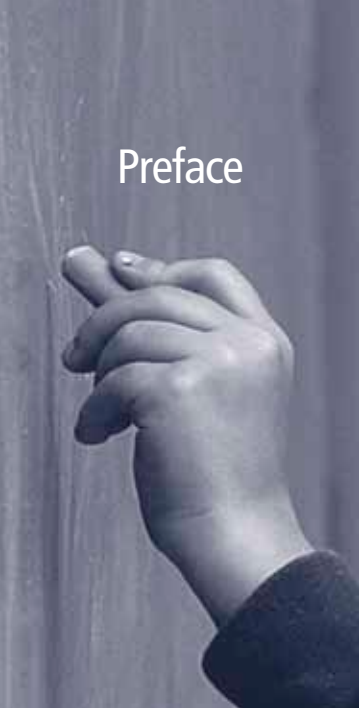
The Core Knowledge Science Sequence

Content and Skill Guidelines for Grades K–5

Core Knowledge®



Preface to the Core Knowledge Science Sequence

Following the release of the Next Generation Science Standards (NGSS), the Core Knowledge Foundation used this opportunity to update and enhance the science portion of the *2010 Core Knowledge Sequenc*e.

The development of the *K–5 Science Sequence* (2020) was informed by the pedagogy and framework of the Next Generation standards. By studying and evaluating NGSS documents, Core Knowledge was able to take the best of new science educational thought and apply it to the principles of the Core Knowledge approach.

This revised *K–5 Science Sequenc*e (2020), and by extension the Core Knowledge Science curriculum (CKSci™), embodies Core Knowledge's vision of best practices in science instruction and knowledge-based schooling.

The core principles of this scope and sequence include:

- building students' knowledge of cumulative and coherent core ideas in life, physical, and earth/space sciences, as well as engineering design;
- developing scientific practices that give students firsthand experience in scientific inquiry, engineering, and technology; and,
- connecting scientific learning to concepts across various disciplines, such as mathematics and literacy.

For more information about the *2010 Core Knowledge Sequence*, which includes additional information about English language arts and other core subject areas, please visit:

www.coreknowledge.org/sequence.

Contact the Core Knowledge Foundation

We encourage you to reach us with any questions about the K–5 Science Sequence. Write to us online by visiting:

www.coreknowledge.org/contact-us.

Please do not hesitate to also contact us directly by phone 1-800-238-3233 or by e-mail: **info@coreknowledge.org.**

Core Knowledge Science, CKSci™

Core Knowledge Science (CKSci) is a comprehensive set of instructional materials that includes units and lessons, written by the Core Knowledge Foundation, which align directly with this 2020 Science Sequence. CKSci is available for free download and/or for purchase as a print publication. We plan to pursue philanthropic funding and hope to expand both the 2020 Science Sequence and the CKSci instructional materials in the future. Please visit the Core Knowledge website for more information about the CKSci program and how it can help your students to systematically build knowledge and skills in science and engineering:

www.coreknowledge.org/science.

Terms of Use

Overview of Topics

Core Knowledge Science

Kindergarten

I. Pushes and Pulls
II. Needs of Plants and Animals
III. Changing Environments
IV. Weather Patterns
V. Health and The Human Body: Our Five Senses
VI. Science Biographies

Grade 1

I. Sun, Moon, and Stars
II. Plant and Animal Survival
III. Exploring Light and Sound
IV. Simple Machines
V. Health and The Human Body: Human Body Systems
VI. Science Biographies

Grade 2

I. Properties of Matter
II. Organisms and Their Habitats
III. Exploring Land and Water
IV. Electricity and Magnetism
V. Health and The Human Body: Cells and Digestion
VI. Science Biographies

Grade 3

I. Investigating Forces
II. Life Cycles, Traits, and Variations
III. Habitats and Change
IV. Weather and Climate
V. Health and The Human Body: Systems and How Our Eyes and Ears Work
VI. Science Biographies

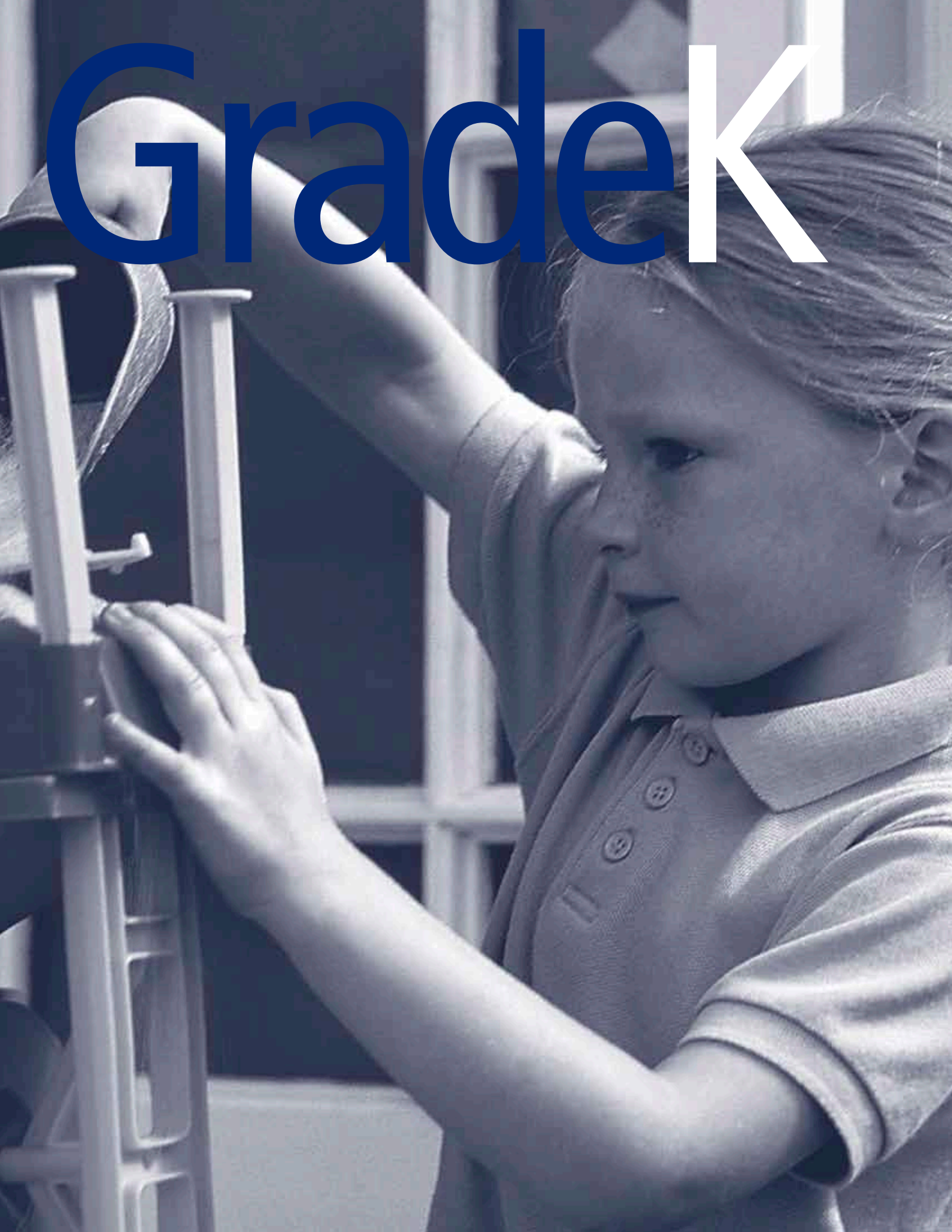
Grade 4

I. Energy Transfer and Transformation
II. Investigating Waves
III. Structures and Functions of Living Things
IV. Processes That Shape Earth
V. Using Natural Resources for Energy
VI. Health and The Human Body: Our Circulatory and Respiratory Systems
VII. Science Biographies

Grade 5

I. Investigating Matter
II. Energy and Matter in Ecosystems
III. Modeling Earth's Systems
IV. Protecting Earth's Resources
V. Astronomy: Space Systems
VI. Health and The Human Body: Our Endocrine and Reproductive Systems
VII. Science Biographies

Grade K



Science: Kindergarten

Teachers: Effective instruction in science requires hands-on experience and observation. In the words of the report from the National Academies of Science, *A Framework for K-12 Science Education*, "...children entering kindergarten have surprisingly sophisticated ways of thinking about the world, based in part on their direct experiences with the physical environment, such as watching objects fall or collide and observing plants and animals. They also learn about the world through everyday activities, such as talking with their families, pursuing hobbies, watching television, and playing with friends. As children try to understand and influence the world around them, they develop ideas about their role in that world and how it works. In fact, the capacity of young children—from all backgrounds and socioeconomic levels—to reason in sophisticated ways is much greater than has long been assumed. Although they may lack deep knowledge and extensive experience, they often engage in a wide range of subtle and complex reasoning about the world. Thus, before they even enter school, children have developed their own ideas about the physical, biological, and social worlds and how they work. By listening to and taking these ideas seriously, educators can build on what children already know and can do."

While experience counts for much, book learning is also important, for it helps bring coherence and order to a child' s scientific knowledge. Only when topics are presented systematically and clearly can children make steady and secure progress in their scientific learning. The child' s development of scientific knowledge and understanding is in some ways a very disorderly and complex process, different for each child. But a systematic approach to the exploration of science, one that combines experience with book learning, can help provide essential building blocks for deeper understanding at a later time.

I. Pushes and Pulls

(CKSci Unit 1, Pushes and Pulls)

Teachers: Through reading aloud, observation, and activities such as identifying examples of different kinds of pushes and pulls, explore the following with children:

Collaborate with your third grade colleagues regarding future expectations and definitions of forces. ***(CKSci Grade 3 Unit 1, Investigating Forces)***

A. PUSHES AND PULLS ARE FORCES

- A force is a push or a pull.
- Pushes and pulls can involve direct contact between objects.
- Pushes and pulls can be explored in everyday life.

B. PUSHES AND PULLS CAN CHANGE AN OBJECT'S MOTION

- Pushes and pulls can cause objects that are at rest, that is, objects that are not moving, to move.
- Pushes and pulls can change the motion, that is, the speed and/or direction, of objects.
    - When objects collide with one another, the motions of the colliding objects can change.

C. MAGNETISM IS A FORCE

- Pushes and pulls can involve indirect contact between objects.
- Magnetism and gravity are examples of indirect, non-contact forces.
- Magnets are certain metals that can push or pull some metal objects.
- Magnets have two ends, called poles, that behave differently.
- Magnets can be useful in everyday devices (cabinet doors, refrigerator magnets).

II. Needs of Plants and Animals

(CKSci Unit 2, Needs of Plants and Animals)

Teachers: Through reading aloud, observation, and activities such as investigating growing plants in your classroom, introduce children to the needs of living things. Children should explore the following:

A. PLANTS AND ANIMALS

- A living thing can grow, respond to its environment, reproduce, and use food energy for life processes.
- Another word for "living thing" is organism.
- Plants are organisms.
  - There are many types of plants (for example, flowering, non-flowering, seedless, with seeds)
  - Most plants have stems, roots, and leaves.
- Animals are organisms.
  - There are many types of animals (for example, insects, birds, mammals, fish, reptiles, amphibians).
  - Animals have certain parts for certain functions (structure: exoskeleton or skeleton; movement: legs, fins, wings; nutrition: mouth, digestive tract; protection: fur, shell).

B. PLANTS, THEIR NEEDS, AND THEIR ENVIRONMENTS

- Plants need air, water, light, and space, and they get what they need from their environment.
- Different types of plants live in different types of environments.
- Plants make their own food using sunlight and air.

C. ANIMALS, THEIR NEEDS, AND THEIR ENVIRONMENTS

- Animals need air, food, water, and shelter to survive.
- Animals get what they need from their environments.
- Different types of animals live in different types of environments.
- Animals get their food from eating other living things.

