

# Science and Technology for Children™

## FIFTH-GRADE UNITS

Grade	Life, Earth, and Physical Sciences and Technology			
1	Organisms	Weather	Solids and Liquids	Comparing and Measuring
2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
5	<b>Microworlds</b>	<b>Ecosystems</b>	<b>Food Chemistry</b>	<b>Floating and Sinking</b>
6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper

**Note:** To accommodate local curriculum specifications and provide grade-level flexibility, fifth-grade STC™ units have been aligned with both the K–4 and 5–8 content standards.

# Fifth-Grade STC™ Units and the NSES (5–8)

National Science Education Standards for Grades 5–8	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
<b>Science as Inquiry</b>				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
<b>Physical Science</b>				
Properties and changes of properties in matter			●	●
Motions and forces				●
Transfer of energy	●			
<b>Life Science</b>				
Structure and function in living systems	●	●		
Reproduction and heredity	●	●		
Regulation and behavior	●	●		
Populations and ecosystems		●		
Diversity and adaptations of organisms	●			
<b>Earth and Space Science</b>				
Structure of the earth system		●		
Earth's history				
Earth in the solar system				
<b>Science and Technology</b>				
Abilities of technological design				●
Understandings about science and technology	●	●	●	●
<b>Science in Personal and Social Perspectives</b>				
Personal health		●	●	●
Populations, resources, and environments		●		
Natural hazards		●		
Risks and benefits		●	●	
Science and technology in society	●	●	●	●
<b>History and Nature of Science</b>				
Science as a human endeavor	●	●	●	●
Nature of science	●	●	●	●
History of science	●		●	●
<b>Unifying Concepts and Processes</b>				
Systems, order, and organization	●	●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement		●	●	●
Evolution and equilibrium		●		●
Form and function	●	●	●	●

# Fifth-Grade STC™ Units and the NSES (K–4)

National Science Education Standards for Grades K–4	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
<b>Science as Inquiry</b>				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
<b>Physical Science</b>				
Properties of objects and materials	●	●	●	●
Position and motion of objects				●
Light, heat, electricity, and magnetism	●			
<b>Life Science</b>				
Characteristics of organisms	●	●	●	
Life cycles of organisms	●	●		
Organisms and environments		●		
<b>Earth and Space Science</b>				
Properties of earth materials		●		
Objects in the sky				
Changes in earth and sky				
<b>Science and Technology</b>				
Abilities of technological design		●		●
Understandings about science and technology	●	●	●	●
Abilities to distinguish between natural objects and objects made by humans	●	●	●	
<b>Science in Personal and Social Perspectives</b>				
Personal health			●	●
Characteristics and changes in populations				
Types of resources		●	●	
Changes in environments		●		
Science and technology in local challenges	●	●	●	●
<b>History and Nature of Science</b>				
Science as a human endeavor	●	●	●	●
<b>Unifying Concepts and Processes</b>				
Systems, order, and organization	●	●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement		●	●	●
Evolution and equilibrium		●		●
Form and function	●	●	●	●

# Microworlds

## Narrative Summary

In *Microworlds*, students examine everyday objects as well as microorganisms with a variety of magnifying devices. They begin by investigating several common objects with the unaided eye. Using a variety of lenses, including hand lenses, acrylic spheres, and water drops, they learn that a magnifying lens must be transparent and curved. Next, students use a microscope to view inanimate objects. They learn proper focusing and lighting techniques, as well as how to prepare slides. Students prepare a section of onion skin and observe its cells. Students' attention then turns to living specimens. Using a microscope, they view three microorganisms—*Volvox*, *Blepharisma*, and the vinegar eel. They study the cell structure of these organisms and observe how the organisms feed, grow, and multiply. In a final challenge, students use the microscope to examine cultures they have grown from hay and grass infusions.

