms of concepts developed to understand objects in the macroscopic world that we can see and touch. In the science classroom student work should align with this process of science and should be guided by the following principles. These should be woven throughout the daily work that students are doing when learning the content presented in the standard indicators.

- Develop explanations based on reproducible data and observations gathered during laboratory investigations.
- Recognize that their explanations must be based both on their data and other known information from investigations of others.
- Clearly communicate their ideas and results of investigations verbally and in written form using tables, graphs, diagrams, and photographs.
- Regularly evaluate the work of their peers and in turn have their work evaluated by their peers.
- Apply standard techniques in laboratory investigations to measure physical quantities in appropriate units and convert known quantities to other units as necessary.
- Use analogies and models (mathematical and physical) to simplify and represent systems that are difficult to understand or directly experience due to their size, time scale, or complexity, and recognize the limitations of analogies and models.
- Focus on the development of explanatory models based on their observations during laboratory investigations.
- Explain that the body of scientific knowledge is organized into major theories, which are derived from and supported by the results of many experiments, and allow us to make testable predictions.
- Recognize that new scientific discoveries often lead to a re-evaluation of previously accepted scientific knowledge and of commonly held ideas.
- Describe how scientific discoveries lead to the development of new technologies, and conversely how technological advances can lead to scientific discoveries through new experimental methods and equipment.
- Explain how scientific knowledge can be used to guide decisions on environmental and social issues.

Standard 1: Motion and Energy of Macroscopic Objects

Core Standard

Describe and explain the motion of macroscopic objects in terms of Newton's laws and use the concepts of kinetic and potential energy to describe motion.

- ICP.1.1 Measure the motion of objects to understand the relationships between distance, velocity, and acceleration and deepen understanding through graphical analysis of the time dependence of acceleration, velocity and distance.
- ICP.1.2 Describe and apply Newton's three laws of motion. By experimentation, determine the relationships among the variables in Newton's laws and how all three laws relate mass, acceleration and force as a triad of proportional variables, leading to the definitions of momentum and energy.
- ICP.1.3 Describe how Newton's law of universal gravitation, together with the laws of motion, explains the motions of objects on earth and of the moon, planets and stars.
- ICP.1.4 Describe the kinetic and potential energies of macroscopic objects, and use measurements to develop an understanding of these forms of energy.

Standard 2: Mechanical Energy and Propagation of Energy by Waves

Core Standard

Explain that waves transmit energy, come in two forms, transverse and longitudinal, and occur throughout nature.

- ICP 2.1 Identify properties of objects that vibrate, using Newton's laws to understand the motion. Understand that vibrating objects can give rise to mechanical waves.
- ICP.2.2 Identify properties of waves including frequency, wavelength, amplitude, energy, and wave speed.
- ICP 2.3 Describe how energy is propagated by waves without the transfer of mass using examples such as water waves, earthquakes, and sound waves.
- ICP.2.4 Apply the properties of waves to wave phenomena including reflection, and refraction, as well as the transmission and loss of energy.

Standard 3: Properties of Matter: Macroscopic as a Model for Microscopic

Core Standard

Understand how the energies and motions of atoms and molecules at the microscopic level can be used to understand and predict the macroscopic properties of matter of gases, liquids and solids.

- ICP.3.1 Describe how we use macroscopic properties of matter to model microscopic processes.
- ICP.3.2 Study the characteristics of solids, liquids, and gases and their changes of state and interpret them in terms of a molecular model which describes their energies and motions.
- ICP 3.3 Understand how thermal energy (the microscopic motions of the atoms and/or molecules) is related to the macroscopic concept of temperature. Examine the differences in these concepts by measuring the temperature changes, and determining specific heat capacity, of water as it is heated or cooled.
- ICP.3.4 Understand how the microscopic kinetic molecular theory, explains observations of macroscopic gas behavior in terms of temperature, volume, pressure, and the number of particles (using the mole concept).

Standard 4: Energy Transport

Core Standard

Describe how vibrations and waves transport energy.

- ICP.4.1 Using conservation of energy, calculate the thermal energy released or absorbed by an object and distinguish between exothermic and endothermic changes.
- ICP.4.2 Differentiate between conduction, convection, and radiation and identify them as types of energy transfer.
- ICP.4.3 Explain that electrons can absorb energy and can release energy, and that electrons in atoms do this at specific energies.
- ICP.4.4 Describe the relationships between velocity, frequency, wavelength, and energy in electromagnetic waves. Describe the regions of the electromagnetic spectrum.

ICP 4.5 Understand that from diffraction we know that visible light is an electromagnetic wave.

Standard 5: Chemical Energy, Reactions, and Bonding

Core Standard

Describe how energy is produced and absorbed in chemical reactions.

- ICP.5.1 Recognize and describe physical properties of matter and use these to differentiate between pure substances and mixtures.
- ICP 5.2 Use the periodic table to understand important patterns in properties of elements. Recognize that the pattern of properties of the elements correlates most closely with the configuration of the electrons in each element.
- ICP.5.3 Understand that the atomic number is unique to each element and is the number of protons in the nucleus of the element.
- ICP.5.4 Use the concept of the mole to relate number of moles and the mass of a sample of a pure substance of known chemical composition.
- ICP.5.5 Using conservation principles write and balance chemical equations.
- ICP.5.6 Identify key indicators of a chemical change and classify simple types of chemical reactions. Differentiate between covalent, ionic, hydrogen and Van der Waals bonding, and write formulas for and name compounds of each type.
- ICP.5.7 Explain that in exothermic chemical reactions chemical energy is converted into other forms such as thermal, electrical, light, and sound energy.

Standard 6: Electrical Energy Propagation and Magnetism

Core Standard

Describe how the movement and transfer of charged particles results in the transfer of electrical energy.

- ICP.6.1 Explain that objects that carry a net charge will exert an electric force on other objects that may be attractive or repulsive.

- ICP.6.2 Explain that when charge is transferred from one object to another, the amount lost by one object equals the amount gained by the other, consistent with the principal of conservation of charge.
- ICP.6.3 Using the example of electrolysis and its application in batteries, explain the relationship between chemical reactions and electrical energy.
- ICP.6.4 Define and describe the relationships between voltage, current, resistance and power in open and closed electrical circuits.
- ICP.6.5 Describe the differences in current flow in parallel and in series circuits.
- ICP.6.6 Explain that some objects, called magnets, exert magnetic forces with no direct contact.
- ICP.6.7 Using the examples of motors and generators, explain that electrical energy can be transformed into mechanical energy and vice versa.

Standard 7: Nuclear Energy (fission/fusion)

Core Standard

Describe how the stability of nuclei in terms of the binding energies of their constituent protons and neutrons explains the energy production processes of fission and fusion.

