This document is a DRAFT of the Core Knowledge Foundation’s alignment comparing the Core Knowledge Sequence to the Next Generation Science Standards and their component three dimensions (i.e., the Disciplinary Core Ideas (DCIs), the Scientific Practices, and the Cross-cutting Concepts). It is highly recommended that educators use the National Research Council’s A Framework for K-12 Science Education in conjunction with this alignment to investigate and understand the intent and progression of these dimensions across the elementary grades. At the end of this document, readers will find hyperlinks directly to the DCI descriptors from the Framework, which can help to pinpoint why a topic is said to be aligned to that core idea.

“To develop a thorough understanding of scientific explanations of the world, students need sustained opportunities to work with and develop the underlying ideas and to appreciate those ideas’ interconnections over a period of years rather than weeks or months [1]. This sense of development has been conceptualized in the idea of learning progressions [1, 25, 26]. If mastery of a core idea in a science discipline is the ultimate educational destination, then well-designed learning progressions provide a map of the routes that can be taken to reach that destination.”

“[A]n important role of science education is not to teach “all the facts” but rather to prepare students with sufficient core knowledge [emphasis added] so that they can later acquire additional information on their own. An education focused on a limited set of ideas and practices in science and engineering should enable students to evaluate and select reliable sources of scientific information and allow them to continue their development well beyond their K-12 school years as science learners, users of scientific knowledge, and perhaps also as producers of such knowledge.”

A Framework for K-12 Science Education, National Academies Press (2012), Pages 26 and 31

Grade-Level Links:

KINDERGARTEN
GRADE 1
GRADE 2
GRADE 3
GRADE 4
GRADE 5
Guiding Questions for each Disciplinary Core Idea
## Kindergarten

### Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Plants and Plant Growth</td>
<td>Practices</td>
<td>at grade level</td>
</tr>
<tr>
<td>CKLA Listening &amp; Learning</td>
<td>Concepts</td>
<td>below or above grade level</td>
</tr>
<tr>
<td>DOMAIN #4 - &quot;Plants&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• What plants need to grow: sufficient warmth, light, and water</td>
<td>LS1.C. Also contributes to LS2.A, ESS2.E, &amp; ESS3.A</td>
<td><strong>K-LS1-1.</strong> Use observations to describe patterns of what plants and animals (including humans) need to survive.</td>
</tr>
<tr>
<td>• Basic parts of plants: seed, root, stem, branch, leaf</td>
<td>LS1.A. Also contributes to LS3.A &amp; LS3.B</td>
<td></td>
</tr>
<tr>
<td>• Plants make their own food.</td>
<td>LS1.C. Also contributes to LS2.A, LS2.B, PS3.D, &amp; ESS2.E</td>
<td><strong>K-ESS2-2.</strong> Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.</td>
</tr>
<tr>
<td>• Flowers and seeds: seeds as food for plants and animals (for example, rice, nuts, wheat, corn)</td>
<td>LS1.A, LS1.C, &amp; LS2.A. May also contribute to ESS2.E</td>
<td>Opportunities to foreshadow future learning: <strong>1-LS3-1.</strong> Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.</td>
</tr>
<tr>
<td>• Two kinds of plants: deciduous and evergreen</td>
<td>LS1.A. Opportunity to connect/foreshadow LS1.B. May...</td>
<td>AND <strong>1-LS1-1.</strong> Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.*</td>
</tr>
</tbody>
</table>

---

¹ Opportunities for integration

² Gap &/or Opportunity Analysis

The Kindergarten study of **Plants, Animals, and The Human Body** can be used together as an opportunity to meet the expectations set forth by the NGSS Kindergarten Topic of **Interdependent Relationships in Ecosystems**. Particularly, the content guideline of **Farming** and its associated sub-guidelines can be used to investigate how humans and other animals interact with their environment to survive.