## Science Content

This unit provides an experiential introduction to lenses, microscopes, and microorganisms. Students observe components of everyday objects and living things using simple tools. Students learn that the image of an object is magnified as light passes through transparent convex lenses. Using various hand lenses and microscopes, students extend their observations. They gain an appreciation for scientific tools and the relationships between cells and



organisms. Through reading selections and direct observation, students also learn about the life cycle and habitats of microscopic organisms. As students read about Robert Hooke and Anton Leeuwenhoek, they are introduced to the invention of the microscope and the discovery of the cell.

## Assessment

In Lesson 1, students engage in a pre-unit assessment in which they

begin to develop their observational skills by closely examining a common object—the penny. Students also discuss what they already know and want to know about magnification, lenses, and microscopes. Following Lesson 16, a post-unit assessment is matched to the activities in Lesson 1. Two embedded assessments allow teachers to evaluate students' growth in skills and concepts. First, in Lesson 9, students attempt to identify unknown specimens—two common crystals and two non-crystals. By doing so, they apply their new skills at making well slides and at focusing on surfaces of three-dimensional objects. In Lessons 15 and 16, a second embedded assessment allows teachers to assess students' progress as students work independently to observe microbes that have developed in the hay and grass infusions they set up earlier in the unit. Additional assessments at the end of the unit include a rating scale that students can use to evaluate themselves and suggestions for evaluating student products. A teacher's record chart is included.

## Goals for *Microworlds*

In this unit, students investigate both living and nonliving specimens with a variety of magnifiers, including the microscope. Their experiences introduce them to the following concepts, skills, and attitudes.

### Concepts

- In order to magnify, a lens must be transparent and curved.
- Magnification is directly related to how much a lens is curved.
- Higher magnification reveals more detail in a smaller area of a specimen being observed.
- In light microscopes, lenses are combined to focus light and increase magnification.
- Scientists designed and used early microscopes to extend their observational ability and to investigate their ideas.
- Some living organisms are too small to see without magnification.
- All living things are made of at least one cell.
- When magnified, all cells have observable structures.
- Microorganisms are widespread in nature.
- Bacteria are partly responsible for the decomposition of organic material over time.
- Some bacteria are eaten by other microorganisms.
- Like all organisms, microorganisms grow and reproduce.
- Microorganisms have structures that help them survive in specific environmental conditions.
- Changing environmental conditions promote the survival of some microorganisms over others and therefore change microbial communities.

### Skills

- Determining which of various objects can magnify.
- Using magnifiers, including hand lenses and microscopes, to observe living and non-living specimens.
- Using appropriate equipment and techniques to prepare microscope slides for viewing.
- Using a microscope to observe basic cell structure.
- Communicating detailed observations through writing, drawing, and discussion.
- Making measurements of small objects using hair-widths and millimeters.
- Exploring ways to slow the movement of living microscopic specimens for closer observation.

### Attitudes

- Developing an interest in exploring microscopic specimens.
- Recognizing that microorganisms have many of the same needs as other living things.
- Developing an awareness of the diversity and complexity of microbial life.
- Developing an awareness of the interactions among living things and between living things and their environment.



# Microworlds

## Fundamental Concepts and Principles Addressed (5–8)

### Science as Inquiry

#### *Abilities necessary to do scientific inquiry*

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

#### *Understandings about scientific inquiry*

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, and events; some involve collecting specimens; and some involve discovery of new objects.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.

### Physical Science

#### *Transfer of energy*

- Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object—emitted by or scattered from it—must enter the eye.

### Life Science

#### *Structure and function in living systems*

- Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells and tissues.
- All organisms are composed of cells—the fundamental unit of life. Most organisms are single cells; other organisms are multicellular.
- Cells carry on the many functions needed to sustain life. They grow and divide, thereby producing more cells. This requires that they take in nutrients.

#### *Reproduction and heredity*

- Reproduction is characteristic of all living systems. Some organisms reproduce asexually.

#### *Regulation and behavior*

- All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions.
- Behavior is one kind of response an organism can make to an internal or environmental stimulus.

#### *Diversity and adaptations of organisms*

- Millions of species of animals, plants, and microorganisms are alive today.

### Science and Technology

#### *Understandings about science and technology*

- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments.
- Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as size.