D. HUMANS, THEIR NEEDS, AND THEIR ENVIRONMENTS

- Human beings are a type of animal.
- Humans need air, food, water, shelter to survive, and they get these from their environment.
- Humans are omnivores.

III. Changing Environments

(CKSci Unit 3, Changing Environments)

Teachers: The emphasis in kindergarten should be on observation, description, and explanation of real world experiences of different environments and explore how natural spaces can change over time; technical explanations of ecological phenomena and human impacts on the environment should be taken up in later grades; see grades 2, 3, and 5 for an increasingly more detailed study of Ecology:

A. ECOSYSTEMS

- Plants and animals live in environments that meet their needs.
  - habitats, ecosystems
- When an environment changes, it affects the organisms that live there.

B. PLANTS IN ECOSYSTEMS

- Plants, such as water hyacinth and kudzu, can change ecosystems, and thus can affect the ability of other living things in the ecosystem to meet their own needs.

Collaborate with your fifth grade colleagues to connect this unit to learning in ***Grade 5 CKSci Unit 4, Protecting Earth's Resources.***

C. ANIMALS IN ECOSYSTEMS

- Animals can change ecosystems, and thus can affect the ability of other living things in the ecosystem to meet their own needs (beaver dams, zebra mussel infestations).

D. HUMAN CHANGES IN ECOSYSTEMS

- Humans can change ecosystems, and thus can affect the ability of other living things in the ecosystem to meet their own needs (roads, cities, pollution).

E. PEOPLE DESIGN SOLUTIONS TO REDUCE HUMAN IMPACT

- People can make choices to reduce the amount of change they cause to ecosystems.
  - For example: sustainable farming, reforestation, recycling, and pollution reduction

IV. Weather Patterns

(CKSci Unit 4, Weather Patterns)

Teachers: The emphasis in kindergarten should be on observation, description, and explanation of real world experiences; technical explanations of meteorological phenomena should be taken up in later grades; see grades 3 and 5 for an increasingly detailed study of Meteorology:

A. SUNLIGHT

- The sun is a star and it lights the sky during the daytime.
- Sunlight warms Earth's surface.
- Blocking sunlight reduces its warming effect on Earth's surface and materials.

B. PATTERNS IN WEATHER CONDITIONS

- Weather is what the air is like outside at any one time and place.
- It can be sunny, cloudy, rainy, or snowy outside.
- People collect and record weather data, such as temperature, rainfall, wind speed and direction, to reveal patterns.
- Seasons are repeating patterns of weather within the course of a year.

C. SEVERE WEATHER

- Weather can be severe and can cause damage (for example, thunder, lightning, heavy rain, high wind, tornadoes, hail, blizzards, hurricanes, drought, heat waves)
- Looking at patterns in weather data helps people predict, or forecast, when severe weather will occur.

V. Health and the Human Body: Our Five Senses

(CKSci Unit 5, Our Five Senses)

A. VISION AND HEARING

- Vision is the ability to detect objects by light.
  - Eyes are the organs of vision.
- Hearing is the ability to detect sound.
  - The ears, outer and inner, are the organs of hearing.
- The senses of sight and hearing enable people to perform many important tasks.
- Corrective lenses and hearing aids may help with vision and hearing impairments.
  - Other ways to help those with impaired hearing or vision include sign language, assistive animals, and braille.

B. SMELL, TASTE, AND TOUCH

- The sense of smell is the ability to detect scent/odor.
  - The nose is the organ of smell.
- The sense of taste is the ability to detect chemicals in the environment.
  - The taste buds enable a sense of taste.
- The sense of touch is the ability to feel things in the environment
  - Nerves in the skin enable a sense of touch.

C. TAKING CARE OF YOUR BODY

- Proper care of the body helps all senses to work most effectively.
- Healthy foods promote wellness of the senses.

VI. Science Biographies

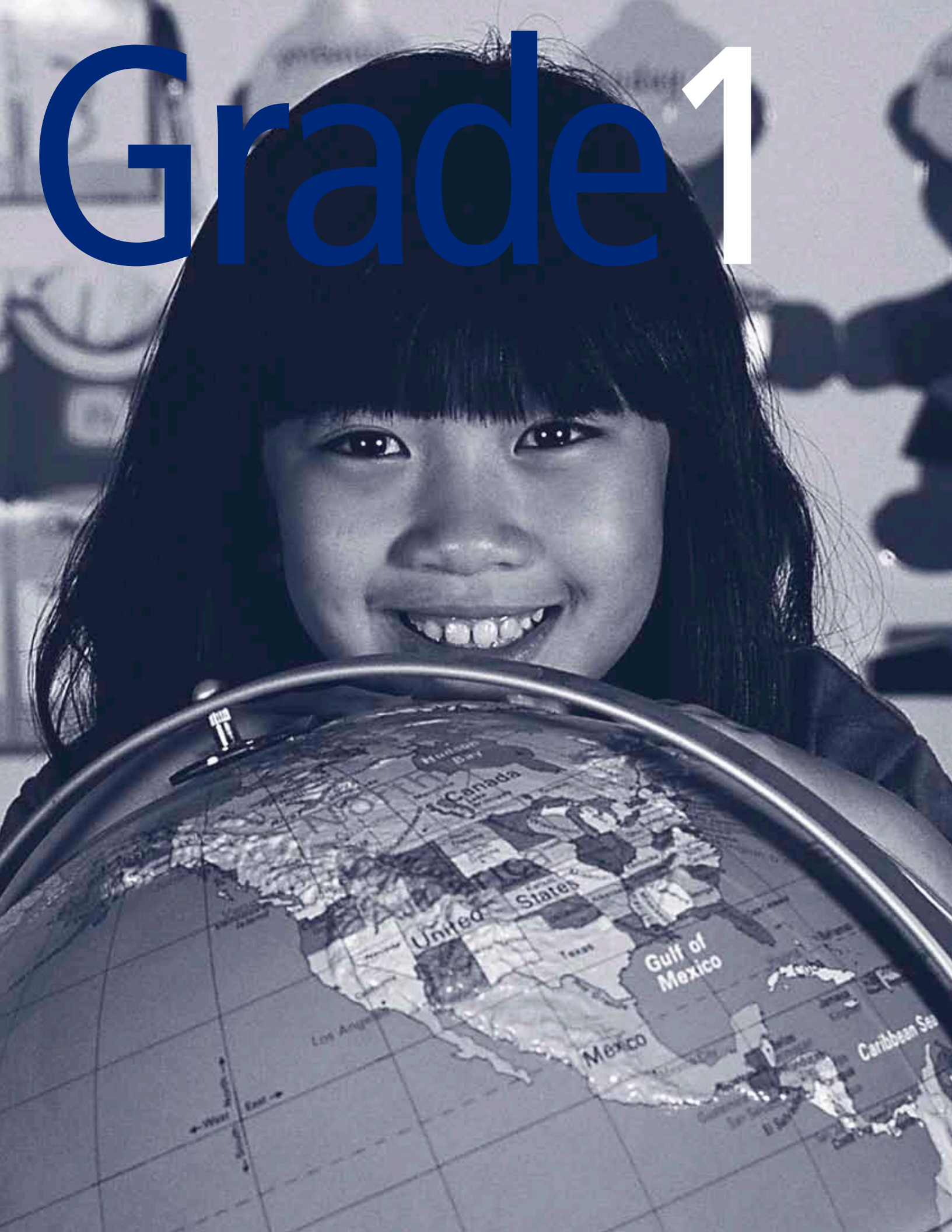
Teachers: Through reading aloud and activities, explore with children the stories and accomplishments of these scientists and engineers. This list of science biographies is by no means exhaustive. Other individuals can be incorporated into learning during a corresponding unit of study for this grade level, and should include:

- Isaac Newton—English physicist and mathematician, described the roles of forces in the universe
  - Studied during CKSci Unit 1, Pushes and Pulls
- Rachel Carson—discussed the dangers of pesticides
  - Studied during CKSci Unit 3, Changing Environments
- George Washington Carver—used plants for human benefit
  - Studied during CKSci Unit 2, Needs of Plants and Animals
- Abbe Cleveland—founded the National Weather Service
  - Studied during CKSci Unit 4, Weather Patterns

Additional recommended scientists

- Jane Goodall—studied animals and their ecosystems
  - Could be added to CKSci Unit 2, Needs of Plants and Animals
- Wright brothers—employed forces for flight
  - Could be added to CKSci Unit 1, Pushes and Pulls

Grade 1



Science: Grade 1

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I. Sun, Moon, and Stars

(CKSci Unit 1, Sun, Moon, and Stars)

Teachers: Through reading aloud, observation, and activities such as describing how the moon appears to change at different times of the month, explore the following with children:

A. THE SUN AND ITS PREDICTABLE PATTERNS

- The sun is a star.
- Earth gets light and heat (thermal energy) from the sun.
- An Earth day (daytime and night together) is twenty-four hours.
- Sunrise and sunset happen because Earth, which is ball-shaped, spins (rotates).

B. ANNUAL PATTERNS OF SUNRISE AND SUNSET

- The times of sunrise and sunset vary a little each day and occur in predictable patterns.

C. THE MOON AND ITS PREDICTABLE PATTERNS

- The moon, which is ball-shaped, is visible in the sky at night and often during the day.
- The moon appears to change shape over about a month; these changes are called the moon's phases (new, crescent, half, full).

D. STARS AND THEIR PREDICTABLE PATTERNS

- Stars are distant objects that give off their own light.
- The positions of some stars are used as dots to draw imagined patterns called constellations (Big Dipper, Orion).
- Like the sun and moon, stars appear to rotate across over the course of a night.

II. Plant and Animal Survival

(CKSci Unit 2, Plant and Animal Survival)

Teachers: Through reading aloud, observation, and activities such as investigating how various animals respond to different stimuli in their environment, help children to explore the following:

A. STRUCTURE AND FUNCTION IN PLANTS AND ANIMALS

- Plants and animals are composed of parts (structures), which they use in support of their survival.

B. INFORMATION PROCESSING: PLANT AND ANIMAL STIMULUS AND RESPONSE

- Animals and plants have parts that enable them to obtain information about their environment through their senses, and to process that information.
- Animals and plants respond to environmental inputs (stimuli) with behaviors that help them survive.

Review and extend learning from ***Kindergarten CKSci Unit 2, Needs of Plants and Animals.***

C. GROWTH AND DEVELOPMENT

- Adult plants and animals reproduce.
- Many kinds of animal parents take care of their offspring until the offspring become mature enough to care for themselves.

D. PARENTS AND OFFSPRING

- Traits are characteristics of living things.
- Individuals of the same kind of animal or plant have similar traits, and they are recognizable as similar, but they can also vary in many ways.

III. Exploring Light and Sound

(CKSci Unit 3, Exploring Light and Sound)

Teachers: The emphasis in grade 1 should be on observation, description, and explanation of real world experiences of light and sound, including how they can be used to solve problems; technical explanations of light and sound should be taken up in later grades; see grades 4, 6, and 8 for an increasingly more detailed study of energy and waves:

A. SOUND AND VIBRATION

- Vibration is an object quickly moving back and forth.
- Vibrating matter can make a sound wave that can travel through many kinds of matter.
- Sound is a phenomenon we detect with our ears.

B. LIGHT

- Light is a phenomenon we detect with our eyes.
- Some objects (the Sun, electric lights) give off light; most objects do not.

C. LIGHT AND MATERIALS

- Light interacts differently with different types of materials.
  - Transparent: light passes through easily and you can see through them.
  - Translucent: light passes partially through and you cannot see clearly through them.
  - Opaque: Light does not pass through and you cannot see through them.
- The dark area created by an obj ect blocking light is a shadow.
- Materials that reflect light may illuminate the surrounding space.