- ICP.7.1 Demonstrate how historical models and experiments supported the development of our current understanding of the atom and its nucleus.
- ICP.7.2 Differentiate between protons, neutrons, and electrons and determine the number of these subatomic particles in each atom.
- ICP.7.3 Understand that the stability of nuclei depends on the numbers of neutrons and protons.
- ICP.7.4 Understand that fission results from large, less stable nuclei decomposing to form smaller, more stable nuclei.
- ICP.7.5 Understand that fusion results from two smaller nuclei combining to form one larger nucleus.
- ICP 7.6 Understand that the energy radiated from the sun derives from the fusion process.

ICP.7.7 Describe the various forms of emission that are typical of radioactive decay.

ICP 7.8 Relate the fission process to the human development and use of the fission process in war (uncontrolled) and in peace (controlled).

Standard 8: Society (Energy production, environment, economics)

Core Standard

Understand the impact of energy production and use on society and the environment.

ICP.8.1 Describe how energy needs have changed throughout history and how energy needs are met in modern society.

ICP.8.2 Describe the benefits and risks of the development of non-renewable forms of energy such as coal, oil, natural gas and uranium fission sources.

ICP.8.3 Describe the benefits and risks of the development of renewable forms of energy such as solar energy, wind-energy, geothermal energy, fusion energy and biofuels.

ICP.8.4 Describe how efficient use of renewable and non-renewable energy sources is essential to maintaining an acceptable environment.

ICP.8.5 Describe how the availability of energy resources is essential to the development of an economically viable society.

ICP.8.6 Contrast the dependence on and use of energy and other natural resources in the economies of industrial nations, of developing nations and of undeveloped nations.

ICP.8.7 Describe the energy needs of a modern urban city, and compare and contrast these needs with those of a modern rural community.

Biology I

Students should understand that scientific knowledge is gained from observation of natural phenomena and experimentation, by designing and conducting investigations guided by theory, and by evaluating and communicating the results of those investigations according to accepted procedures. Thus, scientific knowledge is scientists' best explanations for the data from many investigations. Further, ideas about objects in the microscopic world that we cannot directly sense are often understood in terms of concepts developed to understand objects in the macroscopic world that we can see and touch. In the science classroom student work should align with this process of science and should be guided by the following principles. These should be woven throughout the daily work that students are doing when learning the content presented in the standard indicators.

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- Focus on the development of explanatory models based on their observations during laboratory investigations.
- Explain that the body of scientific knowledge is organized into major theories, which are derived from and supported by the results of many experiments, and allow us to make testable predictions.
- Recognize that new scientific discoveries often lead to a re-evaluation of previously accepted scientific knowledge and of commonly held ideas.
- Describe how scientific discoveries lead to the development of new technologies, and conversely how technological advances can lead to scientific discoveries through new experimental methods and equipment.
- Explain how scientific knowledge can be used to guide decisions on environmental and social issues.

Standard 1: Cellular Chemistry

Core Standard

Describe the basic molecular structure and function of the four major categories of organic compounds (carbohydrates, lipids, proteins and nucleic acids) essential to cellular function.

Core Standard

Describe how work done in cells is performed by a variety of organic molecules, especially proteins, whose functions depend on the sequence of their monomers and the consequent shape of the molecule.

- B.1.1 Describe the structure of the major categories of organic compounds which make up living organisms in terms of their building blocks and the small number of chemical elements (carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur) from which they are composed.
- B.1.2 Understand that the shape of a molecule determines its role in the many different types of cellular processes including metabolism, homeostasis, growth and development, and heredity, and understand that the majority of these processes involve proteins that act as enzymes.
- B.1.3 Explain and give examples of how the function and differentiation of cells is influenced by their external environment, including temperature, acidity and the concentration of certain molecules, and that changes in these conditions may affect how a cell functions.

Standard 2: Cellular Structure

Core Standard

Describe features that are common to all cells and contrast those with distinctive features that allow cells to carry out specific functions.

- B.2.1 Describe features common to all cells that are essential for growth and survival, and explain their functions.
- B.2.2 Describe the structure of a cell membrane and explain how it regulates the transport of materials into and out of the cell and prevents harmful materials from entering the cell.
- B.2.3 Explain that most cells contain mitochondria, the key sites of cellular respiration, where stored chemical energy is converted into useable energy for the cell and some cells, including many plant cells, contain chloroplasts, the key sites of photosynthesis, where the energy of light is captured for use in chemical work.

B.2.4 Explain that all cells contain ribosomes, the key sites for protein synthesis, where genetic material is decoded in order to form unique proteins.

B.2.5 Explain that cells use proteins to form structures, including cilia, flagella, which allow them to carry out specific functions, including movement, adhesion, and absorption.

B.2.6 Investigate a variety of different cell types and relate the proportion of different organelles within these cells to their functions.

Standard 3: Matter Cycles and Energy Transfer

Core Standard

Describe how the sun's energy is captured and used to construct sugar molecules which can be used as a form of energy or serve as building blocks of organic molecules.

Core Standard

Diagram how matter and energy cycle through an ecosystem.

B.3.1 Describe how some organisms capture the sun's energy through the process of photosynthesis by converting carbon dioxide and water into high energy compounds and releasing oxygen.

B.3.2 Describe how most organisms can combine and recombine the elements contained in sugar molecules into a variety of biologically essential compounds by utilizing the energy from cellular respiration.

B.3.3 Recognize and describe that metabolism consists of all of the biochemical reactions that occur inside cells, including the production, modification, transport, and exchange of materials that are required for the maintenance of life.

B.3.4 Describe how matter cycles through an ecosystem by way of food chains and food webs and how organisms convert that matter into a variety of organic molecules to be used in part in their own cellular structures.

B.3.5 Describe how energy from the sun flows through an ecosystem by way of food chains and food webs and only a small portion of that energy is used by individual organisms while the majority of energy is lost as heat.

Standard 4: Interdependence

Core Standard

Describe the relationship between living and nonliving components of ecosystems and describe how that relationship is in flux due to natural changes and human actions.

- B.4.1 Explain that the amount of life an environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the remains of dead organisms.
- B.4.2 Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.
- B.4.3 Describe the consequences of introducing non-native species into an ecosystem and identify the impact it may have on that ecosystem.
- B.4.4 Describe how climate, the pattern of matter and energy flow, the birth and death of new organisms, and the interaction between those organisms contribute to the long term stability of an ecosystem.

Standard 5: Molecular Basis of Heredity

Core Standard

Describe the basic structure of DNA and how this structure enables DNA to function as the hereditary molecule that directs the production of RNA and proteins.

Core Standard

Understand that proteins largely determine the traits of an organism.

- B.5.1 Describe the relationship between chromosomes and DNA along with their basic structure and function.
- B.5.2 Describe how hereditary information passed from parents to offspring is encoded in regions of DNA molecules called genes.
- B.5.3 Describe the process by which DNA directs the production of protein within a cell.
- B.5.4 Explain how the unique shape and activity of each protein is determined by the sequence of its amino acids.
- B.5.5 Understand that proteins are responsible for the observable traits of an organism and for most of the functions within an organism.