## Science in Personal and Social Perspectives

### *Science and technology in society*

- Science influences society through its knowledge and world view.
- Technology influences society through its products and processes.
- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

## History and Nature of Science

### *Science as a human endeavor*

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

### *Nature of science*

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- Different scientists might draw different conclusions from the same data.

### *History of science*

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

## Unifying Concepts and Processes

### *Systems, order, and organization*

### *Evidence, models, and explanation*

### *Form and function*



# Microworlds

## Fundamental Concepts and Principles Addressed (K–4)

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### Science as Inquiry

#### *Abilities necessary to do scientific inquiry*

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

#### *Understandings about scientific inquiry*

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations depending on the questions they are trying to answer. Types of investigations include describing objects, events, and organisms.
- Simple instruments, such as magnifiers and rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

### Physical Science

#### *Properties of objects and materials*

- Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools.
- Objects are made of one or more materials and can be described by the properties of the materials from which they are made.

#### *Light, heat, electricity, and magnetism*

- Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object.

### Life Science

#### *Characteristics of organisms*

- Organisms have basic needs. The world has many different environments, and distinct environments support the life of different types of organisms.
- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction.
- The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as change in the environment).

#### *Life cycles of organisms*

- Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying.

### Science and Technology

#### *Understandings about science and technology*

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

*Abilities to distinguish between natural objects and objects made by humans*

- Some objects occur in nature while others have been designed by people to solve human problems.

### **Science in Personal and Social Perspectives**

*Science and technology in local challenges*

- People continue inventing new ways of doing things and solving problems.
- Science and technology have greatly improved food quality and quantity, transportation, health, sanitation, and communication. These benefits of science and technology are not available to all of the people of the world.

### **History and Nature of Science**

*Science as a human endeavor*

- There is still much more to be understood about science.
- Many people choose science as a career. Many people derive great pleasure from doing science.

### **Unifying Concepts and Processes**

*Systems, order, and organization*

*Evidence, models, and explanation*

*Form and function*

# Ecosystems

## Narrative Summary

Students begin the unit by setting up a terrarium in which they grow grass, mustard, and alfalfa plants. They then add crickets and isopods. They also set up an aquarium into which they introduce snails, guppies, elodea, algae, and duckweed. By connecting the terrarium and aquarium bottles to create an “ecocolumn,” students are able to observe the relationship between the two environments and the organisms living within them. Using test ecocolumns that contain only plants, students simulate the effects of pollutants—such as road salt, fertilizer, and acid rain—on an environment. Students then use a food chain wheel to make inferences about the effects these pollutants might have on their own miniature ecosystems. Later, students read about, explore, and discuss the Chesapeake Bay as a model ecosystem. They analyze this ecosystem from the viewpoint of various users—waterman, dairy farmer, land developer, recreational boater, and resident—and present their findings to the class. This activity enables students to appreciate the trade-offs that must be made to reach mutually acceptable solutions to environmental problems.

## Science Content

*Ecosystems* helps students understand the relationships between plants and animals and the interdependence of living things within an environment. By modeling complex systems, students investigate the relationships between life and earth sciences while simultaneously exploring science in personal



and social perspectives. As students observe the structure and function of model ecosystems, they grapple with the effects of pollutants, overpopulation, and natural hazards on these systems. Working in teams, students design and test the effects of pollutants created by humans and examine the roles of people in a real-world ecosystem—the Chesapeake Bay. Unifying concepts and processes are central to this unit as students use

their models as evidence on which to base their conclusions. Extensive reading selections provide additional information on many of the organisms and concepts covered in the unit.

## Assessment

Matched pre- and post-unit assessments in which students analyze relationships in a riverbank ecosystem give teachers information about what students already know about ecosystems and what they have learned by the close of the unit. Teachers are given guidance on how to assess students as they develop and perform experiments, record observations, and make presentations. Two self-assessments in the unit allow students to reflect on their own learning and examine their attitudes toward the study of ecosystems. Additional assessments at the close of the unit allow students to apply their learning to new situations. They include an activity in which students read about an environmental problem, evaluate the differing points of view, and take a stand on the issue.