D. SOLVING PROBLEMS WITHLIGHT OR SOUND

- People use light and sound in devices to solve problems.
- People use light and sound in a variety of devices to communicate (send and receive information) over long distances.

IV. Simple Machines

(CKSci Unit4, Simple Machines)

Teachers: The emphasis in grade 1 should be on observation, description, and explanation of real world applications of simple machines and how they are placed together to form compound machines; technical explanations of work, power, and force should be taken up in later grades; see grade 8 for a detailed introduction to Physics:

Review and extend learning from ***Kindergarten CKSci Unit 1, Pushes and Pulls.***

A. SIMPLE MACHINES

- A simple machine is a device that changes the strength or direction of a force (a push or a pull).
- There are six types of simple machines:
  - Lever
  - Wheel and axel
  - Pulley
  - Inclined plane
  - Wedge
  - Screw
- Simple machines make work easier because less force is used.

B. COMPOUND MACHINES

- A compound machine consists of two or more simple machines working together.
- Examples of compound machines:
- scissors
- pencil sharpener
- bicycle,
- wheelbarrow, and many other useful devices.

V. Health and the Human Body: Human Body Systems

(CKSci Unit 5, Human Body Systems)

A. SKELETAL AND MUSCULAR SYSTEMS

- The skeletal system is made up of bones that provide structure to the human body and work with muscles to enable movement.
- The muscular system is made up of three types of muscle tissue (cardiac, smooth, skeletal).

B. RESPIRATORY AND CIRCULATORY SYSTEMS

- The respiratory system performs an exchange of gases between the body and the atmosphere (breathing).
- The respiratory system interacts with the circulatory system to move matter back and forth between the lungs and cells in the body.
- The circulatory system includes the body's blood, blood vessels, and heart.

Review and extend learning from ***Kindergarten CKSci Unit 5, Our Five Senses.***

C. NERVOUS SYSTEM

- The nervous system is made up of nerves and the brain.
- The nervous system interacts with all the body's other systems and controls all the body's voluntary and involuntary functions.

D. TAKING CARE OF YOUR BODY

- Body systems require healthy choices to function properly.
- Neglect of your health can lead to illnesses.

VI. Science Biographies

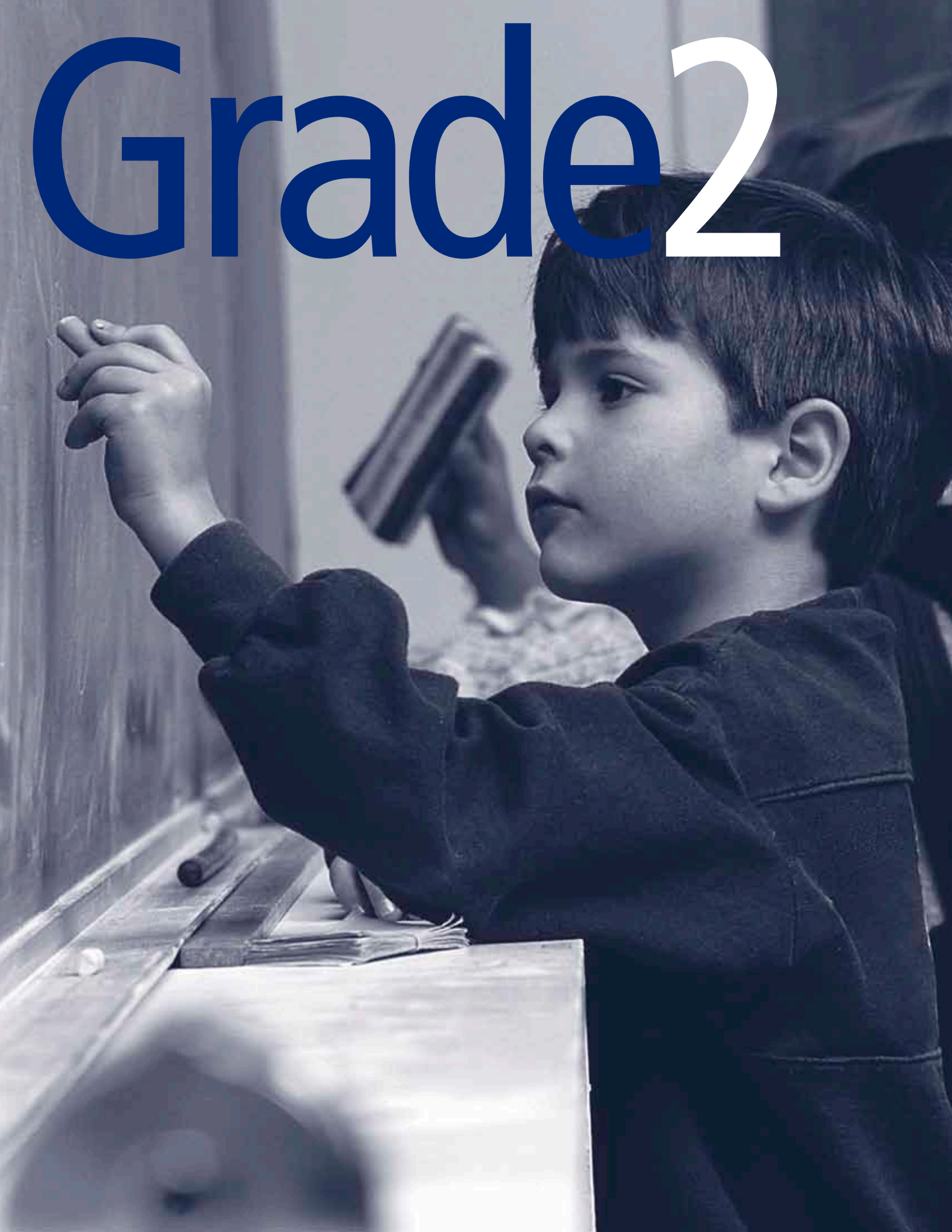
Teachers: Through reading aloud and activities, explore with children the stories and accomplishments of these scientists and engineers. This list of science biographies is by no means exhaustive. Other individuals can be incorporated into learning during a corresponding unit of study for this grade level, and should include:

- Galileo—astronomer, physicist, and engineer who observed planetary movement
  - Studied during CKSci Unit 1, Sun, Moon, and Stars
- Shi Shen, Gan De, and Wu Xian—Chinese astronomers who developed ancient star charts
  - Studied during CKSci Unit 1, Sun, Moon, and Stars
- Jacques Cousteau—explored the oceans, invented equipment for undersea exploration
  - Studied during CKSci Unit 2, Plant and Animal Survival
- Gordon Gould—physicist who developed the laser
  - Studied during CKSci Unit 3, Exploring Light and Sound
- Archimedes—Greek mathematician and inventor
  - Studied during CKSci Unit 4, Simple Machines

Additional recommended scientist

- Elizabeth Blackwell—first female to graduate from medical school in the United States
  - Could be added to CKSci Unit 5, Human Body Systems, also studied in grade 4

Grade 2



Science: Grade 2

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I. Properties of Matter

(CKSci Unit 1, Properties of Matter)

Teachers: Through reading aloud, observation, and activities such as describing and sorting different kinds of matter, explore the following with children:

A. INTRODUCTION TO MATTER

- Matter is anything that has mass and takes up space.
- There are many types of matter; matter takes different forms, or states (solid, liquid, gas).

B. PROPERTIES AND USES OF MATTER

- Matter can be measured to help describe it (size, weight, volume).
- Matter can be sorted, or classified, by properties.

C. HEATING AND COOLING MATTER

- The state of matter depends on temperature.
- Heating or cooling a substance can change its properties.
    - Water has three states: liquid, solid (ice), and gas (water vapor).

D. BUILDING WITH MATTER

- Some objects are made from a single type of matter.
- Other objects are made from different types of matter being combined or placed together.

II. Organisms and Their Habitats

(CKSci Unit 2, Organisms and Their Habitats)

Teachers: Through reading aloud, observation, and activities such as investigating differences in variety of plants and animals in different environments, help children to explore the following:

Review and extend learning from ***Kindergarten CKSci Unit 2, Needs of Plants and Animals.***

A. PLANT NEEDS

- Plants use their body parts (roots, stems, leaves) to survive and grow.
- Plants are living organisms and typically grow in fixed locations.
- Though there are many different types of plants, they have common needs (air, water, minerals, light).

B. PLANT DIVERSITY

- Plants are diverse in size, structure, and ecological needs.
- Plants live in environments to which they are suited; those environments also differ dramatically.
    - Deciduous forests (oak trees)
    - Tropical forests (vines, epiphytes)
    - Meadows and prairies (grasses)
    - Deserts (cacti)
    - Tundra (plants of small size)
    - Ponds, lakes, rivers, and streams
    - Oceans are home to less than a dozen known species of plants.
- Many plant habitats change in cycles over time—seasons—and plants are adapted to survive during those changes.

C. ANIMAL NEEDS

- Adult plants and animals reproduce.
- Many kinds of animal parents take care of their offspring until the offspring become mature enough to care for themselves.

D. ANIMAL DIVERSITY

- Animals are diverse in size, shape, and ecological needs.
- Animals vary in their structure.
    - Invertebrates: without backbones (snails, insects, coral)
    - Vertebrates: with backbones (mammals, birds, fish, reptiles, and amphibians)
- Animals live in environments to which they are suited; those environments differ dramatically.
    - Deciduous forests (squirrels, raccoons)
    - Tropical forests (moles, worms)
    - Meadows and prairies (prairie dogs)
    - Deserts (lizards, scorpions)
    - Tundra (arctic fox, polar bears)
    - Ponds, lakes, rivers, and streams (fish, oysters)
    - Oceans (there are numerous species of animals in the world's oceans such as sea stars and whales)

E. ECOSYSTEMS: PLANT AND ANIMAL RELATIONSHIPS

- Many plants and animals live in the same space, or habitat.
- Organisms that share a given space affect each other.
    - Animals depend on plants for food and shelter.
    - Plants depend on animals (for example, pollination, seed dispersal)
- There are also groups of living things that are neither plants nor animals (fungi, algae, bacteria).

III. Exploring Land and Water

(CKSci Unit 3, Exploring Land and Water)

Teachers: Through reading aloud, observation, and activities such as developing models of the shapes and kinds of land and water in an are, help children to explore the following:

A. LANDFORMS

- Earth's surface has various landforms such as:
  - plains, hills, plateaus, mountains, valleys, canyons, buttes, basins,
  - cliffs, beaches, dunes, underwater mountains and valleys
- Maps are models of Earth's surface.
  - A globe is a spherical map of the Earth that helps to visualize locations of continents, the poles, and the equator.

B. EARTH'S WATER

- Most of Earth's surface is covered with water and occurs in various places.
- Most of Earth's water is liquid; some is solid (ice). Some is fresh water (rivers, lakes, groundwater, glaciers); most is salt water (ocean).

C. EFFECTS OF WIND AND WATER ON LAND

- Wind and water can change the shape of land.
- Wind and water produce many distinctive landforms (dunes, beaches, cliffs, hoodoos, arches, oxbows and meanders, canyons, mesas).
- Wind and water cause relatively slow changes to Earth's crust.
- Scientists and engineers work together to design solutions that slow or prevent unwanted weathering and erosion.