---

**K-LS1-1.** Use observations to describe patterns of what plants and animals (including humans) need to survive.

**K-ESS2-2.** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

**1-LS3-1.** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

**1-LS1-1.** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.*
<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>Core Knowledge Sequence: Science Content Guidelines</th>
<th>Aligned Disiplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aligned Disiplinary Core Ideas (DCIs)</td>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
<td>below or above grade level</td>
</tr>
<tr>
<td>CKLA Listening &amp; Learning</td>
<td>DOMAIN #5 - &quot;Farms&quot;</td>
<td>ESS3.A. May also be applied to ESS2.E, ESS3.C &amp; ETS2.B</td>
<td>Developing and Using Models</td>
<td>Systems &amp; System Models</td>
<td>K-ESS3-1. Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.</td>
</tr>
<tr>
<td>• Farming</td>
<td><strong>Farming</strong></td>
<td>ESS3.A. May also be applied to ESS2.E, ESS3.C &amp; ETS2.B</td>
<td>Developing and Using Models</td>
<td>Systems &amp; System Models</td>
<td></td>
</tr>
<tr>
<td>How some food comes from farms as crops</td>
<td>LS1.C &amp; ESS3.A</td>
<td>Obtaining, Evaluating, and Communicating Information</td>
<td>Cause and Effect</td>
<td>K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.*</td>
<td></td>
</tr>
<tr>
<td>How farmers must take special care to protect their crops from weeds and pests</td>
<td>Contributes to LS2.A. May also be applied to ESS2.E, ESS3.C and/or ETS1.B</td>
<td>Asking Questions and Defining Problems</td>
<td>Structure and Function</td>
<td>Opportunities for application with engineering design: K-2-ETS1-1, -2 and/or -3</td>
<td></td>
</tr>
<tr>
<td>How crops are harvested, kept fresh, packaged, and transported for people to...</td>
<td>ESS3.A &amp; ETS2.B</td>
<td>Developing and Using Models</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Opportunities for integration: Practices, Concepts, at grade level, below or above grade level. ² Gap &/or Opportunity Analysis: The study of "how farmers take special care to protect crops" is also a significant opportunity to begin addressing the K-2 Engineering Design standards such as K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
## II. Animals and Their Needs

**CKLA Listening & Learning**

**DOMAIN #5 - "Farms"**

- **Animals, like plants, need food, water, and space to live and grow.**
  - **LS1.C.** Also contributes to **LS2.A, ESS2.E, & ESS3.A**
  - **Opportunity for application:**
    - **K-LS1-1.** Use observations to describe patterns of what plants and animals (including humans) need to survive.
  - **Analyzing and Interpreting Data**
  - **Patterns**

- **Plants make their own food, but animals get food from eating plants or other living things.**
  - **Engaging in Argument from Evidence**
  - **Systems & System Models**
  - **K-ESS2-2.** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

- **Offspring are very much (but not exactly) like their parents.**
  - **LS3.A & LS3.B.** Also applies **LS1.A.**
  - **Constructing Explanations & Designing Solutions**
  - **Patterns**
  - **1-LS3-1.** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

- **Most animal babies need to be fed and cared for by their parents; human babies are especially in need of care when young.**
  - **LS1.B**
  - **Developing and Using Models**
  - **Systems & System Models**
  - **Opportunity for application:**
    - **K-ESS3-1.** Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.
  - **1-LS1-2.** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

- **Pets have special needs and must be cared for by their owners.**
  - **LS1.B**

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*Kindergarten teachers may also find it beneficial to work with Grade 1 teachers re: the future studies of Habitats as they work to prepare students for K-ESS3-1.*
### III. The Human Body

**CKLA Listening & Learning DOMAIN #2 - "The Five Senses"

<table>
<thead>
<tr>
<th>Practices</th>
<th>Concepts</th>
<th>at grade level</th>
<th>below or above grade level</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS1.A &amp; LS1.D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS1.A &amp; LS1.D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS1.A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS1.A &amp; LS1.D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Opportunities for application:**

- The opportunities at left relate to addressing K-ESS2-2 and K-ESS3-1 as noted above.
- 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.*
- K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

**The study of the Five Senses directly supports the progression of the Disciplinary Core Ideas of LS1.D (Information Processing) and PS4.C (Information Technologies & Instrumentation) which are found in grades 1, 4, and MS of the NGSS.**

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**IV. Introduction to Magnetism**

<table>
<thead>
<tr>
<th>Opportunities for integration⁴:</th>
<th>Next Generation Science Standards:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Grade-level Links**

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Draft
### Kindergarten

#### Core Knowledge Sequence:

**Science Content Guidelines**

**Aligned Disciplinary Core Ideas (DCIs)**

<table>
<thead>
<tr>
<th>Practices</th>
<th>Concepts</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1.A</td>
<td>Planning and Carrying Out Investigations</td>
<td>Cause and Effect</td>
<td>Opportunities for application &amp; extension: K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.</td>
<td>Opportunity to foreshadow future learning: 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*</td>
</tr>
<tr>
<td>PS1.A</td>
<td>Analyzing and Interpreting Data</td>
<td>Patterns</td>
<td>K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*</td>
<td></td>
</tr>
<tr>
<td>PS1.A</td>
<td>Planning and Carrying Out Investigations</td>
<td>Patterns</td>
<td>2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.</td>
<td>magnets and magnetism as the beginning guidepost for introducing Pushes and Pulls to kindergarteners relative to the Disciplinary Core Ideas of PS2.A and PS3.C. It is important, however, to recognize and plan for the Assessment Boundary defined by the NGSS standard of K-PS2-1, which states &quot;Assessment [will not] include non-contact pushes or pulls such as those produced by magnets.&quot; It is highly recommended that teachers continue to introduce magnetism in Kindergarten relative to everyday uses and for classification. The skills of pattern identification and classification directly support standards in the Common Core Math expectations as well as later studies of classification / categorization of materials and organisms.</td>
</tr>
</tbody>
</table>