## Goals for *Ecosystems*

In this unit, students explore the web of relationships that link organisms to each other and to their natural environment. From their experiences, they develop an understanding of the following concepts, skills, and attitudes.

### Concepts

- An ecosystem is a community of organisms and its interaction with its environment.
- Organisms can be categorized by the functions they serve in an ecosystem: producers, consumers, or decomposers.
- Organisms in an ecosystem have dependent and interdependent relationships, which can be illustrated by food webs.
- Factors that affect growth and reproduction of organisms in an ecosystem include light, water, temperature, and soil.
- Natural and human-made events can “disturb” an ecosystem.
- A pollutant is anything that can harm living organisms when too much of it is released into an ecosystem. Pollution is the condition that results when pollutants interact with the environment.
- Pollutants can affect the stability of an ecosystem; solutions can be developed to minimize or alleviate the effects of pollutants.
- Model ecosystems can be used to learn more about the complex relationships that exist on earth.

### Skills

- Using a hand lens, pH paper, measuring devices, and other testing equipment appropriately.
- Conducting, recording, and organizing daily observations.
- Planning, implementing, and analyzing experiments and drawing conclusions from the results.
- Making and testing predictions.
- Identifying ecosystems as stable or disturbed and recognizing whether the causes of a disturbed ecosystem are natural or human-made.
- Reading for more information about ecosystems and pollution.
- Communicating information through writing, drawing, and discussion.
- Applying previously learned information to analyze a problem and suggest solutions.

### Attitudes

- Developing sensitivity toward living things and understanding that human behavior can positively or negatively affect them.
- Respecting evidence from an experiment and recognizing that evidence can inform a decision.
- Developing an interest in investigating ecosystems.
- Recognizing the importance of repeating experiments to get valid test results.



# Ecosystems

## Fundamental Concepts and Principles Addressed (5–8)

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### Science as Inquiry

#### *Abilities necessary to do scientific inquiry*

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

#### *Understandings about scientific inquiry*

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data.

### Life Science

#### *Structure and function in living systems*

- Living systems at all levels of organization demonstrate the complementary nature of structure and function, including the structure of ecosystems.
- Most organisms are single cells; other organisms are multicellular.

#### *Reproduction and heredity*

- Reproduction is characteristic of all living systems and is essential to the continuation of the species.

#### *Regulation and behavior*

- All organisms must be able to grow, reproduce, and maintain a relatively stable internal environment while living in a constantly changing external environment.
- Behavior is one kind of response an organism can make to an internal or environmental stimulus.

#### *Populations and ecosystems*

- A population consists of all individuals of a species that occur together in a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.
- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some microorganisms are producers—they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.
- For ecosystems, the major source of energy is sunlight, which passes from organism to organism in food webs.
- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition.

## Earth and Space Science

### *Structure of the earth system*

- Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria.
- Water is a solvent. As it passes through the water cycle, it dissolves minerals and gases and carries them to the oceans.
- Living organisms have played many roles in the earth system.

## Science and Technology

### *Understandings about science and technology*

- Perfectly designed solutions do not exist; all solutions have trade-offs.
- Technological designs have constraints.
- Technological solutions have intended benefits and unintended consequences.

## Science in Personal and Social Perspectives

### *Personal health*

- Safe living involves the development and use of safety precautions and the recognition of risk in personal decisions.
- Natural environments may contain substances that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.

### *Population, resources, and environments*

- When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.
- Causes of environmental degradation and resource depletion may vary.

### *Natural hazards*

- Human activities can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.

### *Risks and benefits*

- Students should understand the risks associated with natural hazards, with chemical hazards (such as pollutants), and with social hazards (transportation).
- Risks and benefits relate directly to personal and social dimensions.
- Important personal and social decisions are made based on perception of benefits and risks.

### *Science and technology in society*

- Science influences society through its knowledge and world view. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment.
- Societal challenges often inspire questions for scientific research.
- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs.