IV. Electricity and Magnetism

(CKSci Unit 4, Electricity and Magnetism)

Teachers: The emphasis in grade 2 should be on observation, description, and explanation of real world applications of electricity and magnetism; technical explanations of electromagnetism should be taken up in later grades; see grades 4, 5, 6, and 8 for an increasingly detailed study of energy, electricity, and magnetism. Students should also engage with the engineering design process and its relationship to scientific knowledge. Contextualized design challenges should be embedded across multiple topics of study such as this unit, including in the later grades; for example, see grades 3, 4, and 5 for an increasingly detailed study of engineering design. At this grade level, explore the following with students:

Collaborate with your fourth grade colleagues regarding future expectations and definitions of energy, transfer, and the transformation of energy. ***(Grade 4 CKSci Unit 1, Energy Transfer and Transformation)***

A. ELECTRICITY

- Electricity is a form of energy. Electricity can cause a change.
- Matter contains two types of electrical charges, which are called positive and negative.
- Types of Electricity
  - Static electricity is electric charges on the surface of things.
  - Current electricity is electrical charges flowing in a circuit through wires and other devices.

B. MAGNETS AND MAGNETISM

- A magnet is an object that can exert a force through a distance on certain types of metal objects.
- A magnet is a piece of metal that has two poles, called north and south
- Similar magnetic poles attract each other; opposite magnetic poles repel each other.

C. DESIGNING AND ENGINEERING USEFUL DEVICES

- Electricity and magnetism are used in many useful devices such as household appliances and motors.
- All useful devices are developed through a process called engineering design.
  - Defining a problem.
  - Developing possible solutions.
  - Refining (optimizing) the design solution.
- Scientists and engineering designers often work together in teams to solve problems and design effective solutions.

D. SAFE USE OF ELECTRICITY AND MAGNETISM

- Electricity is potentially dangerous.
- Safety rules for electricity include:
  - never put your finger or anything metallic in an electrical outlet;
  - never touch a switch or electrical appliance when your hand or body is wet;
  - never put your finger in a lamp socket.

V. Health and the Human Body: Cells and Digestion

(CKSci Unit 5, Human Cells and Digestion)

Emphasis at this grade is to introduce the hierarchy of structures in the body.

Review and extend learning from Kindergarten and Grade 1. ***(CKSci Unit 5, Our Five Senses and Unit 5, Human Body Systems)***

A. CELLS, TISSUES, AND ORGANS

- All living things are made up of cells too small to be seen without a microscope.
- The human body is made up of different types of cells (stem, bone, blood, muscle, fat, skin, nerve).
- Cells combine to form tissues; tissues combine to form organs; organs combine to form organ systems.

B. DIGESTIVE AND EXCRETORY SYSTEMS

- The human body has complex systems, including the digestive and excretory systems.
  - The digestive system includes body parts that take in and process food (salivary glands, taste buds, teeth, esophagus, stomach, liver, small intestine, large intestine).
  - The excretory system includes those body parts that eliminate some kinds of wastes (kidneys, bladder, urethra).

C. TAKING CARE OF YOUR BODY

- A healthy lifestyle involves performing certain behaviors and avoiding other behaviors.
- The body needs specific foods, vitamins, and minerals in certain quantities to function properly.
- Organizations make recommendations about what nutrients people need to stay healthy.
- Vaccinations can help protect health.

VI. Science Biographies

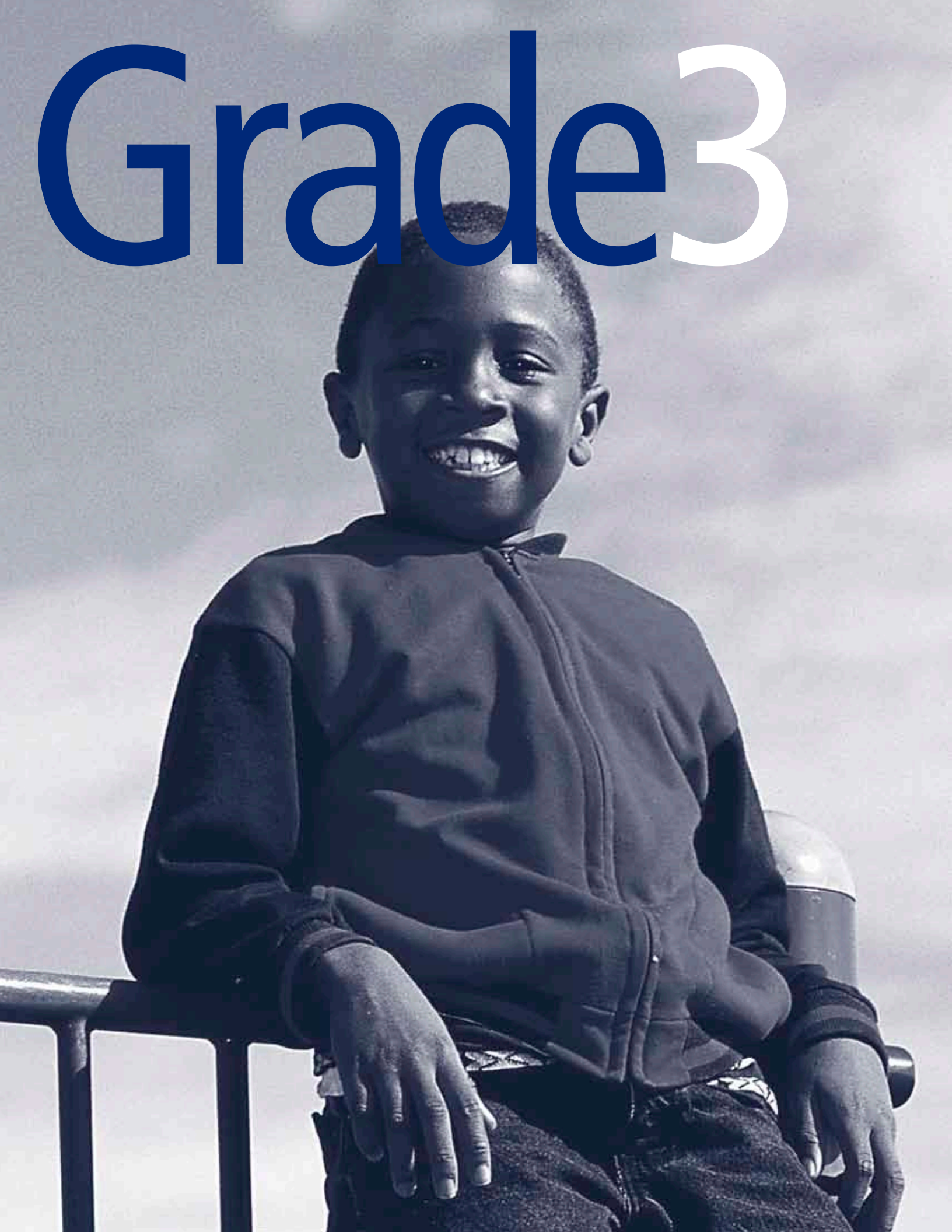
Teachers: Through reading aloud and activities, explore with children the stories and accomplishments of these scientists and engineers. This list of science biographies is by no means exhaustive. Other individuals can be incorporated into learning during a corresponding unit of study for this grade level, and should include:

- Dmitri Mendeleev—developed the periodic table
  - Studied during CKSci Unit 1, Properties of Matter
- John James Audubon—artist specializing in American birds
  - Studied during CKSci Unit 2, Organisms and Their Habitats
- Marie Tharp—pioneer in mapping the ocean floor
  - Studied during CKSci Unit 3, Exploring Land and Water
- Louis Pasteur—explored bacteria and the safety of foods
  - Studied during CKSci Unit 5, Human Cells and Digestion

Additional recommended scientists

- Anton van Leeuwenhoek—invented the microscope
- Florence Nightingale—helped make hospitals sanitary
- Daniel Hale Williams—performed the first open-chest surgery
- Edward Jenner—developed the concept and process of vaccination
  - Each could be added to CKSci Unit 5, Human Cells and Digestion

Grade 3



Science: Grade 3

Teachers: Effective instruction in science requires hands-on experience and observation. In the words of the report from the National Academies of Science, *A Framework for K-12 Science Education*, "...children have surprisingly sophisticated ways of thinking about the world, based in part on their direct experiences with the physical environment, such as watching objects fall or collide and observing plants and animals. They also learn about the world through everyday activities, such as talking with their families, pursuing hobbies, watching television, and playing with friends. As children try to understand and influence the world around them, they develop ideas about their role in that world and how it works. In fact, the capacity of young children—from all backgrounds and socioeconomic levels—to reason in sophisticated ways is much greater than has long been assumed. Although they may lack deep knowledge and extensive experience, they often engage in a wide range of subtle and complex reasoning about the world. Thus, before they even enter school, children have developed their own ideas about the physical, biological, and social worlds and how they work. By listening to and taking these ideas seriously, educators can build on what children already know and can do."

While experience counts for much, book learning is also important, for it helps bring coherence and order to a child's scientific knowledge. Only when topics are presented systematically and clearly can children make steady and secure progress in their scientific learning. The child's development of scientific knowledge and understanding is in some ways a very disorderly and complex process, different for each child. But a systematic approach to the exploration of science, one that combines experience with book learning, can help provide essential building blocks for deeper understanding at a later time.

I. Investigating Forces

(CKSci Unit 1, Investigating Forces)

Teachers: Through reading aloud, observation, and activities such as planning and conducting investigations of colliding objects, explore the following with children:

Review and extend learning from ***Kindergarten CKSci Unit 1 Pushes and Pulls.***

A. FORCES AND MOTION

- A force is a push or a pull.
- Forces can cause changes in an object's motion.
- Forces can change an object's direction and speed, sometimes starting or stopping the object's motion.
- Gravity is a force that pulls objects toward each other.
- Forces on an object may be balanced or unbalanced.
- If an object is at rest the forces acting on it are balanced.

B. THE FORCE OF FRICTION

- Friction is a force that occurs when objects are in contact with one another.
- Friction opposes motion.
- Friction can create heat (for example, rubbing hands together).
- Friction can be helpful (bicycle brakes) or harmful (in automobile engines).
- Lubricants reduce friction.

C. PREDICTING MOTION

- If an object moves in regular patterns, we can predict the object's future motion.

D. THE FORCE OF MAGNETISM

- Magnetism is a force that can push or pull.
- Only certain metals can be magnetic or be affected by magnetism (for example, iron).
- The strength of a magnetic force depends on the distance between the magnet and the object.
- Unlike poles, called north and south, attract, like poles repel.
- People use magnets to solve problems.
    - refrigerator magnets, cabinet locks, mag lev trains

II. Life Cycles, Traits, and Variations

(CKSci Unit 2, Life Cycles, Traits, and Variations)

Teachers: Through reading aloud, observation, and activities such as investigating differences in traits between parents and offspring, help children to explore the following:

Review and extend learning from ***Grade 2 CKSci Unit 2, Organisms and Their Habitats.***

A. ORGANISMS HAVE LIFE CYCLES

- Life cycles are the patterns of changes that organisms go through during their lives.
- Different organisms have different life cycles, but all life cycles share common stages: birth, growth, reproduction, death.
- The life cycle of a typical flowering plant:
  birth (germination of seeds) > growth > reproduction (flowering) > death.
- Metamorphosis is the process some animals go through involving a great change in form in becoming an adult, such as:
  - butterfly (egg, larva, pupa, adult)
  - frog (egg, tadpole, adult).

B. ORGANISMS HAVE TRAITS

- An organism is any individual life form.
- A community of organisms of the same species within an ecosystem is a population. Traits can vary to help certain individuals survive and reproduce.
- Organisms are divided into species, which share specific traits.
- Traits are the characteristics of living things, including structures, functions, and behaviors; traits we can observe are called physical traits.
- Offspring and siblings generally look like, but are not identical to, their parents or one another.
- Inheritance is the traits that are passed from parents to offspring.
- A population is a group of organisms of the same species that live in the same area.
- Variations are the differences among specific traits in a population.

C. THE ENVIRONMENT AFFECTS TRAITS

- The environment can influence an organism's traits.
- The environment can affect all stages of an organism's life cycle.
- Cause and effect relationships exist between populations and their ecosystems.