B.5.6 Recognize that traits can be structural, physiological or behavioral and can include readily observable characteristics at the organismal level or less recognizable features at the molecular and cellular level.

Standard 6: Cellular Reproduction

Core Standard

Explain the processes, both mitosis and meiosis, by which new cells are formed from existing cells and how in multicellular organisms, groups of cells cooperate to perform essential functions within an organism.

Core Standard:

Explain the cellular processes that occur to generate natural genetic variations between parents and offspring.

- B.6.1 Describe the process of mitosis and explain that this process ordinarily results in daughter cells with a genetic make-up identical to the parent cells.
- B.6.2 Understand that most cells of a multicellular organism contain the same genes, but develop from a single cell (e.g., a fertilized egg) in different ways due to differential gene expression.
- B.6.3 Explain that in multicellular organisms the zygote produced during fertilization undergoes a series of cell divisions that lead to clusters of cells that go on to specialize and become the organism's tissues and organs.
- B.6.4 Describe and model the process of meiosis and explain the relationship between the genetic make-up of the parent cell and the daughter cells (gametes).
- B.6.5 Explain how, in sexual reproduction, crossing over, independent assortment, and random fertilization, result in offspring that are genetically different from the parents.

Standard 7: Genetics

Core Standard

Explain how the genetic information from parents determines the unique characteristics of their offspring.

- B.7.1 Distinguish between dominant and recessive alleles and determine the phenotype that would result from the different possible combinations of alleles in an offspring.

- B.7.2 Describe dominant, recessive, codominant, sex-linked, incompletely dominant, multiply allelic, and polygenic traits and illustrate their inheritance patterns over multiple generations.
- B.7.3 Determine the likelihood of the appearance of a specific trait in an offspring given the genetic make-up of the parents.
- B.7.4 Explain the process by which a cell copies its DNA and identify factors that can damage DNA and cause changes in its nucleotide sequence.
- B.7.5 Explain and demonstrate how inserting, substituting or deleting segments of a DNA molecule can alter a gene, which is then passed to every cell that develops from it and that the results may be beneficial, harmful or have little or no effect on the organism.

Standard 8: Evolution

Core Standard

Describe how biochemical, fossil, anatomical, developmental, and genetic findings are used to determine relationships among organisms, producing modern classification systems.

Core Standard

Describe how modern evolutionary theory provides an explanation of the history of life on earth and the similarities between organisms that exist today.

- B.8.1 Explain how anatomical and molecular similarities among organisms suggests that life on earth began as simple, one-celled organisms about 4 billion years ago and multicellular organisms evolved later.
- B.8.2 Explain how organisms are classified and named based on their evolutionary relationships into taxonomic categories.
- B.8.3 Use anatomical and molecular evidence to establish evolutionary relationships between organisms.
- B.8.4 Understand that molecular evidence supports the anatomical evidence for these evolutionary relationships and provides additional information about the order in which different lines of descent branched.
- B.8.5 Describe how due to genetic variations, environmental forces, and reproductive pressures, organisms with beneficial traits are more likely to survive, reproduce, and pass on their genetic information.

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B.8.6 Explain how genetic variation within a population (a species) can be attributed to mutations as well as a random assortment of existing genes.

B.8.7 Describe the modern scientific theory of the origins and history of life on earth, and evaluate the evidence that supports it.

Chemistry I

Students should understand that scientific knowledge is gained from observation of natural phenomena and experimentation, by designing and conducting investigations guided by theory, and by evaluating and communicating the results of those investigations according to accepted procedures. Thus, scientific knowledge is scientists' best explanations for the data from many investigations. Further, ideas about objects in the microscopic world that we cannot directly sense are often understood in terms of concepts developed to understand objects in the macroscopic world that we can see and touch. In the science classroom student work should align with this process of science and should be guided by the following principles. These should be woven throughout the daily work that students are doing when learning the content presented in the standard indicators.

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- Explain how scientific knowledge can be used to guide decisions on environmental and social issues.

Standard 1: Properties and States of Matter

Core Standard

Describe the nature of physical and chemical properties and changes of matter.

Core Standard

Compare and contrast states of matter at the molecular level.

- C.1.1 Based on physical properties, differentiate between pure substances and mixtures.
- C.1.2 Observe and describe chemical and physical properties of different types of matter and designate them as either extensive or intensive.
- C.1.3 Recognize observable indicators of chemical changes.
- C.1.4 Describe physical and chemical changes at the molecular level.
- C.1.5 Describe the characteristics of solids, liquids, and gases and state changes at the molecular level.
- C.1.6 Explain and apply the law of conservation of mass as it applies to chemical processes.
- C.1.7 Define density and distinguish among materials based on densities. Perform calculations involving density.

Standard 2: Atomic Structure and the Periodic Table

Core Standard

Describe how the properties and arrangement of the subatomic particles contributes to the structure of the atom.

Core Standard

Describe how the structure of the periodic table reflects the numbers of electrons and protons and the configuration of the electrons in an atom.

- C.2.1 Describe how models of atomic structure changed over time based on available experimental evidence and understand the current model of atomic structure.
- C.2.2 Describe how the subatomic particles (protons, neutrons, and electrons) contribute to the structure of an atom and recognize that the particles within the nucleus are held together against the electrical repulsion of the protons.

- C.2.3 Determine the number of protons, neutrons, and electrons in isotopes and in those isotopes that comprise a specific element. Relate these numbers to atomic number and mass number.
- C.2.4 Calculate the average atomic mass of an element from isotopic abundance data.
- C.2.5 Write the electron configuration of an element and relate this to its position on the periodic table.
- C.2.6 Use the periodic table and electron configurations to determine an element's number of valence electrons, and chemical and physical properties.
- C.2.7 Compare and contrast nuclear reactions with chemical reactions. For nuclear reactions, describe how the fusion and fission processes transform elements present before the reaction into elements present after the reaction.
- C.2.8 Understand that the radioactive decay process is random for any given atom, but that this property leads to a predictable and measurable exponential decay of a sample of radioactive material. Calculate the initial amount, the fraction remaining, or the half-life of a radioactive isotope, given two of the three variables.

Standard 3: Bonding and Molecular Structure

Core Standard

Describe how the configuration of electrons within an atom determines its interactions with other atoms.

Core Standard

Describe the attractive forces between molecules and how their effect on chemical and physical properties.

- C.3.1 Describe, compare, and contrast the characteristics of the interactions between atoms in ionic and covalent compounds.
- C.3.2 Compare and contrast how ionic and covalent compounds form.
- C.3.3 Compare and contrast ionic, covalent network, metallic and polar and non-polar molecular crystals with respect to constituent particles, strength of bonds, melting and boiling points and conductivity; provide examples of each type.
- C.3.4 Draw structural formulas for and name simple molecules.
- C.3.5 Write chemical formulas for ionic compounds given their names and vice versa.

Standard 4: Reactions and Stoichiometry

Core Standard

Use balanced chemical equations and the mole concept to determine the quantities of reactants and products.