## History and Nature of Science

### *Science as a human endeavor*

- Some scientists work in teams, and some work alone, but all communicate extensively with one another.
- Science requires different abilities, human qualities, and habits of the mind.

### *Nature of science*

- Scientists formulate and test their explanations using observation, experiments, and models. Scientists do and have changed their ideas when led to do so by experimental evidence.
- Different scientists might publish conflicting experimental results or might draw different conclusions from the same data.
- It is part of scientific inquiry to evaluate the results of investigations, experiments, observations, models, and explanations proposed by other scientists.

## Unifying Concepts and Processes

### *Systems, order, and organization*

### *Evidence, models, and explanation*

### *Constancy, change, and measurement*

### *Evolution and equilibrium*

### *Form and function*



# Ecosystems

## Fundamental Concepts and Principles Addressed (K–4)

### Science as Inquiry

#### *Abilities necessary to do scientific inquiry*

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

#### *Understandings about scientific inquiry*

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

### Physical Science

#### *Properties of objects and materials*

- Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances.
- Objects are made of one or more materials and can be described by the properties from which they are made.

### Life Science

#### *The characteristics of organisms*

- Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light.
- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction.
- The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as change in the environment).

#### *Life cycles of organisms*

- Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying.
- Plants and animals closely resemble their parents.
- Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interactions with the environment.

#### *Organisms and their environments*

- All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.
- An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment. When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations.
- All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.

- Humans depend on their natural and constructed environments. Humans change environments in ways that can be either beneficial or detrimental for themselves and other organisms.

## **Earth and Space Science**

### *Properties of earth materials*

- Earth materials are solid rocks and soils, water, and the gases of the atmosphere; these materials have different physical properties. Earth materials provide many of the resources that humans use.
- Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants.

## **Science and Technology**

### *Abilities of technological design*

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

### *Understandings about science and technology*

- Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations.

### *Abilities to distinguish between natural objects and objects made by humans*

- Some objects occur in nature while others have been designed by people to solve human problems.
- Objects can be categorized into two groups, natural and designed.

## **Science in Personal and Social Perspectives**

### *Types of resources*

- Resources are things we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources include basic materials, such as air, water, and soil; some are produced from basic resources; and some resources are nonmaterial, such as quiet places and beauty.
- The supply of many resources is limited. If used, resources can be extended through recycling and decreased use.

### *Changes in environments*

- Environments are the space, conditions, and factors that affect an individual's and a population's ability to survive and their quality of life.
- Changes in environments can be natural or influenced by humans.
- Some environmental changes occur slowly, and others occur rapidly.

### *Science and technology in local challenges*

- People continue inventing new ways of doing things and solving problems.

## **History and Nature of Science**

### *Science as a human endeavor*

- There is still much more to be understood about science.
- Many people choose science as a career. Many people derive great pleasure from doing science.

## **Unifying Concepts and Processes**

### *Systems, order, and organization*

### *Evidence, models, and explanation*

### *Constancy, change, and measurement*

### *Evolution and equilibrium*

### *Form and function*

# Food Chemistry

## Narrative Summary

In *Food Chemistry*, students explore basic concepts related to food and nutrition. They set up their own classroom laboratory and perform physical and chemical tests to identify the presence of starch, glucose, fats, and proteins in common foods. Some of the tests are relatively simple and produce “yes-or-no” results; others require multiple steps. Still other tests, such as the glucose test, produce results that require interpretation.

Through readings, students discover how proteins, fats, and carbohydrates, as well as vitamins, are related to good health. They also learn how to interpret food labels. In a final challenge, students apply their knowledge and skills to analyze the nutritional components of a marshmallow.

## Science Content

This physical science unit allows students to explore chemistry in a familiar context. The unit emphasizes the transfer of energy in biological systems and the nutrition of common foods. Students have opportunities to gather, organize, and interpret data throughout this unit. They discover that scientific inquiry can provide useful information about nutrients and foods. Through making predictions, conducting tests, analyzing results, and discussing findings with classmates, students become engaged in processes that encourage problem solving and foster the understanding that scientific conclusions



must be justified by evidence. Reading selections about vitamins reveal both their importance in nutrition and in the history of health and science.