D. ADVANTAGES OF SPECIFIC TRAITS

- In a changing environment, some traits help some living things (advantageous) while other traits do not help (disadvantageous).
- Some individuals in a population may reproduce more successfully than others if their traits help them thrive in their specific environment.

III. Habitats and Change

(CKSci Unit 3, Habitats and Change)

Teachers: Through reading aloud, observation, and activities such as developing models of the shapes and kinds of land and water in an are, help children to explore the following:

A. LIVING THINGS AND THEIR ENVIRONMENTS

- Living things are adapted to the environment in which they live.
  - Adaptations promote survival.
- Organisms have traits that indicate they are adapted to live in their environment, and able to survive.
- Organisms have adaptations to specific habitats (tundra, seashore, desert and underground).
- Some animals form groups to help them survive in their habitat.

Collaborate with your fifth grade colleagues regarding future expectations within ***Grade 5 CKSci Unit 2, Energy and Matter in Ecosystems*** *and* ***CKSci Unit 4, Protecting Earth's Resources****.*

B. ECOSYSTEMS AND ENVIRONMENTAL CHANGE

- An ecosystem is all the biotic and abiotic factors in a specific environment.
- Ecosystems undergo natural and human-induced changes over time.
- When an ecosystem changes, some organisms survive while others may not.
    - Describe specific evidence that shows what a habitat and a specific organism in that habitat were like before and after a significant environmental change.
- Humans can cause threats to the environment (air pollution: emissions, smog; water pollution: industrial waste, run-off from farming).
- Debate the merits of solutions for reconstructing an ecosystem after a significant environmental change.

Fossils are explored in more depth in ***Grade 4 CKSci Unit 4, Processes That Shape Earth****.*

C. EVIDENCE OF HOW ORGANISMS AND ENVIRONMENTS HAVE CHANGED OVER TIME

- Fossils
- Scientists analyze and interpret fossils (bones, amber, traces, impressions) for evidence of how organisms and environments have changed over time.
- As a past environment changed, so did the organisms that continue to live there (coral reefs, grasslands).
- Many organisms that once existed are now extinct.

IV. Weather and Climate

(CKSci Unit 4, Weather and Climate)

A. EARTH'S ATMOSPHERE

- Air is a mixture of gases.
- Air is matter and takes up space.
- The most common gases in the atmosphere are nitrogen and oxygen.
- The atmosphere grows thinner as you move upward from Earth's surface.
- Air pressure is the weight of air in the atmosphere.
- Humidity is the amount of water vapor in the air.
- Evaporation is the sun's energy changing liquid water to gas.
- Condensation of water vapor in the atmosphere forms clouds and fog.
- Precipitation is water that falls from clouds, such as rain, snow, sleet, or hail.
- A simple machine is a device that changes the strength or direction of a force (a push or a pull).

Review and extend learning from ***Kindergarten CKSci Unit 4 Weather Patterns****.*

B. WIND: THE MOVEMENT OF AIR

- Energy from the sun warms the Earth unevenly, which creates areas of warm air (lower air pressure) and areas of cool air (higher air pressure).
- Winds are the result of air moving from areas of high air pressure to areas of low air pressure.
- Prevailing winds are regular patterns of wind flow across earth's surface.

C. WEATHER AND CLIMATE

- Weather is the conditions in the lowest layer of the atmosphere at a specific time and place.
- Weather conditions vary from place to place and over time.
- Meteorologists are scientists who study weather and climate.
- Climate is the pattern of weather conditions in a large area over a long time.
- Climate varies from place to place.
- Climate in one location varies over a year's time.
- Climatologists are scientists who study long-term weather data.

D. REDUCING THE IMPACT OF HAZARDOUS WEATHER

- Storms: high winds, heavy rains, lightning, thunder
- Extreme weather events: tornadoes, hurricanes, blizzards, drought
- Flooding can occur during and after storms.
- Extreme weather conditions can endanger people and cause destruction.
- People can plan and take steps to reduce damage and avoid danger from weather hazards (levies, warning systems, lightning rods, special buildings).

(CKSci Unit 5, Systems and How Our Eyes and Ears Work)

V. Health and the Human Body: Systems and How Our Eyes and Ears Work

Emphasis at this grade is to build on prior knowledge and to explore how our body systems and senses work together.

A. THE MUSCULAR SYSTEM

- Muscles
  - Involuntary and voluntary muscles

B. THE SKELETAL SYSTEM

- Skeleton, bones, marrow
- Musculo-skeletal connections
  - Ligaments
  - Tendons, Achilles tendon
  - Cartilage
- Skull, cranium, spinal column, vertebrae
- Joints
- Ribs, rib cage, sternum
- Scapula (shoulder blades), pelvis, tibia, fibula
- Broken bones, x-rays

C. THE NERVOUS SYSTEM

- Brain: medulla, cerebellum, cerebrum, cerebral cortex
- Spinal cord
- Nerves
- Reflexes

*Review and extend learning from **Kindergarten CKSci Unit 5, Our Five Senses**.*

D. VISION: HOW THE EYE WORKS

- Parts of the eye: cornea, iris and pupil, lens, retina
- Optic nerve
- Farsighted and nearsighted vision
- Ways to help those with impaired vision, including corrective lens, assistive animals, and braille.

E. HEARING: HOW THE EAR WORKS

- Sound as vibration
- Outer ear, ear canal
- Eardrum
- Three tiny bones (hammer, anvil, and stirrup) pass vibrations to the cochlea
- Auditory nerve
- Ways to help those with impaired hearing, including sign language, cochlear implants, and other hearing aids.

VI. Science Biographies

Teachers: Through reading aloud and activities, explore with children the stories and accomplishments of these scientists and engineers. This list of science biographies is by no means exhaustive. Other individuals can be incorporated into learning during a corresponding unit of study for this grade level, and should include:

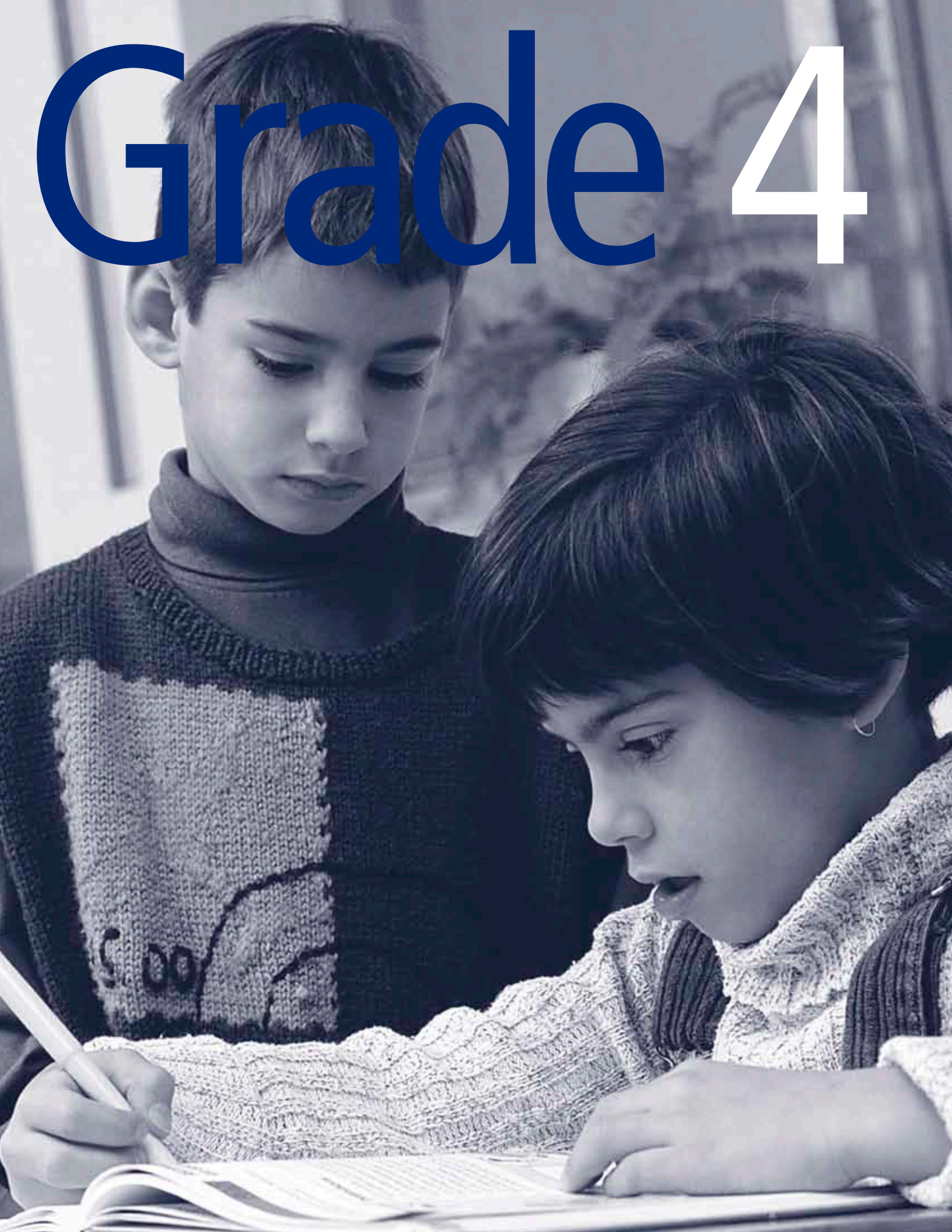
- Petrus Peregrinus de Maricourt—French scholar who worked on compasses
  - Studied during CKSci Unit 1, Investigating Forces
- Elijah McCoy—American inventor, invented lubrication devices to improve the efficiency of train travel.
  - Studied during CKSci Unit 1, Investigating Forces
- Gregor Mendel—Austrian monk who studied pea plants, and developed models of simple inheritance)
  - Studied during CKSci Unit 2, Life Cycles, Traits, and Variations
- Rachel Carson—warned of the environmental impacts of pesticides in her book Silent Spring.
  - Studied during CKSci Unit 3, Habitats and Change

- John Muir—studied wilderness areas and worked to convince people to protect them.
  - Studied during CKSci Unit 3, Habitats and Change
- Edward D. Cope and Othniel C. Marsh—paleontologists and competitors whose competition started "the Bone Wars," also known as the Great Dinosaur Rush of the late 19th century.
  - Studied during CKSci Unit 3, Habitats and Change
- Evangelista Torricelli—invented the barometer and studied air pressure.
  - Studied during Unit 4, Weather and Climate
- Benjamin Franklin—invented a lightning rod to protect people, buildings, and other structures.
  - Studied during CKSci Unit 4, Weather and Climate
- Tetsuya Fujita and Alan Pearson—researched storms and rated the severity of tornadoes.
  - Studied during CKSci Unit 4, Weather and Climate

Additional recommended scientists

- Galileo—made advances in the study of motion and friction
  - Could be added to CKSci Unit 1, Investigating Forces, also studied during Grade 5 CKSci Unit 5, Astronomy: Space Systems
- Isaac Newton—made advances in the study of forces and motion
  - Could be added to CKSci Unit 1, Investigating Forces
- Robert Hooke made advances in the study of forces and motion
  - Could be added to CKSci Unit 1, Investigating Forces
- Thales—observed magnets
  - Could be added to CKSci Unit 1, Investigating Forces
- Charles Darwin—first described evolution by natural selection
  - Could be added to CKSci Unit 2, Life Cycles, Traits, and Variations, also studied during Grade 7, Evolution
- Carl Linnaeus—developed a system of classification
  - Could be added to CKSci Unit 2, Life Cycles, Traits, and Variations, also studied during Grade 5 CKSci Unit 2, Energy and Matter in Ecosystems regarding different kinds of plants and animals
- George Washington Carver—developed new uses for many plants
  - Could be added to CKSci Unit 2, Life Cycles, Traits, and Variations and/or CKSci Unit 3 Habitats and Change
- Jane Goodall—observed animal behavioral traits
  - Could be added to CKSci Unit 2, Life Cycles, Traits, and Variations
- Blaise Pascal—formulated Pascal's Law regarding pressure
  - Could be added to CKSci Unit 4, Weather and Climate

Grade 4



Science: Grade 4

Teachers: Effective instruction in science requires hands-on experience and observation. In the words of the report from the National Academies of Science, *A Framework for K-12 Science Education*, "...children have surprisingly sophisticated ways of thinking about the world, based in part on their direct experiences with the physical environment, such as watching objects fall or collide and observing plants and animals. They also learn about the world through everyday activities, such as talking with their families, pursuing hobbies, watching television, and playing with friends. As children try to understand and influence the world around them, they develop ideas about their role in that world and how it works. In fact, the capacity of young children—from all backgrounds and socioeconomic levels—to reason in sophisticated ways is much greater than has long been assumed. Although they may lack deep knowledge and extensive experience, they often engage in a wide range of subtle and complex reasoning about the world. Thus, before they even enter school, children have developed their own ideas about the physical, biological, and social worlds and how they work. By listening to and taking these ideas seriously, educators can build on what children already know and can do."