- C.4.1 Predict products of simple reactions such as synthesis, decomposition, single replacement and double replacement.
- C.4.2 Balance chemical equations using the law of conservation of mass and use them to describe chemical reactions.
- C.4.3 Use the mole concept to determine the number of moles and number of atoms or molecules in samples of elements and compounds, given mass of the sample.
- C.4.4 Using a balanced chemical equation, calculate the quantities of reactants needed and products made in a chemical reaction that goes to completion.
- C.4.5 Describe, classify and give examples of various kinds of reactions-synthesis (combination), decomposition, single displacement, double displacement and combustion.
- C.4.6 Determine oxidation states and identify the substances apparently gaining and losing electrons in redox reactions.
- C.4.7 Perform calculations to determine percent composition by mass of a compound or mixture when given the formula.

Standard 5: Behavior of Gases

Core Standard

Using the kinetic molecular theory, describe and explain the behavior of ideal gases.

Core Standard

Examine the relationship between number of moles, volume, pressure, and temperature for ideal gases, using the ideal gas equation of state $PV = nRT$.

- C.5.1 Use kinetic molecular theory to explain changes in gas volumes, pressure, moles, and temperature.

C.5.2 Using the ideal gas equation of state, $PV = nRT$, calculate the change in one variable when another variable is changed and the others are held constant.

C.5.3 Given the equation for a chemical reaction involving one or more gases as reactants and/or products calculate the volumes of gas assuming the reaction goes to completion and the ideal gas law holds.

Standard 6: Thermochemistry

Core Standard

Recognize that chemical reactions result in either the release or absorption of energy.

Core Standard

Apply the law of conservation of energy.

C.6.1 Explain that atoms and molecules that make up matter are in constant motion and that this motion increases as thermal energy increases.

C.6.2 Distinguish between the concepts of temperature and heat flow in macroscopic and microscopic terms.

C.6.3 Solve problems involving heat flow and temperature changes, using known values of specific heat and/or phase change constants (latent heat values).

C.6.4 Classify chemical reactions and phase changes as exothermic or endothermic.

Standard 7: Solutions

Core Standard

Describe the composition and characteristics of solutions.

Core Standard

Identify the factors that qualitatively affect solubility, reaction rates and dynamic equilibrium.

C.7.1 Describe the composition and properties of types of solutions.

C.7.2 Explain how temperature, pressure and polarity of the solvent affect the solubility of a solute.

C.7.3 Describe the concentration of solutes in solution in terms of molarity. Perform calculations using molarity, mass, and volume.

C.7.4 Prepare a specific volume of a solution of a given molarity when provided with a known solute.

C.7.5 Explain how the rate of a reaction is qualitatively affected by changes in concentration, temperature, surface area, and the use of a catalyst.

C.7.6 Write equilibrium expressions for reversible reactions.

Standard 8: Acids and Bases

Core Standard

Use acid-base definitions to identify acids and bases given their formulas and reactions.

Core Standard

Explain the meaning of the value indicated by the pH scale in terms of the hydrogen ion concentration for any aqueous solution.

C.8.1 Use Arrhenius and Brønsted-Lowry definitions to classify substances as acids or bases.

C.8.2 Describe the characteristic properties of acids and bases.

C.8.3 Compare and contrast the dissociation and strength of acids and bases in solution.

C.8.4 Given the hydronium (H_3O^+) ion concentration in a solution, calculate the pH, and vice versa. Explain the meaning of these values.

C.8.5 From acid-base titration data, calculate the concentration of an unknown solution.

Standard 9: Organic Chemistry and Biochemistry

Core Standard

Describe the unique nature of carbon atoms demonstrated by their ability to bond to one another and other elements, forming countless carbon-based substances and macromolecules.

C.9.1 Use structural formulas to illustrate carbon atoms' ability to bond covalently to one another to form many different substances.

C.9.2 Illustrate the variety of molecular types formed by the covalent bonding of carbon atoms and describe the typical properties of these molecular types.

Earth and Space Science I

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- Use analogies and models (mathematical and physical) to simplify and represent systems that are difficult to understand or directly experience due to their size, time scale, or complexity, and recognize the limitations of analogies and models.
- Focus on the development of explanatory models based on their observations during laboratory investigations.
- Explain that the body of scientific knowledge is organized into major theories, which are derived from and supported by the results of many experiments, and allow us to make testable predictions.
- Recognize that new scientific discoveries often lead to a re-evaluation of previously accepted scientific knowledge and of commonly held ideas.
- Describe how scientific discoveries lead to the development of new technologies, and conversely how technological advances can lead to scientific discoveries through new experimental methods and equipment.
- Explain how scientific knowledge can be used to guide decisions on environmental and social issues.

Standard 1: The Universe

Core Standard

Describe the age, origin and evolution of the universe

Core Standard

Describe the size and organization of stars and galaxies found within the universe.

- ES.1.1 Describe the Big Bang theory and understand that evidence to support the formation of the universe and its age is found in Hubble's law and the cosmic background microwave radiation. Describe the role of gravitational attraction in formation of stars and galaxies.
- ES.1.2 Differentiate between the different types of stars, including our sun, found on the Hertzsprung - Russell diagram. Compare and contrast the evolution of stars of different masses.
- ES.1.3 Understand and discuss the basics of the fusion processes that are the source of energy of stars and the formation of the elements.
- ES.1.4 Understand and explain the hierarchical relationship and scales of planetary systems, stars, multiple-star systems, star clusters, galaxies, and galactic groups in the universe.

Standard 2: The Solar System

Core Standard

Describe the age, origin and evolution of our solar system and describe the characteristics of objects in our solar system.

Core Standard

Recognize the role of gravity and other forces in determining the motion of bodies in the solar system.

- ES.2.1 Understand and discuss the nebular theory concerning the formation of solar systems. Include in the discussion the roles of planetesimals and protoplanets.
- ES.2.2 Describe the motions of the various kinds of objects in our solar system, including planets, satellites, comets, and asteroids. Explain that Kepler's laws determine the orbits of those objects and know that Kepler's laws are a direct consequence of Newton's law of universal gravitation together with his laws of motion.

- ES 2.3 Describe the characteristics of the various kinds of objects in our solar system, including planets, satellites, comets, and asteroids. Recognize that planets have been identified in the neighborhood of stars other than the sun.
- ES.2.4 Recognize that the sun is the main source of external energy for the earth. Describe the cycles of solar energy and some of their impacts on earth.

Standard 3: The Earth

Core Standard

Recognize and describe that earth sciences address planet-wide interacting systems, including the oceans, the air, the solid earth, and life on earth, as well as interactions with the solar system.

Core Standard

Examine the interrelationships between society and the planet-wide interacting systems and understand the basic physical and chemical laws that control these interactions.