## Assessment

Lesson 1 serves as a pre-unit assessment. By brainstorming what they know and want to know about foods and discussing foods they eat for specific meals, students begin to consider the relationship of nutrition to health. In the

post-unit assessment, the class revisits these questions, providing the teacher with two sets of comparable data that indicate students' growth in knowledge and skills. Lesson 16 is an embedded assessment in which students apply the testing techniques they have learned in the unit to determine the nutritional value of a marshmallow. Additional assessments at the close of the unit include a student self-assessment, a performance-based assessment in which students identify mystery foods using tests from the unit, and an activity in which students read and interpret sample food labels.

## Goals for *Food Chemistry*

In this unit, students investigate the basic nutrients found in a variety of common foods. From their experiences, they are introduced to the following concepts, skills, and attitudes.

### Concepts

- Foods contain starches, sugars, fats, and/or proteins.
- Specific chemical and physical tests can be used to determine whether a food contains starches, sugars (in this unit, glucose), fats, or proteins.
- Iodine can be used to test for starches, test strips for glucose, brown paper for fats, and Coomassie blue for proteins.
- Varying amounts of starches, sugars (in this unit, glucose), fats, and proteins are found in foods.
- Starches and sugars are carbohydrates.
- Glucose is one kind of sugar.
- Carbohydrates, fats, proteins, water, vitamins, and minerals are nutrients.
- Nutrients are essential to human health.

### Skills

- Learning to perform four chemical and physical tests to identify the presence or absence of nutrients in foods.
- Predicting the nutrient content of foods.
- Conducting independent research on nutrients.
- Observing, recording, and organizing test results.
- Interpreting a range of test results to draw conclusions about the kinds and amounts of nutrients in foods.
- Developing laboratory techniques to avoid contamination of the test samples.
- Communicating results in writing and through discussion.
- Reflecting on experiences in writing and through discussion.
- Applying previously learned concepts and skills to solve a problem.

### Attitudes

- Developing an interest in investigating the nutritional content of food.
- Recognizing the importance of repeating tests to validate results.
- Recognizing that nutritional information can be used to make informed decisions about the foods we eat.



# Food Chemistry

## Fundamental Concepts and Principles Addressed (5–8)

### Science as Inquiry

#### *Abilities necessary to do scientific inquiry*

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.

#### *Understandings about scientific inquiry*

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data.

### Physical Science

#### *Properties and changes of properties in matter*

- A substance has characteristic properties, such as solubility.
- Substances react chemically in characteristic ways with other substances.

### Science and Technology

#### *Understandings about science and technology*

- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity. Technology also provides tools for investigations, inquiry, and analysis.

### Science in Personal and Social Perspectives

#### *Personal health*

- Regular exercise is important to the maintenance and improvement of health. The benefits of physical fitness include maintaining healthy weight, having energy and strength for routine activities, good muscle tone, bone strength, strong heart/lung systems, and improved mental health.
- Food provides energy and nutrients for growth and development. Nutrition requirements vary with body weight, age, sex, activity, and body functioning.

### *Risks and benefits*

- Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences. The results are used to determine the options for reducing or eliminating risks.
- Students should understand the risks associated with chemical hazards (food), biological hazards (viruses, bacteria), and with personal hazards (diet).
- Individuals can use a systematic approach to thinking critically about risks and benefits.
- Important personal and social decisions are made based on perceptions of benefits and risks.

### *Science and technology in society*

- Science influences society through its knowledge and world view.
- Societal challenges often inspire questions for scientific research.
- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact.
- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.
- Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, research institutes, and government agencies.
- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs.

## **History and Nature of Science**

### *Science as a human endeavor*

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

### *Nature of science*

- Scientists formulate and test their explanations of nature using observation and experiments.
- It is normal for scientists to differ with one another about the interpretation of the evidence.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, and the explanations proposed by other scientists.