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I. Energy Transfer and Transformation

(CKSci Unit 1, Energy Transfer and Transformation)

Teachers: The emphasis in grade 4 should be on observation, description, and explanation of real world applications of energy; technical explanations of energy transfer and transformation should be taken up in later grades; see grades 5, 6, and 8 for an increasingly detailed study of energy:

A. INTRODUCTION TO ENERGY

- Energy is the ability to cause change.
- Energy has many forms, including motion, light, sound, thermal (heat), and electrical.
- Stored energy is the potential to cause change (holding a ball at a height, or the stored chemical energy of a battery)

Review and extend learning from ***Grade 2 CKSci Unit 4 Electricity and Magnetism.***

B. ENERGY AND MOTION

- All moving objects possess energy of motion.
- The faster an object is moving, the greater its energy.
- People use motion energy to cause changes that accomplish useful tasks.

C. ENERGY TRANSFER

- Energy can be transferred from place to place.
  - Sound is transferred from a faraway bell or siren.
  - Light is transferred from the Sun to the Earth.
  - Thermal (heat) is transferred from a campfire to a camper.
- Electrical currents can transfer energy from place to place and the energy is then converted into sound, light, or thermal energy.
- Hydroelectric power plants convert the energy of moving water into electrical energy.

D. COLLISIONS

- Moving objects transfer energy from place to place.
  - For example, a rolled ball knocking over a stack of blocks.
- When objects collide, the energy of motion can be transferred or transformed.
  - In a collision, some energy is transferred from the objects to the air as sound or heat (for example, the sound when a bat hits a baseball).

E. ENERGY TRANSFORMATION AND ENGINEERING

- One form of energy can be converted into another form of energy.
- Many useful devices convert one form of energy into another
  - For example, toasters convert electrical energy to heat energy, and solar panels convert light energy to electrical energy.

II. Investigating Waves

(CKSci Unit 2, Investigating Waves)

Teachers: Through reading aloud, observation, and activities such as planning and conducting investigations of light and sound, help children to explore the following:

A. WAVES TRANSFER ENERGY

- Waves have energy, and cause change, carrying energy from one place to another.
- Waves are characterized by amplitude, frequency, and wavelength.

Review and extend learning regarding engineering design, which is introduced in CKSci grades K–2 during units:
Kindergarten Unit 1, Pushes and Pulls
Kindergarten Unit 4, Weather Patterns
Grade 1 Unit 3, Exploring Light and Sound
Grade 1 Unit 4, Simple Machines
Grade 2 Unit 3, Exploring Land and Water
Grade 2 Unit 4, Electricity and Magnetism.

B. SOUND WAVES TRANSFER ENERGY

- Sound waves transfer energy from one place to another and can cause changes (musical instruments, whale calls).
- Sound waves are produced when objects vibrate.
- Sound waves can travel through solids, liquids, and gases.
- Properties of sound waves are pitch and intensity.
- Animals have specialized structures for detecting sound waves (the ears of bats, the lateral line in fish).

C. LIGHT WAVES TRANSFER ENERGY

- Light waves transfer energy from one place to another and can cause changes.
- Sources of light include the sun and electrical devices.
- Light waves can travel through empty space and through some solids, liquids, and gases.
- Light waves are characterized by amplitude, frequency, and wavelength.
- Animals have specialized structures for detecting light (eyes of a hawk).

D. PEOPLE USE WAVES TO TRANSFER INFORMATION

- Patterns of sound waves can transfer information (Morse code, drum signals).
- Patterns of light waves can transfer information (smoke signals, ship-to-ship signals).
- Sound and light waves can be converted to digital signals for information transfer (radio, television, cell phones).

III. Structures and Functions of Living Things

(CKSci Unit 3, Structures and Functions of Living Things)

Teachers: Through reading aloud, observation, and activities such as developing models of the shapes and kinds of land and water in an are, help children to explore the following:

A. STRUCTURE IS RELATED TO FUNCTION

- Cells are the smallest unit of life.
- Unicellular organisms have only one cell. Multicellular organisms are made up of many cells.
- Cells make up tissues, tissues make up organs.
- Organs work together in systems.
- Different structures work together in systems to support survival, growth, behavior, and reproduction.

- At any level of organization, each internal and external structure of an organism reflects its function.
- Different structures work together in systems to support survival (heart and lungs in many animals, roots and stems in many plants)
- Some animals form groups to help them survive in their habitat.

Review and extend learning from third grade regarding how the eyes and ears work to include new understandings of light and sound waves as forms of energy. ***(Grade 3 CKSci Unit 5, Systems and How Our Eyes and Ears Work)***

B. THE STRUCTURE AND FUNCTION OF THE EYES AND EARS

- Light enters through the eye after being reflected off objects.
  - Structures in the eyes focus and receive the light.
  - The optic nerve carries electrical signals to the brain.
- The outer ear captures sound waves.
  - In the middle ear, sound waves hit the eardrum and are passed to three small bones
  - In the inner ear, vibrations move tiny hairs that create nerve signals.
  - Auditory nerve sends signals to the brain.

C. STIMULUS, RESPONSE, AND SURVIVAL

- Stimulus is something that causes living tissue to respond.
- Response is the reaction an organism has to a stimulus.
- Organisms have sensory organs that detect different kinds of information about the environment.
- In most animals, sensory organs transmit information to the brain.
- The brain processes this information as perceptions and stores them as memories.
- Plants also respond to stimuli (for example: a plant can sense the direction of light and grow toward it).
- Response to stimuli helps survival, growth, reproduction, and behavior.

IV. Processes That Shape Earth

(CKSci Unit 4, Processes That Shape Earth)

Review and extend learning from ***Grade 2 CKSci Unit 3, Exploring Land and Water.***

A. FEATURES OF THE EARTH

- Geologists are scientists who study Earth's surface and its interior, and the processes that change it
- Earth's layers consist of the crust, mantle, outer core, and inner core.
- Features of Earth's surface include mountains and ranges, seamounts and ocean trenches, volcanoes.
- Geologists use maps to study patterns of Earth's changing surface.

B. EVIDENCE THAT EARTH'S SURFACE HAS CHANGED OVER TIME

- Rocks and rock layers provide evidence of how Earth's surface has changed over time.
- By studying the evidence in rocks and rock layers, geologists can create models of what Earth was like in the past.
- Scientists classify rocks as sedimentary, metamorphic, and igneous.
- Fossils (the preserved remains or impressions of once-living things) are often found in and among rock layers.
- Fossils provide evidence that Earth's surface has changed over time.

C. PROCESSES THAT CHANGE EARTH'S SURFACE

- Different processes create and break down different types of mountains.
- Mountains form when plates of Earth's surface press against one another.
- Weathering is the breaking down of rocks on Earth's surface
- Agents of weathering include wind, water, ice, plants, and animals
- Erosion: the movement of rocks and soil primarily caused by wind, water, or ice in the form of glaciers

Students should engage with and discuss possible design solutions that prepare for geologic events and processes.

D. HOW GEOLOGIC EVENTS CAN AFFECT PEOPLE

- Geologic events that can affect humans include:
  - Earthquakes and tsunamis
  - Volcanoes: ash clouds and lava flows
  - Avalanches and mudslides
- People build hazard-resistant structures to prepare for possible danger.
- People use data and tools to predict disasters and minimize damage.

V. Using Natural Resources for Energy

(CKSci Unit 5, Using Natural Resources for Energy)

Teachers: Through reading aloud and activities, introduce students to examples of how humans use the natural world to meet our needs and create things such as fuel. Help students to explore:

A. NATURAL RESOURCES: RENEWABLE AND NONRENEWABLE

- Humans use natural resources to provide energy for much of modern life, such as using coal to produce electricity, oil and wood to produce heat, and gasoline to fuel cars.
- Renewable resources can be replaced relatively quickly.
- Nonrenewable resources cannot be replaced quickly.
- Renewable resources include wind energy, water behind dams, geothermal energy, sunlight, and biofuels.
- Nonrenewable resources include:
  - fossil fuels (including coal, oil, and natural gas)
  - nuclear fuels

B. USING NONRENEWABLE RESOURCES FOR ENERGY

- Fuel: a material burned to produce heat.
- Fossil fuels are formed from the remains of once-living organisms.
- Fossil fuels must be extracted from beneath Earth's surface (mining, drilling, fracking).
- Crude oil must be refined into products that are usable, such as motor oils and plastics.
- Much of our electricity is generated by burning coal.
- Air pollution often results from burning fossil fuels.
- Major sources of pollution include cars and trucks, coal-fired power plants, large industries, and ships and airplanes.
- Nuclear power plants use heat released from splitting uranium atoms to make electricity.
- Environmental benefits include lower emissions than those from fossil fuels.
- Environmental risks include escape of dangerous nuclear waste and risk of catastrophic disasters, such as Fukushima in 2011 and Chernobyl in 1986.

C. USING RENEWABLE RESOURCES FOR ENERGY

- New and improving technologies for using renewable resources for energy
  - hydroelectric power plants
  - wind turbines
  - solar panels
- Environmental benefits of using renewable resources for energy
  - reduced need for fossil fuels
  - less need for major construction such as oil fields, offshore platforms, or refineries and storage facilities
  - reduced cost of the transportation of fossil fuels
- Environmental risks, for example: building dams for hydroelectric energy affects water habitats; wind turbines may be harmful to birds that fly into them

(CKSci Unit 6, Our Circulatory and Respiratory Systems)

Note: The lymphatic system will be studied in Grade 6.

Review and extend learning about taking care of your body from previous grades:

Kindergarten Unit 5, Our Five Senses

Grade 1 Unit 5, Human Body Systems

VI. Health and the Human Body: Our Circulatory and Respiratory Systems

A. THE CIRCULATORY SYSTEM

- Pioneering work of William Harvey
- Heart: four chambers (atrium/atria or atriums [plural] and ventricle/ventricles), aorta
- Blood
  - Red blood cells (corpuscles), white blood cells (corpuscles), platelets, hemoglobin,
  - plasma, antibodies
  - Blood vessels: arteries, veins, capillaries
  - Blood pressure, pulse
  - Coagulation (clotting)
- Filtering function of liver and spleen
- Fatty deposits can clog blood vessels and cause a heart attack.
- Blood types (four basic types: A, B, AB, O) and transfusions
- Blood transfusions and the work of Charles Drew.