- ES.3.1 Understand that the Earth system contains fixed amounts of each stable chemical element and that each element moves among reservoirs in the solid Earth, oceans, atmosphere and living organisms as part of biogeochemical cycles (nitrogen, water, carbon, oxygen and phosphorus cycles) that are driven by energy from within the earth and from the sun.
- ES.3.2 Demonstrate the possible effects of atmospheric changes brought about by natural and manmade processes.
- ES.3.3 Identify and differentiate between renewable and nonrenewable resources present within Earth’s systems. Describe the possible long term consequences that increased human consumption has placed on natural processes that renew some resources.
- ES.3.4 Recognize that fundamental physical and chemical laws control past, present, and future dynamic interactions between and within Earth systems.

Standard 4: The Atmosphere and Hydrosphere

Core Standard

Understand the structure and circulation of Earth’s atmosphere and hydrosphere and explain how natural and human factors may interact with these processes.

Core Standard

Understand that both weather and climate involve the transfer of matter and energy throughout the atmosphere and hydrosphere, driven by solar energy and gravity.

- ES.4.1 Examine the origins, structure, composition, and function of Earth’s atmosphere. Include the role of living organisms in the production and cycling of atmospheric gases.
- ES.4.2 Explain the importance of heat transfer between and within the atmosphere, land masses, and bodies of water.
- ES.4.3 Explain the role of Milankovitch cycles (rotation, revolution, and procession of axis) on differential heating of Earth, leading to climate changes such as the cycles of glaciation.
- ES.4.4 Understand and describe the origin, life cycle, and behavior, of weather systems and methods of predicting them. Investigate the causes of severe weather and propose appropriate safety measures that can be taken in the event of severe weather.
- ES.4.5 Understand the origin, effects and uses of tides.
- ES.4.6 Describe the relationships among evaporation, precipitation, ground water, surface water, and glacial systems in the water cycle. Discuss the effect of human interactions with the water cycle.

Standard 5: The Solid Earth

Core Standard

Understand the structural and compositional layers of the earth, its magnetic field, and how this knowledge is based on data from direct and indirect observation.

Core Standard

Understand how the processes of rock formation, weathering, sedimentation, and reformation continually shape the surface of the Earth.

- ES 5.1 Explain how sea level changes over time have exposed continental shelves, created and destroyed inland seas, and shaped the surface of the land.

- ES.5.2 Compare and contrast the properties of rocks and minerals. Explain the uses of rocks and minerals in daily life, particularly those found in Indiana.
- ES.5.3 Illustrate the various processes that are involved in the rock cycle and discuss the conservation of matter during formation, weathering, sedimentation, and reformation.
- ES 5.4 Understand the role of changing sea level and climate in the formation of the sedimentary rocks of Indiana.
- ES 5.5 Describe the large scale structure and compositional layers of the Earth.
- ES.5.6 Understand the origin and effects of Earth's magnetic field.
- ES.5.7 Understand the concepts of relative and absolute geologic time and their measurement by means of evidence from fossils and radioactive dating.

Standard 6: Earth Processes

Core Standard

Understand the cyclical nature of processes that modify the Earth and how humans interact with these cycles.

Core Standard

Understand the role of plate tectonics in controlling the large scale structure of Earth's surface. Understand how the dynamic Earth impacts human society.

- ES.6.1 Understand and discuss the development of plate tectonic theory which is derived from the combination of two theories: continental drift and seafloor spreading.
- ES.6.2 Explain the origin of geologic features and processes that result from plate tectonics such as earthquakes, volcanoes, trenches and mountain ranges.
- ES.6.3 Explain that the source of Earth's energy, which drives the process of tectonics is derived from the decay of radioactive isotopes and gravitational energy from Earth's original formation.
- ES.6.4 Investigate and discuss how humans affect and are affected by geological systems and processes.
- ES.6.5 Differentiate among the processes of weathering, erosion, transportation of materials, deposition, and soil formation.

Physics I

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- Explain how scientific knowledge can be used to guide decisions on environmental and social issues.

Standard I: Motion and Forces

Core Standard

Collaboratively describe, test through experiments, explain and defend mathematical models of the motion of macroscopic objects in terms of Newton's Laws: 1) The motion of an object is constant unless a net force acts on the object; 2) The magnitude of the acceleration of an object varies directly with the magnitude of the net force acting on the object and inversely with the mass of the object, and the direction of the acceleration is in the direction of the net force acting on the object; and 3) Forces are interactions between objects. Whenever an object exerts a force on another object, the second object exerts an equal and opposite force on the first.

- P.1.1 Describe, measure, and analyze using motion maps, graphs, and algebraic equations, constant acceleration motion in terms of time and the vector quantities of displacement, velocity and acceleration.
- P.1.2 Describe, measure, and analyze, using motion, maps, graphs, and algebraic equations, constant acceleration motion in one dimension in terms of time and the vector quantities of displacement, velocity, and acceleration.
- P.1.3 Describe, measure, and analyze, using motion, maps, graphs, and algebraic equations, constant acceleration motion in two dimensions in terms of time and the vector quantities of displacement, velocity, and acceleration. Consider specifically projectile motion and uniform circular motion.
- P.1.4 Describe the magnitude and direction of kinds of forces, including both contact forces and non-contact forces, those that act at a distance. Find the net force acting on an object using free-body diagrams and the addition of forces. Use Newton's three laws to deductively analyze static and dynamic systems.
- P.1.5 Use Newton's Law of universal gravitation and the laws of motion to quantitatively analyze the motions of orbiting objects such as the moon, the planets and satellites, e.g. Kepler's third law.
- P.1.6 Use Newton's law of universal gravitation to quantitatively analyze the motions of orbiting objects such as the moon, the planets and satellites, e.g., Kepler's third law.

Standard 2: Energy and Momentum

Core Standard

Collaboratively describe, test, explain and defend mathematical models of the motion of macroscopic objects in terms of energy, momentum and their conservation laws as developed using Newton's three laws of motion.

- P.2.1 Describe qualitatively and quantitatively the concepts of momentum, work, kinetic energy, potential energy, and power.
- P.2.2 Quantitatively predict changes in momentum using the impulse- momentum theorem and in kinetic energy using the work-energy theorem, as developed from Newton's laws of motion.
- P.2.3 Analyze evidence that illustrates the laws of conservation of energy and conservation of momentum. Apply these laws to analyze elastic and completely inelastic collisions.
- P.2.4 Describe and quantify energy in its different mechanical forms (such as kinetic, gravitational potential, elastic potential) and recognize that these forms of energy can be transformed one into another and into non-mechanical forms of energy (such as thermal, chemical, nuclear, and electromagnetic).

Standard 3: Temperature and Thermal Energy Transfer

Core Standard

Describe and distinguish the concepts of temperature and thermal energy, and use the kinetic-molecular theory to explain some thermal properties of gases and phase changes of solids, liquids and gases.