#### V. Seasons and Weather

**CKLA Listening & Learning**

**DOMAIN #8 - "Seasons & Weather"**

**Grade-level Links**

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## Kindergarten

### Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Core Disciplinary Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
</table>
| **The four seasons**          | **ESS1.B.** May also be connected to the beginnings of ESS1.C "Some events on Earth occur in cycles."
|                               | Analyzing and Interpreting Data | Patterns                          |                                |
| **Characteristic local weather patterns during the different seasons** | **ESS1.B & ESS2.D**              | K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time. |                                |
| **The sun: source of light and warmth** | **ESS1.A. Also directly supports later study of ideas such as LS2.B & PS3.B.** | K-PS3-1. Make observations to determine the effect of sunlight on Earth’s surface. | 1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year. |
| **Daily weather changes –**   | **ESS2.D**                      |                                   |                                |
| **Temperature: thermometers are used to measure temperature** | **PS1.A, ESS2.D, & ETS2.A**      | Cause and Effect                  |                                |
| **Clouds**                    | **ESS2.C & ESS2.D**             | Opportunity for application: K-PS3-2. Use tools and materials provided to design and build a structure that will reduce the warming effect of sunlight on Earth’s surface.* |                                |
| **Rainfall: how the condition of the ground varies with rainfall; rainbows** | **ESS2.C & ESS2.D**             | Cause and Effect                  | 2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid. |

¹ Note: Practices and Concepts as appropriate for grade level.

² Note: Gap & Opportunity Analysis is provided for reference.
## Kindergarten

### Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thunderstorms: lightning and thunder, hail, safety during thunderstorms</strong></td>
<td><strong>ESS3.B</strong></td>
<td>and respond to, severe weather.*</td>
</tr>
<tr>
<td><strong>Snow and snowflakes, blizzard</strong></td>
<td><strong>ESS2.C &amp; ESS2.D. May also be applied to ESS3.B.</strong></td>
<td><strong>Interdependence of Science, Engineering, and Technology</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td><strong>Influence of Eng., Tech., &amp; Sci. on Society and the Natural World</strong></td>
</tr>
</tbody>
</table>

### VI. Taking Care of the Earth

**CKLA Listening & Learning DOMAIN #11 - "Taking Care of the Earth"**

- Conservation: Some natural resources are limited, so people must be careful not to use too much of them (example: logging and reforestation).

<table>
<thead>
<tr>
<th><strong>ESS3.A &amp; ESS3.C</strong></th>
<th><strong>Cause &amp; Effect</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td><strong>K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.</strong>*</td>
</tr>
</tbody>
</table>

- Practical measures for conserving energy and resources (for example, turning off unnecessary lights, tightly turning off faucets, etc.)

<table>
<thead>
<tr>
<th><strong>ESS3.C</strong></th>
<th>****</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td>****</td>
</tr>
</tbody>
</table>
### Kindergarten

#### Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Some materials can be recycled (for example, aluminum, glass, paper).</td>
<td>PS1.A &amp; ESS3.A</td>
<td>Energy &amp; Matter</td>
<td>Opportunities to extend/connect previous learning: (review standards associated with the Plants &amp; Animals Domains; for example K-ESS2-2 &amp; K-ESS3-1)</td>
</tr>
<tr>
<td>• Pollution (for example, littering, smog, water pollution) can be harmful, but if people are careful they can help reduce pollution.</td>
<td>ESS2.E &amp; ESS3.C</td>
<td>Systems &amp; System Models</td>
<td>Opportunity to foreshadow future learning: 2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.</td>
</tr>
</tbody>
</table>

#### VII. Science Biographies

**George Washington Carver** (botanist/discovered ways to keep soil rich)

- **Opportunity to connect** ETS1.A, ETS1.B, and/or ETS2.B
- **Planning and Carrying Out Investigations**
- **Cause & Effect**

Opportunities for application:

(Review the standards associated with the Plants Domain above)

**Jane Goodall** (studied chimpanzees)

- **Opportunity to connect** LS2.D and/or ETS2.B
- **Engaging in Argument from Evidence**
- **Cause & Effect**

(Review the standards associated with the Animals Domain above)

**Wilbur and Orville Wright** (made first airplane)

- **Planning and Carrying Out Investigations**
- **Cause & Effect** K-2-ETS1-1, 2 & 3; K-PS2-1 & 2

(Review the standards associated with the Animals Domain above)

Opportunity to foreshadow future learning: 3-LS2-1. Construct an argument that some animals form groups that help members survive.
# GRADE 1