B. THE RESPIRATORY SYSTEM

- Process of taking in oxygen and getting rid of carbon dioxide
- Nose, throat, voice box, trachea (windpipe)
- Lungs, bronchi, bronchial tubes, diaphragm, ribs, alveoli (air sacs)
- Smoking: damage to lung tissue, lung cancer

VII. Science Biographies

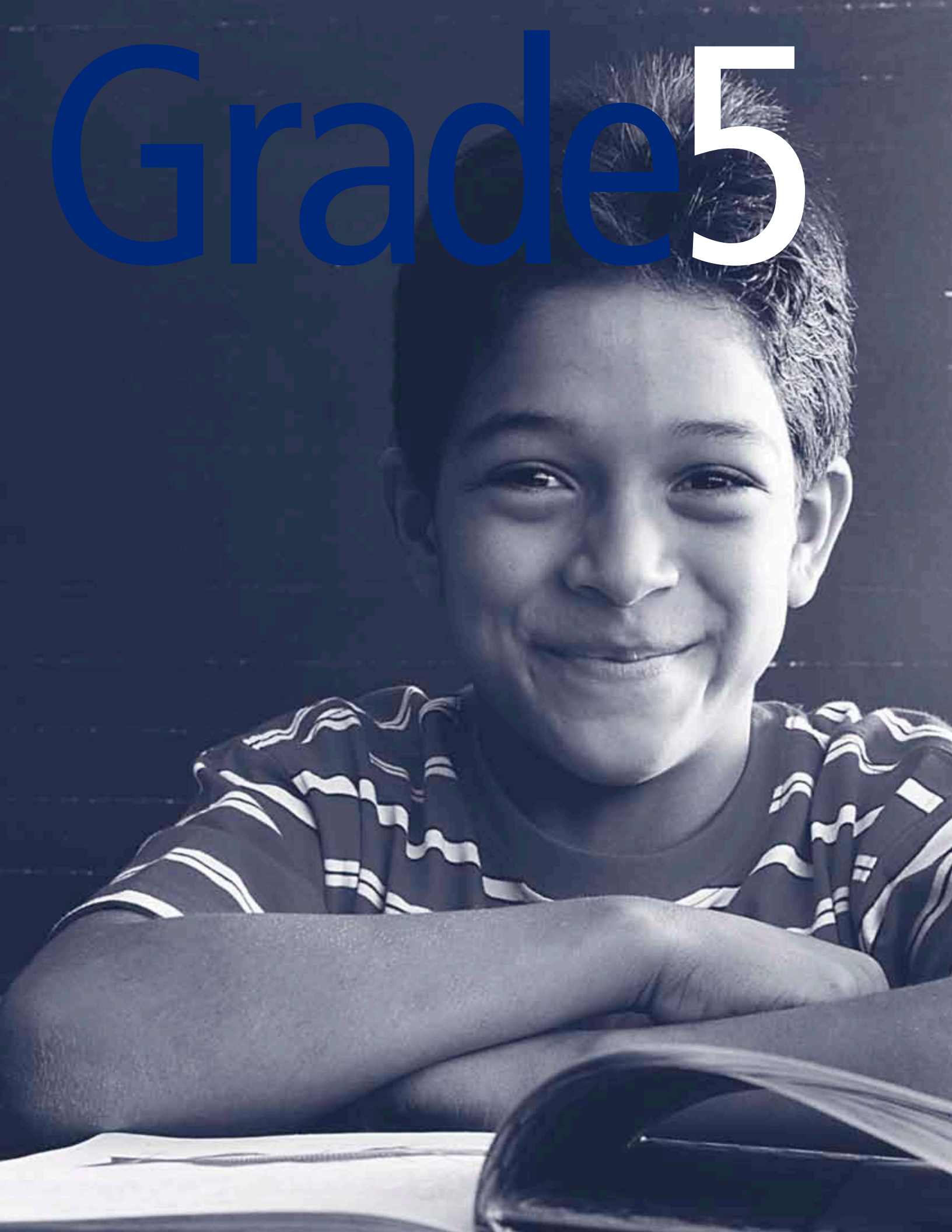
Teachers: Through reading aloud and activities, explore with children the stories and accomplishments of these scientists and engineers. This list of science biographies is by no means exhaustive. Other individuals can be incorporated into learning during a corresponding unit of study for this grade level, and should include:

- Thomas Edison—invented an electric light bulb and investigated storing energy for practical uses.
- Lewis H. Latimer—electrical engineer who, among other things, secured patents that improved Edison's lightbulb.
  - Edison and Latimer are both studied during CKSci Unit 1, Energy Transfer
- Helen Keller—led a remarkable life as an author and champion of those with disabilities, although she could not see or hear.
- Louis Braille—French inventor of the Braille systems, which allowed blind people to read by touching a pattern of dots.
  - Keller and Braille are both studied during CKSci Unit 3, Structures and Functions of Living Things

Additional recommended scientists

- Nikola Tesla—pioneered the generation, transmission, and use of alternating current (AC) electricity
  - Could be added to CKSci Unit 1, Energy Transfer and Transformation
- Marie Curie—pioneered research on radioactivity
  - Could be added to CKSci Unit 1, Energy Transfer and Transformation
- Lise Meitner—discovered that nuclear fission can produce enormous amounts of energy
  - Could be added to CKSci Unit 1, Energy Transfer and Transformation
- Alexandre-Edmond Becquerel—created the first photo-voltaic cell that is applied in solar cells.
  - Could be added to CKSci Unit 1, Energy Transfer and Transformation
- Alexander Graham Bell—pioneered information technology and invented the telephone.
  - Could be added to CKSci Unit 2, Investigating Waves
- Ada Lovelace—developed some of the first computer codes and considered by some to be the first computer programmer in history.
  - Could be added to CKSci Unit 2, Investigating Waves
- Mary Allen Wilkes—a prominent coder/programmer in the early forms of digital code
  - Could be added to CKSci Unit 2, Investigating Waves
- Samuel Morse—invented Morse code
  - Could be added to CKSci Unit 2, Investigating Waves
- Isaac Newton—demonstrated that white light is composed of a spectrum of colors
  - Could be added to CKSci Unit 2, Investigating Waves
- Mary Grace Roman—helped plan and develop the Hubble Space Telescope
  - Could be added to CKSci Unit 2, Investigating Waves
- Charles Lyell—popularized the concept that Earth was shaped by the same forces in the past as those experienced today
  - Could be added to CKSci Unit 4, Processes That Shape Earth
- Charles F. Richter—developed the Richter scale for measuring earthquake magnitude
  - Could be added to CKSci Unit 4, Processes That Shape Earth
- Lonnie Thompson—studied the movement and melting of glaciers
  - Could be added to CKSci Unit 4, Processes That Shape Earth
- Edwin L. Drake—studied ways to drill for oil, and was credited with building the first oil well in the U.S.
  - Could be added to CKSci Unit 4, Processes That Shape Earth
- Elizabeth Blackwell—first female doctor to graduate from medical school in the United States
  - Could be added to CKSci Unit 6, Our Circulatory and Respiratory Systems

Grade 5



Science: Grade 5

Teachers: Effective instruction in science requires hands-on experience and observation. In the words of the report from the National Academies of Science, *A Framework for K-12 Science Education*, "...children have surprisingly sophisticated ways of thinking about the world, based in part on their direct experiences with the physical environment, such as watching objects fall or collide and observing plants and animals. They also learn about the world through everyday activities, such as talking with their families, pursuing hobbies, watching television, and playing with friends. As children try to understand and influence the world around them, they develop ideas about their role in that world and how it works. In fact, the capacity of young children—from all backgrounds and socioeconomic levels—to reason in sophisticated ways is much greater than has long been assumed. Although they may lack deep knowledge and extensive experience, they often engage in a wide range of subtle and complex reasoning about the world. Thus, before they even enter school, children have developed their own ideas about the physical, biological, and social worlds and how they work. By listening to and taking these ideas seriously, educators can build on what children already know and can do."

While experience counts for much, book learning is also important, for it helps bring coherence and order to a child's scientific knowledge. Only when topics are presented systematically and clearly can children make steady and secure progress in their scientific learning. The child's development of scientific knowledge and understanding is in some ways a very disorderly and complex process, different for each child. But a systematic approach to the exploration of science, one that combines experience with book learning, can help provide essential building blocks for deeper understanding at a later time.

I. Investigating Matter

(CKSci Unit 1, Investigating Matter)

Teachers: Through reading aloud, observation, and activities such as planning and conducting investigations of interacting types of matter, explore the following with children:

Review and extend learning from ***Grade 2 CKSci Unit 1, Properties of Matter.***

A. PROPERTIES OF MATTER

- Matter is anything that has mass.
- Basic properties of matter include its mass, volume, and weight.
- Materials can be identified and described in terms of many properties, such as hardness, color, malleability, and density.

B. STRUCTURE OF MATTER

- Matter is made of particles too small to be seen.
- Observations that demonstrate and model that matter is made of particles:
  - Sugar cubes dissolve in water.
  - A balloon expands when air is blown into it.
  - Salt water can be evaporated when boiled.

C. PHYSICAL CHANGES IN MATTER

- Physical changes occur when a physical characteristic of the matter is changed but the type of matter remains the same.
- Solid matter has definite shape and volume.
- A liquid takes the shape of its container.
- A gas has no definite shape; it fills its container.
- Matter can change states; water is a common example.
- Other physical changes include dividing an object into pieces, dissolving a substance, and mixing substances.
- When substances undergo physical change, no matter is gained or lost—the total weight of matter is conserved.

D. CHEMICAL CHANGES IN MATTER

- A chemical change occurs when two types of matter interact to form a new substance.
- Evidence that a chemical change has occurred include:
  - formation of a gas, and changes in odor, color, or temperature.
- Examples of chemical changes include:
  - burning wood, rusting metal, and digesting foods
- When substances undergo chemical change, no matter is gained or lost—the total weight of matter is conserved.
- In a changing environment, some traits help some living things (advantageous) while other traits do not help (disadvantageous).

E. THE LANGUAGE OF CHEMISTRY

- Chemistry is the scientific study of what matter is made of and how matter changes.
- Matter is made of particles too small to be seen, which are called atoms.
- Atoms can join to form molecules.
- Models of common molecules (such as water and carbon dioxide)

II. Energy and Matter in Ecosystems

(CKSci Unit 2, Energy and Matter in Ecosystems)

Teachers: Through reading aloud, observation, and activities such as creating models of food webs, help students to explore the following:

A. ORGANISMS NEED AND USE ENERGY

Review and extend learning about the life cycles of particular organisms from ***Grade 3 CKSci Unit 2 Life Cycles, Traits, and Variations.***

- Living things need chemical energy from food for all life processes.
- The energy in animals' food originated as energy from the sun.
  - Producers use energy from the sun to make their own food.
  - Consumers get their food by eating other organisms.
  - Decomposers break down the tissues of dead organisms for food and function as recyclers.
- Life cycles are the patterns of changes that organisms go through during their lives.

B. PLANTS AND ANIMALS

- Plants need sunlight, water, and air to grow.
- Plants get the substances they need for growth mainly from air and water.
- Photosynthesis: Plants use air, water, and the energy of sunlight to make a form of sugar, glucose.
- Plants use glucose as the fundamental food for all life processes.
- Animals get their food energy by eating other organisms.
  - Herbivores are animals that eat only plants.
  - Carnivores are animals that eat other animals.
  - Omnivores are animals that eat both plants and animals.

C. MATTER CYCLES THROUGH ECOSYSTEMS

- Energy is transferred from the sun to producers and then to consumers.
- Ecosystems are the living and nonliving things in an area.
- Producers make food; the chemical energy of food cycles moves from producers to consumers.
- Food chain and food web are models of how matter and energy flows through an ecosystem.
- As matter cycles through an ecosystem, the interactions of producers, consumers, and decomposers meet the needs of living things in the ecosystem.
- Anything that disrupts food webs may harm an ecosystem.
  - Plants and animals can disrupt an ecosystem, for example: invasive zebra mussels or kudzu.
  - Humans can disrupt an ecosystem. Environmental changes can disrupt ecosystems.