- P.3.1 Describe temperature, thermal energy, and thermal energy transfer in terms of the kinetic molecular model. Expand the concept of conservation of mechanical energy to include thermal energy.
- P.3.2 Describe the kinetic molecular model, use it to derive the ideal gas law and show how it explains the relationship between the temperature of an object and the average kinetic energy of its molecules.
- P.3.3 Use the kinetic theory to explain that the transfer of heat occurs during a change of state.
- P.3.4 Use examples from everyday life to describe the transfer of thermal energy by conduction, convection and radiation.

Standard 4: Electricity and Magnetism

Core Standard

Understand the interplay of electricity and magnetism. Apply this understanding to electrostatic problems and basic electrical circuits.

- P.4.1 Describe and determine the force on a stationary charge due to other stationary charges using Coulomb's Law. Know that this force is many times greater than the gravitational force.
- P.4.2 Define electric field and describe the motion of a charged particle in a simple electric field.
- P.4.3 Describe electric potential energy and electric potential (voltage), and use voltage to explain the motion of electrical charges and the resulting electric currents in conductors.
- P.4.4 Explain and analyze simple arrangements of electrical components in series and parallel circuits in terms of current, resistance, voltage, and power and use Ohm's and Kirchhoff's laws to analyze circuits.
- P.4.5 Describe the magnetic forces and fields produced by, and acting on, moving charges and magnetic materials.

Standard 5: Vibrations, Waves

Core Standard

Apply Newton's laws and the concepts of kinetic and potential energy to describe and explain the motion of vibrating objects.

- P.5.1 Identify properties of objects that vibrate, using Newton's Laws to describe and explain the vibrational motion resulting from restoring forces, such as Hooke's Law in the case of spring, or gravity in the case of a small amplitude pendulum.
- P.5.2 Describe how vibrating objects can generate transverse and/or longitudinal waves so that energy is transmitted without the transfer of energy. Distinguish longitudinal waves from transverse waves.
- P.5.3 Describe and analyze propagating waves in terms of their fundamental characteristics such as wave speed, wavelength, frequency or period, and amplitude.
- P.5.4 Describe and explain the behavior of waves such as transmission, reflection, interference, and polarizations. Qualitatively describe and explain the production and properties of standing waves.

Standard 6: Light and Optics

Core Standard

Understand the geometric nature of light propagation and its wave nature as observed in the propagation of light through space, and its interactions with and in matter.

- P.6.1 Understand the geometric nature of light in reflection and refraction, and in image formation by lenses and mirrors. Use that geometric nature to graphically predict the formation of images by lens and mirrors.
- P.6.2 Describe the electromagnetic spectrum (radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, gamma rays) in terms of frequency, wavelength and energy, recognizing that all these waves travel at the same speed in a vacuum.
- P.6.3 Understand that electromagnetic waves are produced by the acceleration of charged particles. Describe how electromagnetic waves interact with matter both as packets (photons) and as waves. Show qualitatively how wave theory helps explain polarization and diffraction.

Standard 7: Modern Physics

Core Standard

Understand how our knowledge of physics has changed during the last hundred years, particularly in the areas of atomic and nuclear physics, quantum theory, and relativity. Describe the structure of the atom and the reactions that occur in its nucleus.

- P.7.1 Explain that electrons, protons, and neutrons are parts of the atom, that the nuclei of atoms are composed of protons and neutrons which experience forces of attraction and repulsion consistent with their charges and masses. Distinguish elements from isotopes.
- P.7.2 Explain that the stability of the nucleus, containing only positive or neutral particles indicates the existence of a new force that is only evident within the nucleus, holding the particles together despite the strong repulsive electrical force.
- P.7.3 Distinguish fission from fusion processes. Describe how the binding energies of protons and neutrons determine the stability/instability of nuclei.
- P.7.4 Describe qualitatively how nuclear reactions—fission and fusion—convert very small amounts of matter into large amounts of energy.
- P.7.5 Understand that fission results from large, less stable nuclei decomposing to form smaller, more stable nuclei. Understand that fusion results from small nuclei at high temperatures and pressures combining to form larger, more stable nuclei with the release of thermonuclear energy.

Anatomy and Physiology

The Nature of Science

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Standard 1: Levels of Organization in the Human Body: Cellular

Core Standard

Describe the different forms of cellular transport within the cell and across the plasma membrane.

Core Standard

Discuss the stages and processes of somatic cell division and investigate cellular differentiation in the course of development and in the adult body.

- AP 1.1 Compare and contrast diffusion and osmosis, facilitated diffusion, active transport, endocytosis, and exocytosis.
- AP 1.2 Define homeostasis, its principal mechanisms at the cellular level, and the consequences of failure to maintain homeostasis.
- AP 1.2 Describe the importance of proteins in cell function and structure. Give specific examples of proteins and their functions and describe how proteins are synthesized.
- AP 1.3 Review the stages of mitosis and discuss differences in lifespan among various types of terminally differentiated cells.

Standard 2: Levels of Organization in the Human Body: Tissue and Organs

Core Standard

Examine the role of adhesion molecules and how these contribute to tissue formation.

Core Standard

Analyze the relationships between and the histology and physiological functions of tissues and their cellular and biochemical composition.

- AP 2.1 Explain the interactions that exist between cells within multicellular organisms to produce tissues and organs with distinct functions.
- AP 2.2 Compare and contrast the structure, function, and location of cells that make up the various types of muscle tissue, nerve tissue, and connective tissue.
- AP 2.3 Describe the general cellular structure of an epithelium, including the basement membrane. Describe the different types and locations of epithelia.

- AP 2.4 Describe endocrine and exocrine glands and their development from glandular epithelium.
- AP 2.5 Describe the body cavities, their membranes, and the organs within each cavity; the major organ systems; and their role in the functioning of the body.

Standard 3: Movement and Support in the Human Body: The Integumentary System

Core Standard

Analyze the structures of the skin, including skin layers as well as accessory structures such as hair follicles, glands and nails.

Core Standard

Describe the function of the Integumentary system and the cause and effect of diseases associated with the integumentary system.

- AP 3.1 Describe the structure of the skin, including the hypodermis, dermis, and the layers of the epidermis.
- AP 3.2 Describe the accessory structures of the skin: hairs, nails, and glands.
- AP 3.3 Describe the important physiological functions of the skin.
- AP 3.4 Evaluate the cause and effect of diseases associated with the integumentary system.

Standard 4: Movement and Support in the Human Body: The Skeletal System

Core Standard

Describe the structure, development, growth and functions of bones.

- AP 4.1 Describe the structure of a typical long bone and indicate how each part functions in the physiology and growth of the bone.
- AP 4.2 Distinguish the axial from the appendicular skeleton, and name the major bones of each. Locate and identify the bones and the major features of the bones that make

up the skull, vertebral column, thoracic cage, pectoral girdle, upper limb, pelvic girdle, and lower limb.

- AP 4.3 Compare and contrast the microscopic organization of compact (cortical) bone and spongy (trabecular) bone.
- AP 4.4 Describe the major types of joints in terms of their mobility and the tissues that hold them together.
- AP 4.5 Analyze and describe the effects of pressure, movement, torque, tension and elasticity on the human body.