## Core Knowledge Sequence: Science Content Guidelines

### Aligned Disciplinary Core Ideas (DCIs)

<table>
<thead>
<tr>
<th>Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis</th>
</tr>
</thead>
</table>
| I. Living Things and Their Environments<br><br>**CKLA Listening & Learning<br>DOMAIN #8 - "Animals & Habitats"**<br><br>A. HABITATS<br><br>• Living things live in environments to which they are particularly suited.<br><br>• Specific habitats and what lives there, for example:<br><br>  - Forest [oak trees, squirrels, raccoons, snails, mice]<br>  - Meadow and prairie [wildflowers, grasses, prairie dogs]<br>  - Underground [fungi, moles, worms]<br>  - Desert [cactus, lizard, scorpion]<br><br>  - Water [fish, oysters, starfish]<br><br>• The food chain: a way of picturing the relationships between living things<br><br>  - LS2.B. Also supports future study of PS3.D<br><br>Animals: big animals eat little ones, big animals die and are eaten by little ones.<br><br>• Developing and Using Models<br><br>  - LS4.D. May also connect to LS4.C<br><br>  - LS4.D. May also connect to LS4.C & ESS2.C<br><br>Draft
### GRADE 1

#### Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. OCEANS AND UNDERSEA LIFE</td>
<td>ESS2.C</td>
<td>Cause and Effect</td>
<td></td>
</tr>
<tr>
<td>• Most of the earth is covered with water.</td>
<td>ESS2.C. May also be connected to ESS2.B re: maps.</td>
<td>Developing and Using Models</td>
<td></td>
</tr>
<tr>
<td>• Locate oceans: Pacific, Atlantic, Indian, Arctic.</td>
<td>ESS2.A &amp; ESS2.C</td>
<td>Patterns</td>
<td></td>
</tr>
<tr>
<td>• Oceans are salt water (unlike fresh water rivers and lakes).</td>
<td>ESS2.C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Coast, shore, waves, tides (high and low)</td>
<td>ESS2.A &amp; ESS2.C</td>
<td>Constructing Explanations and Designing Solutions</td>
<td></td>
</tr>
<tr>
<td>• Currents, the Gulf Stream</td>
<td>ESS2.C. Also contributes to future study of ESS2.D.</td>
<td>Influence of Eng., Tech., and Sci. on Society and the Natural World</td>
<td></td>
</tr>
<tr>
<td>• Landscape of the ocean floor: mountain peaks and deep valleys (trenches)</td>
<td>ESS2.B</td>
<td>Analyze and Interpret Data</td>
<td></td>
</tr>
<tr>
<td>• Diversity of ocean life: from organisms too small for the eye to see (plankton), to giant whales</td>
<td>LS4.D</td>
<td>Planning and Carrying Out Investigations</td>
<td></td>
</tr>
</tbody>
</table>

¹: Opportunities for integration

²: Gap &/or Opportunity Analysis

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**Grade-level Links**

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| Grade 1 |
|---------------------|---------------------|---------------------|---------------------|
| **Core Knowledge Sequence: Science Content Guidelines** | **Aligned Disciplinary Core Ideas (DCIs)** | **Opportunities for integration** | **Next Generation Science Standards:** |
| **C. ENVIRONMENTAL CHANGE AND HABITAT DESTRUCTION** | **ESS3.C. May also be connected to LS2.C & LS4.D.** | **Obtaining, Evaluating, and Communicating Information** | **Gap &/or Opportunity Analysis** |
| • Dangers to ocean life (for example, overfishing, pollution, oil spills) | **ESS3.C.** | **Cause and Effect** | Opportunities for review and application: K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment. |
| **D. SPECIAL CLASSIFICATIONS OF ANIMALS** | **LS2.C. May also be connected to ESS2.E & ESS3.C.** | **Engaging in Argument from Evidence** | K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. |
| • Environments are constantly changing, and this can sometimes pose dangers to specific habitats, for example: | **ESS3.C.** | **Systems & System Models** | 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment. |
| Effects of population and development | | **Obtaining, Evaluating, and Communicating Information** | |
| • Rainforest clearing, pollution, litter | | **Constructing Explanations and Designing Solutions** | |
| **Grade-level Links** | | **Structure and Function** | |
| | | **Influence of Eng., Tech., and Sci. on Society and the Natural World** | |
| | | | |
| Teachers should be sure to review page 220 ( & 222) of the NRC's Framework for an example of a performance task aligned to this CK content. (See "By the End of Grade 2" columns found on these pages.)
### GRADE 1

**Core Knowledge Sequence:** Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs):**

- Extinct animals (for example, dinosaurs)

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<tr>
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<td>Concepts</td>
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<tr>
<td>Analyze and Interpret Data</td>
<td>Scale, Proportion, &amp; Quantity</td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### II. The Human Body

**CKLA Listening & Learning DOMAIN #2 - “The Human Body”**

**A. BODY SYSTEMS**
- Skeletal system: skeleton, bones, skull
- Muscular system: muscles
- Digestive system: mouth, stomach
- Circulatory system: heart and blood
- Nervous system: brain, nerves

**B. GERMS, DISEASES, AND PREVENTING ILLNESS**
- Taking care of your body: exercise, cleanliness, healthy foods, rest

**Grade 1 teachers are encouraged to work with Kindergarten teachers to review and expand on their students’ experiences in the Animals domain as well as in The Five Senses domain from the previous grade.**