III. Modeling Earth's Systems

(CKSci Unit 3, Modeling Earth's Systems)

This unit draws upon background knowledge developed across all previous grades. This is an opportunity for students to demonstrate their cumulative knowledge within the context of systems thinking.

Teachers: Through reading aloud, observation, and activities such as creating models of the different spheres of the Earth, help students to explore the following:

A. SPHERES OF THE EARTH

- Hydrosphere: All the water in all its forms—in the air, lakes, streams, estuaries, glaciers, and oceans.
  - The oceans hold nearly all of Earth's water.
  - Ocean water is salt water, not suitable for drinking.
  - Brackish water: a mix of salt water and fresh water.
  - Earth's fresh water is in glaciers or underground; much less is found in streams, lakes, wetlands, and the atmosphere.
- Geosphere: All rocks, minerals, and landforms.
  - Earth's crust and upper mantle move slowly over time.
  - Evidence of changes to Earth's surface can be found in rocks and rock layers.
- Atmosphere is all the air around us and all that it contains.
  - The air is a mixture of gases, including nitrogen, oxygen, carbon dioxide, and water vapor.
  - Nitrogen makes up the most abundant gas in our atmosphere (approximately 78%).
- Biosphere: All living things.
  - Biome: a large region with a specific climate and with living things adapted to that climate.
  - Major biomes include tundra, forests, grasslands, and desert.
  - Living things rely on their habitats to meet their needs.

B. MODELING EARTH'S INTERACTING SPHERES

- Hydrosphere interactions
  - Water shapes the Earth's surface over time. (Erosion by rivers, oceans, and weather)
  - The sun's energy evaporates water into the atmosphere.
  - The ocean influences climate and weather
- Atmosphere interactions
  - Wind and weather cause the weathering and erosion of rock.
  - Weather and climate affect the habitats and ecosystems of living things. Water vapor forms rain, which falls to the ground and forms freshwater reservoirs for living things to use.
  - Nitrogen gas in the air enters the ground and is chemically transformed by bacteria for plant use.
- Geosphere interactions
  - Mountain ranges affect the formation of clouds and other weather events.
  - Living things can cause erosion in a specific environment.
  - Certain rock layers provide the necessary space for the formation of aquifers.
- Biosphere interactions
  - Freshwater lakes provide a habitat for fish and algae.
  - Minerals in soils are absorbed into plants through their roots to provide important chemicals for life.

*(CKSci Unit 4, **Protecting Earth's Resources**)*

IV. Protecting Earth's Resources

*Using the models created in the previous unit, **CKSci Unit 3, Modeling Earth's Systems**, work with students to create scientific arguments about Earth's resources.*

A. PROTECTING EARTH'S WATER

- All living things depend on water (fresh or salt water) to survive.
- Water pollution, such as untreated sewage, pesticide and industrial runoff, and oil spills, can be harmful to living things.
- Unlimited use of fresh water sources may result in shortages (including during droughts) resulting in:
  - Destruction of ecosystems
  - Reduction of biodiversity
  - Loss of recreational and living space
- Conservation practices include:
  - Using only as much water as necessary.
  - Protecting river systems and watersheds by managing the use of water by industries, agriculture, and residential areas.
  - Regulations to prevent and reduce water pollution such as the Clean Water Act.

B. PROTECTING EARTH'S AIR

- Many organisms, including most plants and animals, depend on the atmosphere to survive.
- Air pollution includes:
  - Emissions from automobiles and other forms of transportation such as nitrogen oxides and carbon monoxide
  - Emissions from industry and burning fossil fuels such as sulfur dioxide
  - Consequences include acid rain, ozone destruction, and average temperature changes
- Solutions include:
  - Smog reduction and transportation incentives, for example car exhaust regulations and HOV lanes
  - Technologies to reduce emission of harmful gases in automotive exhaust
  - Regulations to prevent and reduce air pollution, such as the Clean Air Act

C. PROTECTING EARTH'S LAND

- Many living things depend on the land around them to meet their needs.
- Sources of land pollution include solid waste, pesticides, construction and mining waste.
- Consequences include habitat destruction and chemical pollution.
- Solutions include:
  - Reducing waste in landfills by following the principles of “reduce, reuse, recycle”
  - Chemical testing of hazardous waste
  - Satellite tracking of soil erosion
  - Environmental Impact Assessments: evaluating the anticipated environmental effects of a proposed project

*Review and extend learning from **Grade 3 CKSci Unit 3, Habitats and Change.***

D. PROTECTING ECOSYSTEMS

- Overuse or misuse of water, air, and land resources can harm living organisms and the environment they need to survive.
- Monitoring is needed to detect ecosystem changes.
- Species may become endangered or even extinct.
- Communities can apply knowledge about how ecosystems interact with other systems of the Earth to help protect them.
- Regulations to protect and conserve ecosystems and wildlife include the Endangered Species Act and The Clean Air Act.

V. Astronomy: Space Systems

(CKSci Unit 5, Astronomy: Space Systems)

A. INTRODUCTION TO ASTRONOMY

- The universe is all matter and energy.
  - Astronomical distance is measured in light years.
- Galaxies: huge collections of stars, dust, and gas
  - There are hundreds of billions of galaxies in the universe.
  - Our galaxy is the Milky Way
  - Andromeda Galaxy is near the Milky Way.
- Our solar system includes:
  - Sun: source of energy
  - The eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
  - Other objects in space: dwarf planets, asteroids, meteors, comets.
- The ways we know about our solar system and the universe include:
  - Earth-based observations
  - Space probes and space-based telescopes (such as the Hubble Space Telescope, Mars rovers)
  - Human space flights (Apollo 11, the first landing on the moon)

Review and extend learning from ***Grade 1 CKSci Unit 1, Sun, Moon, and Stars.***

B. EVIDENCE OF EARTH'S MOVEMENT

- Earth-moon-sun make a system.
- Earth rotates around its axis, resulting in:
  - Sun seems to move east to west across the sky
  - Stars seem to move in the night sky
  - Shadows change in length and direction throughout the day.
- Earth orbits the sun, resulting in:
  - Changing seasons
  - Seasonal changes in the length and direction of shadows
- The moon reflects light from the sun, providing evidence that the Earth, moon, and sun interact as a system, such as:
  - Phases of the moon: the moon's position relative to the Earth and sun determines how much of the sunlit side of moon we see from Earth.

C. STARS

- Stars give off their own light.
- Stars vary greatly in size and brightness.
- The perceived brightness of a star depends on:
  - size
  - energy (actual brightness)
  - distance from Earth, for example:
- The sun appears brighter than other stars because it is the closest star to Earth.
- Stars brighter and bigger than the sun appear dimmer and smaller because they are farther away.
- Constellations are recognizable patterns of stars.
- Some stars and constellations are only visible in certain seasons because of the position of Earth as it orbits the sun.

D. GRAVITY

- Gravity is a force that pulls objects towards each other.
- Gravity is a universal force.
- The gravitational force is an attraction force that two masses exert on each other, such as the Sun and Earth; Earth and Moon; Earth and all objects close to its mass.
- Earth's gravitational force is perceived as pulling "down."
- Gravity of the sun pulls on all the objects in our solar system, including the Earth, causing predictable orbits of the planets.
- The earth-moon-sun gravitational forces cause ocean tides on Earth.

Review and extend learning from ***Grade 3 CKSci Unit 1, Investigating Forces.***

VI. The Human Body

(CKSci Unit 6, Our Endocrine and Reproductive Systems)

A. CHANGES IN HUMAN ADOLESCENCE

- Puberty
  Glands and hormones (see below, Endocrine System), growth spurt, hair growth, breasts, voice change

B. THE ENDOCRINE SYSTEM

- The human body has two types of glands: duct glands (such as the salivary glands), and ductless glands, also known as endocrine glands.
- Endocrine glands secrete (give off) chemicals called hormones. Different hormones control different body processes.
- Pituitary gland: located at the bottom of the brain; secretes hormones that control other glands, and hormones that regulate growth
- Thyroid gland: located below the voice box; secretes a hormone that controls the rate at which the body burns and uses food
- Pancreas: both a duct and ductless gland; secretes a hormone called insulin that regulates how the body uses and stores sugar; when the pancreas does not produce enough insulin, a person has a sickness called diabetes (which can be controlled)

C. THE REPRODUCTIVE SYSTEM

- Females: ovaries, fallopian tubes, uterus, vagina, menstruation
- Males: testes, scrotum, penis, urethra, semen
- Sexual reproduction: intercourse, fertilization, zygote, implantation of zygote in the uterus, pregnancy, embryo, fetus, newborn

VII. Science Biographies

Teachers: Through reading aloud and activities, explore with children the stories and accomplishments of these scientists and engineers. This list of science biographies is by no means exhaustive. Other individuals can be incorporated into learning during a corresponding unit of study for this grade level, and should include:

- Democritus—ancient philosopher who argued that there are small indivisible bodies from which everything else is composed
  - Studied during CKSci Unit 1, Investigating Matter
- John Dalton—developed the theory of atomism
  - Studied during CKSci Unit 1, Investigating Matter
- Eugene Odum—pioneered studies on the ecology of ecosystems
  - Studied during CKSci Unit 2, Energy and Matter in Ecosystems
- Charles Elton—ecologist and expert in the role of invasive species
  - Studied during CKSci Unit 2, Energy and Matter in Ecosystems
- Beatrix Potter —author of The Tales of Peter Rabbit, was also a respected illustrator and naturalist specializing in mushrooms and other fungi
  - Studied during CKSci Unit 2, Energy and Matter in Ecosystems
- E.O. Wilson—a leading authority on the ecology of ants
  - Studied during CKSci Unit 2, Energy and Matter in Ecosystems
- Robert T. Paine—developed the concept of keystone species in ecosystems
  - Studied during CKSci Unit 2, Energy and Matter in Ecosystems
- Henry A. Gleason—known for his work in ecological succession
  - Studied during CKSci Unit 2, Energy and Matter in Ecosystems
- Boyan Slat—Dutch inventor, developed a system for removing floating garbage from the ocean surface
  - Studied during CKSci Unit 4, Protecting Earth's Resources

- Valentina Tereshkova—Russian cosmonaut who was the first woman in space
  - Studied during CKSci Unit 5, Astronomy: Space Systems
- Sally Ride—astronaut who was the first American woman in space
  - Studied during CKSci Unit 5, Astronomy: Space Systems
- Mae Jemison—physician and biologist who was the first African American woman astronaut
  - Studied during CKSci Unit 5, Astronomy: Space Systems
- Nancy Grace Roman—one of the first female executives at NASA, particularly known for her planning of the Hubble Space Telescope
  - Studied during CKSci Unit 5, Astronomy: Space Systems
- Katherine Johnson—African American mathematician who was critical to the success of NASA's early orbital missions
  - Studied during CKSci Unit 5, Astronomy: Space Systems

Additional recommended scientists

- Rufus Stokes—patented an air-purification device to reduce the gas and ash emissions of furnace and power plant smokestacks.
  - Could be added to CKSci Unit 4, Protecting Earth's Resources
- Copernicus—proposed the heliocentric model of the solar system.
  - Could be added to CKSci Unit 5, Astronomy: Space Systems
- Galileo—made advances that helped prove the Copernican model of the solar system
  - Could be added to CKSci Unit 5, Astronomy: Space Systems
- Isaac Newton—developed the universal law of gravitation.
  - Could be added to CKSci Unit 5, Astronomy: Space Systems
- Maria Mitchell—discovered "the comet of 1847" that is now known as Mitchell 1847VI.
  - Could be added to CKSci Unit 5, Astronomy: Space Systems
- Ellen Ochoa—first Hispanic woman to go to space and, later, to direct the Johnson Space Center.
  - Could be added to CKSci Unit 5, Astronomy: Space Systems