Standard 5: Movement and Support in the Human Body: *The Muscular System*

Core Standard

Describe the physiology and structure of skeletal, smooth and cardiac muscle as they interact to provide movement and support of the human body.

Core Standard

Compare and contrast the microscopic structure, organization, functions, and molecular basis of contraction in skeletal, smooth and cardiac muscle.

- AP 5.1 Name the components of a skeletal muscle fiber and describe their functions. Describe how the thin and thick filaments are organized in the sarcomere.
- AP 5.2 Explain the molecular processes and biochemical mechanisms that provide energy for muscle contraction and relaxation.
- AP 5.2 Describe a motor unit and its importance in controlling the force and velocity of muscle contraction. Describe the neuromuscular junction and the neurotransmitter released at the neuromuscular junction.
- AP 5.3 Distinguish between isotonic and isometric contractions of skeletal muscle; cite examples of each and discuss how the forces generated in muscle contraction are amplified by the use of levers.
- AP 5.4 Identify the major muscles on a diagram of the body's musculature and/or through dissection, and describe the movements associated with each muscle.
- AP 5.5 Explain what is meant by muscular hypertrophy and atrophy and discuss causes of these processes.

Standard 6: Integration and Coordination in the Human Body: The Nervous System

Core Standard

Recognize that the nervous system consists of two parts: the peripheral nervous system and the central nervous system, and understand the structure and function of each.

Core Standard

Recognize uses of contemporary electrophysiological technologies such as (for example) electroencephalogram (EEG), electrocardiogram (ECG), transcutaneous electrical nerve stimulation (TENS) and cardioversion.

- AP 6.1 Distinguish the structures of the various types of neurons; diagram the structure of a motor neuron and explain the function of each of its parts.
- AP 6.2 Describe the different types of neuroglia. Describe the function of oligodendrocytes and Schwann cells; describe the structure and function of the myelin sheath and the role that Schwann cells play in myelin and in regeneration of a severed axon.
- AP 6.3 Discuss mathematically the origin of the resting potential, referring to transcellular gradients of sodium and potassium ions, the “permeability” of the plasma membrane to these ions, and the intracellular concentration of negatively-charged proteins.
- AP 6.4 Explain the changes in membrane potential during the action potential and their relationship to the number of open channels for sodium and potassium ions.
- AP 6.5 Explain the role of excitatory and inhibitory neurotransmitters. Explain why is it important to remove a neurotransmitter from its site of action and describe two mechanisms for doing this.
- AP 6.6 Describe the meninges of brain and spinal cord. Describe the cerebral ventricles and their interconnections. Describe the secretion, flow pathways, and absorption of cerebrospinal fluid, its locations, and its functions.
- AP 6.7 Discuss the functions of the spinal cord. Describe the five segments (regions) of the spinal cord and explain its organization in terms of gray matter; white matter; dorsal and ventral roots.
- AP 6.8 Discuss the components and broad function of the brain stem and the diencephalon. Describe and give the functions of the various structures that make up the cerebrum including the cerebral cortex and its anatomical divisions, the cerebral components of the basal ganglia, and the corpus callosum.
- AP 6.9 Describe the structure and functions of the cerebellum and its nuclei regarding postural control, smooth coordination of movements, and motor learning.

- AP 6.10 Describe the major characteristics of the autonomic nervous system and contrast its efferent pathways with those of somatic nervous system. Compare and contrast the actions, origins and pathways of nerve fibers in the parasympathetic and sympathetic divisions of the autonomic nervous system including their associated ganglia and neurotransmitters.

Standard 7: Integration and Coordination in the Human Body: *Somatic and Special Senses*

Core Standard

Distinguish between somatic senses and special senses and classify sensory receptors according to the types of stimuli that activate them.

- AP 7.1 Explain how information on stimulus intensity and stimulus quality is signaled to the brain.
- AP 7.2 Explain what is meant by sensory receptor adaptation and give examples related to everyday experience.
- AP 7.3 Describe the structure, function, and location of olfactory and taste receptor cells.
- AP 7.4 Identify and describe the parts of the eye. Describe the cells found in the neural retina and the functional dependence of the rods and cones on the pigmented epithelium (the non-neural retina).
- AP 7.5 Compare the structures of rods and cones, describe the fovea and its function, and discuss the relationship of rods and cones to visual acuity, night vision, dark-adaptation, color vision, and color blindness.
- AP 7.6 Describe the three regions of the ear. Distinguish the structure and function of the vestibular apparatus from the auditory apparatus. Describe how sound is transmitted from the external auditory meatus to the cochlea.
- AP 7.7 Explain how the hair cells in the vestibular apparatus and cochlea respond to head tilt, linear acceleration, rotation, and sound.

Standard 8: Integration and Coordination in the Human Body: *The Endocrine System*

Core Standard

Understand the structure and function of the endocrine system in relation to homeostasis, including a discussion of the specific role of hormones and distinguishing between endocrine glands and endocrine secretory cells found in other organs.

- AP 8.1 Discuss the difference between an endocrine gland and an exocrine gland.
- AP 8.2 Explain the nature of a hormone and the importance of the endocrine system in relation to digestion and metabolism, homeostasis, growth, development, and reproduction.
- AP 8.3 Identify the chemical classes to which important hormones belong and explain that some hormones act via second messengers.
- AP 8.4 Discuss chemical signals that can control hormone secretion.
- AP 8.5 Describe the structure and hormones of the hypothalamus-pituitary complex, and the function of these hormones in controlling the thyroid, gonads, and adrenal cortex. Describe structure of these glands and the functions of the hormones secreted by them.
- AP 8.6 Describe the structure, the hormones secreted and their function, and the stimuli for secretion of glands that are *not* under the control of the hypothalamus-pituitary complex
- AP 8.7 Discuss how the hypothalamus-pituitary complex, the sympathetic nervous system, the adrenal medulla, and the adrenal cortex are all involved in the body’s response to stress.
- AP 8.8 Explain how the cells of the adrenal medulla supplement the actions of the autonomic nervous system.

Standard 9: Transport in the Human Body: The Blood

Core Standard

Define hemostasis and how it is achieved.

Core Standard

Analyze the functions of blood including its role in responding to invading microorganisms, its defense mechanisms (e.g., acute inflammation), and the immune response.

- AP 9.1 Distinguish whole blood from plasma and serum. Classify and explain the functions of the formed elements found in blood, and describe where they are produced.

AP 9.2 Describe how erythropoietin regulates red blood cell production.

AP 9.3 Explain the ABO blood types and their significance in blood transfusion.

AP 9.4 Describe the basic processes in blood clotting.

Standard 10: Transport in the Human Body: *The Cardiovascular System*

Core Standard

Identify and locate the organs of the cardiovascular system and discuss their functions.

Core Standard

Analyze the cardiac cycle and explain how it is controlled.