*Grade 1 teachers are encouraged to work with Kindergarten teachers to review and expand on their students’ experiences in the Animals domain as well as in The Five Senses domain from the previous grade.*
<table>
<thead>
<tr>
<th>GRADE 1</th>
<th>Core Knowledge Sequence: Science Content Guidelines</th>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration(^1):</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
<td>below or above grade level</td>
</tr>
<tr>
<td>• Vaccinations</td>
<td></td>
<td>Analyzing &amp; Interpreting Data</td>
<td>(See opportunities identified on the previous page.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III. Matter</td>
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</tr>
<tr>
<td>• Basic concept of atoms (Please note that, as stated by the CK Sequence, the goal here is simply to introduce concepts and language that, over time, will be more precisely defined. This guideline may also be used to explore the subcomponent of PS1.A which states, by the end of grade 2, students will understand that &quot;[a] great variety of objects can be built up from a small set of pieces (e.g., blocks, construction sets).&quot; [Pg. 108 from the NRC Framework]</td>
<td>PS1.A</td>
<td>Constructing Explanations and Designing Solutions</td>
<td>Energy and Matter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Names and common examples of three states of matter:</td>
<td></td>
<td>Planning and Carrying Out Investigations</td>
<td>Patterns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>solid (for example, wood, rocks)</td>
<td>PS1.A</td>
<td>Engaging in Argument from Evidence</td>
<td>Cause &amp; Effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>liquid (for example, water)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gas (for example, air, steam)</td>
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</tbody>
</table>

It is highly recommended that teachers read the progression of PS1.A across the grades in the NRC’s Framework to determine how this opportunity for application may be effectively introduced in their classrooms. Reviewing this progression may help to address/avoid potential misconceptions re: our abilities to reassemble atoms into new objects.

2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

Teachers should be sure to review page 224 (§ 226-228) of the NRC’s Framework for an example of a performance task aligned to this CK content. (See "By the End of Grade 2" columns)

2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and cannot.
| GRADE 1 |
|-----------------|-----------------|-----------------|-----------------|
| **Core Knowledge Sequence:** Science Content Guidelines | **Aligned Disciplinary Core Ideas (DCIs)** | **Opportunities for integration¹:** | **Next Generation Science Standards:** |
| *Water as an example of changing states of matter of a single substance* | **Concepts** | **at grade level** | **below or above grade level** |
| **IV. Properties of Matter:** Measurement | **Practices** | **Patterns** | **2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.** |
| • Units of measurement: | | | |
| **Length:** centimeter, inch, foot | PS1.A | **Analyzing and Interpreting Data** | **Oppportunities for application:** |
| **Volume:** gallon, quart | | **Cause & Effect** | **2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** |
| • Temperature: degrees Fahrenheit | | **Influence of Eng., Tech., & Sci. on Society & the Natural World** | |
| **V. Introduction to Electricity** | | | |

---

¹ **Opportunities for integration:**

² **Gap &/or Opportunity Analysis:**

³ Note that the Assessment Boundary of 2-PS1-2 states that only length will be used as a quantitative measurement to demonstrate achievement of this standard. Other properties to discuss/explore while determining a material's suitability include comparative measures of "strength, flexibility, hardness, texture, and absorbency."
<table>
<thead>
<tr>
<th>Grade: Grade 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Knowledge Sequence:</strong> Science Content Guidelines</td>
</tr>
<tr>
<td><strong>Opportunities for integration:</strong> Practices</td>
</tr>
<tr>
<td><strong>Next Generation Science Standards:</strong> at grade level</td>
</tr>
<tr>
<td><strong>Gap &amp;/or Opportunity Analysis</strong></td>
</tr>
</tbody>
</table>

1. **Static electricity**
   - PS2.B
   - Asking Questions & Defining Problems
   - Cause & Effect
   - **Next Generation Science Standards:** 3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

2. **Basic parts of simple electric circuits (for example, batteries, wire, bulb or buzzer, switch)**
   - Constructing Explanations and Designing Solutions
   - Influence of Eng., Tech., & Sci. on Society & the Natural World
   - Energy & Matter
   - **Gap &/or Opportunity Analysis:**
     - **Next Generation Science Standards:** 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
     - Note that this domain directly supports the later grades such as the Grade 4 domain of Electricity, which aligns well with and can be used to support the future standards of 2-PS1-1, 3-PS2-3, and 4-PS3-4.