### *History of science*

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

## **Unifying Concepts and Processes**

### *Systems, order, and organization*

### *Evidence, models, and explanation*

### *Constancy, change, and measurement*

### *Form and function*



# Food Chemistry

## Fundamental Concepts and Principles Addressed (K–4)

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### Science as Inquiry

#### *Abilities necessary to do scientific inquiry*

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

#### *Understandings about scientific inquiry*

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigation public.
- Scientists review and ask questions about the results of other scientists' work.

### Physical Science

#### *Properties of objects and materials*

- Objects have many observable properties, including size, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools.
- Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

### Life Science

#### *Characteristics of organisms*

- Organisms have basic needs, such as food and water.

### Science and Technology

#### *Understandings about science and technology*

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

#### *Abilities to distinguish between natural objects and objects made by humans*

- Some objects occur in nature; others have been designed and made by people to solve human problems and enhance the quality of life.

## Science in Personal and Social Perspectives

### *Personal health*

- Safety and security are basic needs of humans. Safety involves freedom from danger, risk, or injury. Student understandings include following safety rules for home and school, preventing neglect, and avoiding injury.
- Individuals have some responsibility for their own health.
- Nutrition is essential to health. Students should understand how the body uses food and how various foods contribute to health. Recommendations for good nutrition include eating a variety of foods, eating less sugar, and eating less fat.
- Students should understand that some substances, such as prescription drugs, can be beneficial, but that any substance can be harmful if used inappropriately.

### *Types of resources*

- Resources are things we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials and some are produced from basic resources, such as food.

### *Science and technology in local challenges*

- People continue inventing new ways of doing things, solving problems, and getting work done.
- Science and technology have greatly influenced food quality.

## History and Nature of Science

### *Science as a human endeavor*

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

## Unifying Concepts and Processes

### *Systems, order, and organization*

### *Evidence, models, and explanation*

### *Constancy, change, and measurement*

### *Form and function*

# Floating and Sinking

## Narrative Summary

In this unit, students investigate the phenomenon of buoyancy. They begin by making a spring scale with which they weigh various objects. They make clay boats, test their boats' buoyancy, and discover that altering the shape of the boats affects buoyancy. Students are then challenged to design a boat that has a certain loading capacity. These experiments allow them to witness several surprising phenomena; for example, some "floaters" are heavier than some "sinkers," and large objects are not always heavier than smaller objects. Students then turn their attention to differences between objects placed in fresh water and in salt water. They construct a hydrometer that compares the levels at which objects float in both types of water.

## Science Content

This unit emphasizes the unifying concepts of evidence, models, and measurement. Model building allows students to engage in the process of technological design. Using models, the students have multiple opportunities to investigate floating and sinking. These experiences introduce students to physical science concepts such as buoyancy and force. Structured and open-ended explorations provide meaningful experiences and data for students to evaluate as they continue to explore and refine their models. The model-building processes not only help students improve their understanding of floating and sinking but also enrich their under-



standing of the process of scientific inquiry.

## Assessment

During a pre-unit assessment in Lesson 1, students share what they know and want to know about why objects sink or float. They then observe an object in two containers of water, one in which the object floats and the other in which the object sinks. Students record their observations and ideas about how this could happen. To assess

growth in understanding, students revisit this same question and investigation in a post-unit assessment. In an embedded assessment, students construct a scientific instrument—the hydrometer—and compare the level at which it floats in graduated cylinders of fresh water and salt water. By observing students doing this activity, teachers can assess students' understanding of buoyant force and displacement. In a final embedded assessment, students make and test predictions about an unknown "mystery cylinder." In doing so, they are challenged to apply what they have learned from their previous experiences with buoyancy. Additional assessments at the end of the unit include a student self-assessment, a questionnaire for students on why objects float or sink, and a performance-based assessment in which students are challenged to make a cylinder with unknown contents float.

## Goals for *Floating and Sinking*

In this unit, students investigate the phenomenon of buoyancy. From their experiences, they are introduced to the following concepts, skills, and attitudes.