AP 10.1 Describe the layers found in the walls of blood vessels and discuss the relative prominence of these layers in the different types of blood vessels. Include an analysis of vasoconstriction and vasodilation and their importance in controlling blood flow through tissues. Describe both the venous pump and varicose veins.

AP 10.2 Diagram the structure of a capillary bed and explain how materials move in and out of capillaries.

AP 10.3 Describe the heart: include the pericardium, the layers in its wall, the four chambers, the valves, and the great vessels entering and leaving the heart. Describe the major arteries branching off from the aorta, and the regions they supply; describe the major veins entering the superior and inferior venae cavae. Explain with diagrams how the heart valves ensure one-way blood flow during systole and diastole. Discuss the heart sounds and the points in the cardiac cycle when they are heard.

AP 10.4 Discuss the importance of the baroreceptor reflex in the regulation of blood pressure. Explain what is meant by hypertension and mention some of the dangers associated with it.

AP 10.5 Describe how the action potential of a cardiac muscle cell differs from that of a neuron. Describe the importance of calcium ion influx during the plateau phase of the action potential. Discuss the functioning of pacemaker cells and the how the wave of depolarization is transmitted to the ventricles.

AP 10.6 Explain the similarities and differences between the adjustment of the cardiovascular system to exercise and hemorrhage. Contrast changes in the distribution of blood flow and cardiac output, and explain the importance of the sympathetic branch of the autonomic nervous system in these responses.

Standard 11: Transport in the Human Body: *The Lymphatic System and Immune Mechanisms*

Core Standard

Identify and locate major organs of the lymphatic system and discuss their functions.

Core Standard

Illustrate lines of defense including the cellular and non-cellular components of the immune system.

- AP 11.1 Discuss the major anatomical structures and functions of the lymphatic system including the lymphatic vessels; the structure and major groupings of lymph nodes; and the structures and functions of the spleen, thymus, and bone marrow.
- AP 11.2 Discuss the different types of pathogens and outline the strategies the body uses to protect itself from them. Compare and contrast non-specific, innate or natural immunity from specific or acquired immunity.
- AP 11.3 Describe the mechanisms of the acute inflammatory response, its causes, and the role of chemical signaling molecules.
- AP 11.4 Describe the development and maturation of B- and T-lymphocytes. Discuss why the development of self-tolerance is important.
- AP 11.5 Define and discuss antigens, antibodies, and complement.

Standard 12: Absorption and Excretion in the Human Body: *The Digestive System*

Core Standard

Identify and locate major and accessory organs of the digestive system and discuss their functions.

Core Standard

Analyze the digestive processes from ingestion to defecation

- AP 12.1 Describe the functions of all the structural components and enzymes of the gastrointestinal tract and accessory organs in relation to the processing, digesting, and absorbing of the three major food classes.
- AP 12.2 Explain the roles of the lacteals and the hepatic portal vein in transporting the products of digestion.
- AP 12.3 Describe the regulation of the enzyme and bicarbonate content of the pancreatic juice.
- AP 12.4 Explain the difference between metabolic and respiratory acidosis and alkalosis.
- AP 12.5 Describe the microscopic anatomy of the liver and its relationship to the functions of the liver.

Standard 13: Absorption and Excretion in the Human Body: *The Respiratory System*

Core Standard

Identify and locate major organs of the respiratory system and discuss their functions.

Core Standard

Analyze the breathing processes (i.e., inspiration, expiration, respiratory volumes and capacities)

- AP 13.1 Contrast inspiration and expiration (quiet and forced) and explain the role of various muscles and of lung elasticity in this process.
- AP 13.2 Compare the percentages of the oxygen and carbon dioxide in the external air to the percentages in the alveolar and the pulmonary capillaries. Explain the meaning of partial pressure.
- AP 13.3 Explain the use of the spirometer and describe the data it generates in a spirogram.
- AP 13.4 Describe the neuronal networks controlling respiration. Contrast and compare the chemoreceptors involved in control of respiration and the stimuli to which they respond. Explain how these receptors affect ventilation under conditions of low arterial oxygen partial pressure, high arterial carbon dioxide, and low arterial pH.

Standard 14: Absorption and Excretion in the Human Body: *The Urinary System*

Core Standard

Identify and locate major organs of the urinary system and discuss their functions

Core Standard

Understand the function of the kidneys in relation to homeostatic control of bodily fluids, blood pressure and erythrocyte production.

- AP 14.1 Describe the external and internal structure of the kidney; describe the parts of a nephron and how it is involved in the three steps in the production of urine; compare the composition of plasma and ultrafiltrate and discuss the percentages of filtered water, sodium, and glucose normally reabsorbed by the kidney tubules.
- AP 14.2 Explain the importance of the juxtaglomerular cells in the secretion of renin, which plays a central role in controlling blood pressure by controlling blood levels of angiotensin and aldosterone.
- AP 14.3 Explain the neural basis of micturition including the function of the sphincters associated with the male and female urethra.
- AP 14.4 Discuss how the volume of body fluid is determined by the balance between ingested and metabolic water on the one hand and water lost in the urine, respiration, feces, and sweating on the other hand.
- AP 14.5 Describe how the kidneys respond to excess water intake and to dehydration; explain the role of antidiuretic hormone and of other hormones that control sodium and water absorption in the kidney.
- AP 14.6 Describe how food and metabolic processes add acid to the body fluids; recognize how chemical buffers, the lungs and the kidneys, interact in protecting the body against lethal changes of pH.

Standard 15: Life Cycle in the Human Body: *The Reproductive System*

Core Standard

Identify and locate major and accessory organs of the female and male reproductive systems and discuss their functions including oogenesis and spermatogenesis.

Core Standard

Discuss the role of hormones in the reproductive system.

- AP 15.1 Discuss the anatomy and physiology of the male and female reproductive systems.
- AP 15.2 Compare and contrast oogenesis and spermatogenesis. Distinguish between diploid germ cells and haploid/monoploid sex cells.

- AP 15.3 Describe the hormones of the gonads, their cellular origins, and their functions; explain the functions of the gonadotropins FSH and LH in males and females.
- AP 15.4 Explain what is happening during the follicular, ovulatory, and luteal phases of the menstrual cycle. Describe how estradiol and progesterone released by the ovaries are responsible for the phases that the uterus goes through during the menstrual cycle.
- AP 15.5 Describe how spermatozoa move through the female reproductive tract and describe the process of fertilization
- AP 15.6 Explain the differences among dikaryon zygote, a zygote, a morula, and a blastocyst; recognize that the implanted blastocyst secretes human gonadotropin, which prolongs the life of the corpus luteum and therefore, maintains progesterone secretion. Describe the process of implantation and development of the placenta, the substances that move across it, and the role of the placenta in maintaining the fetus.
- AP 15.7 Describe the changes in the breast leading to lactation, the hormonal events that initiate milk secretion, the maintenance of milk secretion by the breasts, and the milk ejection reflex.