3. **Conductive and nonconductive materials**
   - PS1.A
   - Opportunity to connect PS3.B.
   - Planning and Carrying Out Investigations
   - Patterns
   - **Next Generation Science Standards:** 2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

4. **Safety rules for electricity** (for example, never put your finger, or anything metallic, in an electrical outlet; never touch a switch or electrical appliance when your hands are wet or when you’re in the bathtub; never put your finger in a lamp socket; etc.)
   - Opportunity to connect ETS2.B
   - **Next Generation Science Standards:** Influence of Eng., Tech., & Sci. on Society & the Natural World
### Grade 1 Core Knowledge Sequence: Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs)**

#### Opportunities for integration:

**Practices**  | **Concepts**  | **Next Generation Science Standards:**  | **Gap &/or Opportunity Analysis**
---|---|---|---

#### Vl. Astronomy: Introduction to the Solar System

**CKLA Listening & Learning DOMAIN #6 - "Astronomy"**

- **Sun:** source of energy, light, heat  
  - ESS1.A & PS4.B. Also directly supports progression of PS3.B and LS ideas such as LS2.B  
  - Analyzing and interpreting Data  
  - Patterns  
  - 1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.

- **Moon:** phases of the moon (full, half, crescent, new)  
  - ESS1.B  
  - Planning and carrying out investigations  
  - Cause and Effect  
  - Opportunities for application: 1-PS4-3. Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.

- **The eight planets (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune)**  
  - ESS1.B  
  - Constructing explanations and designing solutions  
  - 1-PS4-2. Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.

- **Stars**  
  - Constellations, Big Dipper  
  - ESS1.A  
  - The sun is a star.

- **Earth and its place in the solar system —**  
  - The earth moves around the sun; the sun does not  
  - ESS1.B  
  - Planning and carrying out investigations  
  - Patterns  
  - 1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the...

*Teachers Note: This domain may also be a good opportunity to review and/or discuss the designs students created in Kindergarten to meet K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.*

*Teachers Note: The clarification statement of 1-PS4-2 states, "illumination could be from an external light source or by an object giving off its own light."

*To maintain a domain immersion approach that fosters language and vocabulary development,...*
## GRADE 1

### Core Knowledge Sequence: Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs)**

<table>
<thead>
<tr>
<th>Opportunities for integration(^1):</th>
<th>Next Generation Science Standards:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practices</td>
<td>at grade level</td>
</tr>
<tr>
<td>Concepts</td>
<td>below or above grade level</td>
</tr>
</tbody>
</table>

### Gap &/or Opportunity Analysis\(^2\)

**Grade-level Links**

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The earth revolves (spins); one revolution takes one day (24 hours). The horizon helps us understand where day meets night.

Sunrise and sunset

When it is day where you are, it is night for people on the opposite side of the earth.

**ESS1.B**

### VII. The Earth

**CKLA Listening & Learning DOMAIN #7 - "History of the Earth"**

**A. GEOGRAPHICAL FEATURES OF THE EARTH'S SURFACE**

- The shape of the earth, the horizon
  - **Contributes to ESS1.B**
- Oceans and continents
  - **Contributes to ESS2.B**
- North Pole and South Pole, Equator
  - **ESS1.B**

### Developing and Using Models

**Patterns**

**2-ESS2-2.** Develop a model to represent the shapes and kinds of land and bodies of water in an area. *(This is also an opportunity to foreshadow future learning re: Geography.)*

- **2-ESS2-2** is rooted in the Disciplinary Core Idea that "Maps show where things are located. One can map the shapes and kinds of land and water in any area." To meet this standard, one might map the locations of volcanoes or possibly where deposits of certain rocks and minerals are found.
### GRADE 1

**Core Knowledge Sequence:**
Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs):**

<table>
<thead>
<tr>
<th>B. WHAT'S INSIDE THE EARTH</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Inside the earth –</td>
<td>Constructing Explanations and Designing solutions</td>
<td>Stability &amp; Change</td>
<td>Opportunity to foreshadow future learning: 2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.</td>
</tr>
<tr>
<td>Layers: crust, mantle, core</td>
<td>Analyze and Interpret Data</td>
<td>Patterns</td>
<td>4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.</td>
</tr>
<tr>
<td>High temperatures</td>
<td></td>
<td></td>
<td>Opportunity to foreshadow future learning: 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.</td>
</tr>
<tr>
<td>• Volcanoes and geysers</td>
<td></td>
<td></td>
<td>An early introduction to <em>What's Inside the Earth</em> will lay a significant foundation for the future study of Geology, Plate Tectonics, and the evidence for the large-scale, very long processes that take place on Earth. For example, this domain directly supports the progression of learning that will be assessed in Grade 4 and in Middle School (e.g., 4-ESS2-2 and MS-ESS2-1 and -2.)</td>
</tr>
<tr>
<td>• Rocks and minerals –</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Formation and characteristics of different kinds of rocks: metamorphic, igneous, sedimentary</td>
<td></td>
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<tr>
<td>Important minerals in the earth (such as quartz, gold, sulfur, coal, diamond, iron ore)</td>
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</tr>
<tr>
<td>• Rocks and minerals –</td>
<td></td>
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<td>Formation and characteristics of different kinds of rocks: metamorphic, igneous, sedimentary</td>
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<tr>
<td>Important minerals in the earth (such as quartz, gold, sulfur, coal, diamond, iron ore)</td>
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</tbody>
</table>