### Concepts

- Several variables affect the buoyancy of an object.
- Water pushes up on both floating and submerged objects with a buoyant force; objects push down on the water.
- The buoyant force on large objects is greater than the buoyant force on smaller objects.
- The amount of water an object displaces is directly related to the object's volume.
- Because of buoyant force, objects appear to weigh less when they are submerged.
- Objects that weigh more than the same volume of water sink; objects that weigh less than the same volume of water float.
- Salt water weighs more than an equal amount of fresh water.
- The buoyancy of an object varies with the density of the liquid.

### Skills

- Observing, recording, and organizing test results.
- Applying previous experiences to make predictions.
- Creating and analyzing graphs.
- Calibrating a spring scale and using it to measure the magnitude of a force.
- Reading science materials for information.
- Communicating results through writing and discussion.
- Solving a problem that requires the application of previously learned concepts and skills.

### Attitudes

- Developing an interest in investigating floating, sinking, and related phenomena.
- Recognizing the importance of repeating a test or measurement and comparing results.

# Floating and Sinking



## Fundamental Concepts and Principles Addressed (5–8)

### Science as Inquiry

#### *Abilities necessary to do scientific inquiry*

- Identify questions that can be answered through scientific inquiry.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

#### *Understandings about scientific inquiry*

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects or organisms; some involve experiments; and some involve discovery of new objects.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.

### Physical Science

#### *Properties and changes of properties in matter*

- A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

#### *Motion and forces*

- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude.

### Science and Technology

#### *Abilities of technological design*

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.
- Evaluate completed technological designs or products.

#### *Understandings about science and technology*

- Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems, needs, and aspirations.
- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique.
- Perfectly designed solutions do not exist; all solutions have trade-offs.

### Science in Personal and Social Perspectives

#### *Personal health*

- Safe living involves the development and use of safety precautions and the recognition of risk in personal decisions. Injury prevention has personal and social dimensions.

#### *Science and technology in society*

- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

## History and Nature of Science

### *Science as a human endeavor*

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields. Some scientists work in teams, others alone, but all communicate with one another.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry. Science is very much a human endeavor and relies on human qualities and habits of the mind.

### *Nature of science*

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Scientists change their ideas when led to do so by experimental evidence.
- Different scientists might draw different conclusions from the same data.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, and observations.

### *History of science*

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.

## Unifying Concepts and Processes

### *Systems, order, and organization*

### *Evidence, models, and explanation*

### *Constancy, change, and measurement*

### *Evolution and equilibrium*

### *Form and function*

# Floating and Sinking



## Fundamental Concepts and Principles Addressed (K–4)

### Science as Inquiry

#### *Abilities necessary to do scientific inquiry*

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

#### *Understandings about scientific inquiry*

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations depending on the questions they are trying to answer.
- Simple instruments, such as rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

### Physical Science

#### *Properties of objects and materials*

- Objects have many observable properties, including size, weight, shape, color, and the ability to react with other substances. Those properties can be measured using tools, such as rulers and balances.
- Objects are made of one or more materials and can be described by the properties of the materials from which they are made.

#### *Position and motion of objects*

- The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

### Science and Technology

#### *Abilities of technological design*

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

#### *Understandings about science and technology*

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things they could not otherwise see, measure, and do.

### Science in Personal and Social Perspectives

#### *Personal health*

- Safety and security are basic needs of humans. Safety involves freedom from danger, risk, or injury. Student understandings include following safety rules for home and school.

#### *Science and technology in local challenges*

- People continue inventing new ways of doing things and solving problems.

- Science and technology have greatly improved transportation and health. These benefits of science and technology are not available to all of the people of the world.

## **History and Nature of Science**

### *Science as a human endeavor*

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Much more remains to be understood about science. Science will never be finished.
- Many people derive great pleasure from doing science.

## **Unifying Concepts and Processes**

*Systems, order, and organization*

*Evidence, models, and explanation*

*Constancy, change, and measurement*

*Evolution and equilibrium*

*Form and function*