**VIII. Science Biographies**

Rachel Carson (got people to stop using DDT) | ESS3.C. Opportunity to connect ETS1.B and/or ETS2.B. | Obtaining, Evaluating, and Communicating Information | K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.*
<table>
<thead>
<tr>
<th>Grade 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Knowledge Sequence:</strong> Science Content Guidelines</td>
</tr>
<tr>
<td><strong>Grade 1</strong></td>
</tr>
<tr>
<td><strong>Aligned Disciplinary Core Ideas (DCIs)</strong></td>
</tr>
<tr>
<td><strong>RE: the biography of Rachel Carson:</strong> Systems &amp; System Models</td>
</tr>
<tr>
<td><strong>ETS2.B</strong></td>
</tr>
<tr>
<td><strong>Thomas Edison (invented an electric light bulb) - Electricity Domain</strong></td>
</tr>
<tr>
<td><strong>Edward Jenner (found a way to stop smallpox)</strong></td>
</tr>
<tr>
<td><strong>Note:</strong> Both vaccination &amp; pasteurization are explicit examples found in the Framework’s discussion of how scientific investigations and the applications of...</td>
</tr>
<tr>
<td>Opportunities for integration¹:</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Practices</td>
</tr>
<tr>
<td><strong>Louis Pasteur (made milk safe to drink)</strong></td>
</tr>
</tbody>
</table>

science can differ from engineering [pgs. 46-48]. The Framework writers recognize that investigations such as these "were undertaken for practical purposes and resulted in important new technologies." Recognizing this, it makes sense to incorporate these scientists within a curriculum to address the core idea of ETS2.B Influence of Engineering, Technology, and Science on Society and the Natural World.
### GRADE 2

<table>
<thead>
<tr>
<th>Core Knowledge Sequence: Science Content Guidelines</th>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration: Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
<th>below or above grade level</th>
<th>Gap &amp;/or Opportunity Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Cycles in Nature</td>
<td></td>
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<tr>
<td>CKLA Listening &amp; Learning</td>
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</tr>
<tr>
<td>DOMAIN #6 - &quot;Cycles in Nature&quot;</td>
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<tr>
<td>A. SEASONAL CYCLES</td>
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</tr>
<tr>
<td>• The four seasons and earth’s orbit around the sun (one year)</td>
<td>ESS1.B</td>
<td>Analyzing &amp; Interpreting Data</td>
<td>Patterns</td>
<td></td>
<td></td>
<td>Opportunity to extend Grade 1 and foreshadow future learning: 5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.</td>
</tr>
<tr>
<td>• Seasons and life processes</td>
<td></td>
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<td></td>
<td>Note: The NGSS outline that assessment of exactly what causes the seasons (the tilt of Earth’s axis and the differential intensity of sunlight on different areas of Earth across the year) is to occur by the end of Middle School. As is true of many core ideas found in Core Knowledge, the CK Sequence may be used to provide early and repeated exposure to core ideas and scientific language so that a student’s understanding of the concept is constructed over time and with intentional opportunities for application, refinement, and reinforcement.</td>
</tr>
<tr>
<td>Summer: growth</td>
<td></td>
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<tr>
<td>Fall: ripening, migration</td>
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<tr>
<td>Winter: plant dormancy, animal hibernation</td>
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<tr>
<td>B. LIFE CYCLES</td>
<td></td>
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</tr>
<tr>
<td>• The life cycle: birth, growth, reproduction, death</td>
<td>LS1.B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth,</td>
</tr>
<tr>
<td>• Reproduction in plants and animals:</td>
<td></td>
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</tbody>
</table>

**Grade-level Links**
### Grade 2

#### Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
<td>below or above grade level</td>
</tr>
<tr>
<td>From seed to seed with a plant</td>
<td>LS1.B. Opportunity to connect LS2.A.</td>
<td>Planning &amp; Conducting Investigations</td>
<td>Cause &amp; Effect</td>
</tr>
<tr>
<td>From egg to egg with a chicken</td>
<td>LS1.B</td>
<td>Developing &amp; Using Models</td>
<td>Patterns</td>
</tr>
<tr>
<td>From frog to frog</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From butterfly to butterfly: Metamorphosis (see below: Insects)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>C. THE WATER CYCLE</td>
<td></td>
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</tr>
<tr>
<td>• Most of the earth’s surface is covered by water.</td>
<td>ESS2.C</td>
<td>Obtaining, Evaluating, &amp; Communicating Information</td>
<td>Patterns</td>
</tr>
<tr>
<td>• The water cycle</td>
<td>ESS2.C &amp; PS1.A</td>
<td>Engaging in Argument from Evidence</td>
<td>Cause &amp; Effect</td>
</tr>
<tr>
<td>Evaporation and condensation</td>
<td>ESS2.C &amp; PS1.A</td>
<td>Developing &amp; Using Models</td>
<td>Energy &amp; Matter</td>
</tr>
<tr>
<td>Water vapor in the air, humidity</td>
<td>ESS2.C &amp; PS1.A</td>
<td>Analyzing &amp; Interpreting Data</td>
<td>Patterns</td>
</tr>
<tr>
<td>Clouds: cirrus, cumulus, stratus</td>
<td>ESS2.C &amp; PS1.A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Opportunities for integration: Please note that these opportunities are aligned with the Next Generation Science Standards.² Gap &/or Opportunity Analysis: This section highlights areas where there may be gaps or opportunities for further development in the existing curriculum.
| GRADE 2 |
|---|---|---|---|---|
| Core Knowledge Sequence: Science Content Guidelines | Aligned Disciplinary Core Ideas (DCIs) | Opportunities for integration¹: | Next Generation Science Standards: |
| | foreshadow ESS2.D | | |
| | | | Opportunity for application: 2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.* |
| II. Insects | CKLA Listening & Learning DOMAIN #8 - "Insects" |
| | ESS3.A. Also contributes to the progression of ESS2.E, LS2.A, & LS4.D | Constructing Explanations & Designing Solutions | Cause & Effect |
| | | | Opportunity to foreshadow future learning: 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. |
| | Helpful: pollination; products like honey, beeswax, and silk; eat harmful insects | Developing & Using Models | Structure & Function |
| | ESS3.A & LS2.A. Also contributes to the progression of LS4.D | | 2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.* |

GRADE-LEVEL LINKS

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It is important to note that the core idea of ESS3.A, as described by the Framework [pg. 191], includes examples of how humans rely on the living biosphere as well as minerals and fossil fuels. Be sure to consider this when preparing students to meet the NGSS endpoints set at Grade 4 and MS.
### GRADE 2

**Core Knowledge Sequence: Science Content Guidelines**
**Aligned Disciplinary Core Ideas (DCIs)**

<table>
<thead>
<tr>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
</tr>
</tbody>
</table>

#### Harmful:
- Destroy crops, trees, wooden buildings, clothes; carry disease; bite or sting

- **Contributes to the progression of ESS2.E.**

- **Opportunity to connect ESS3.C.**

#### Engaging in Argument from Evidence

#### Stability & Change

#### Next Generation Science Standards:

- **Opportunity to foreshadow future learning:** HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.

#### Gap &/or Opportunity Analysis²

Note that ESS2.E is a good example of how the Framework specifies broad "by the end of grade 2" endpoints. For example, ESS2.E states, "Plants and animals (including humans) depend on the land, water, and air to live and grow. They in turn can change their environment (e.g., the shape of land, the flow of water)." This Core Knowledge Insects domain directly supports this understanding. The NGSS, however, only assess ESS2.E for K-2 at the Kindergarten level and not again until Grade 4, where the standard 4-ESS2-1 focuses on erosion and weathering by water, ice, wind, or vegetation. Teachers will need to be sure to build their students’ understanding of all component ideas found within ESS2.E to sufficiently support later learning in MS and HS.
### GRADE 2

<table>
<thead>
<tr>
<th>Core Knowledge Sequence: Science Content Guidelines</th>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
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<td></td>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
<td>below or above grade level</td>
</tr>
<tr>
<td>• Distinguishing characteristics: (II. Insects continued)</td>
<td>Constructing Explanations &amp; Designing Solutions</td>
<td>Structure &amp; Function</td>
<td></td>
<td>Opportunity to connect and extend previous learning: 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* (Also see 1-LS3-1.)</td>
</tr>
<tr>
<td>Exoskeleton, chitin</td>
<td>Influence of Eng., Tech., &amp; Sci. on Society &amp; the Natural World</td>
<td>Engaging in Argument from Evidence</td>
<td>Systems &amp; System Models</td>
<td>4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.</td>
</tr>
<tr>
<td>Six legs and three body parts: head, thorax and abdomen</td>
<td>LS1.A. Opportunity to apply LS3.A</td>
<td>Analyzing &amp; Interpreting Data</td>
<td>Patterns</td>
<td>Opportunity to foreshadow future learning: 3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.</td>
</tr>
<tr>
<td>Most but not all insects have wings.</td>
<td>LS1.B</td>
<td>Developing &amp; Using Models</td>
<td>Patterns</td>
<td>3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.</td>
</tr>
<tr>
<td>• Life cycles: metamorphosis –</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Opportunities for integration
² Gap &/or Opportunity Analysis
<table>
<thead>
<tr>
<th>GRADE 2</th>
<th>Grade-level Links</th>
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</thead>
<tbody>
<tr>
<td><strong>GRADE 2</strong></td>
<td><strong>Core Knowledge Sequence: Science Content Guidelines</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Aligned Disciplinary Core Ideas (DCIs)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Opportunities for integration</strong>:</td>
</tr>
<tr>
<td></td>
<td><strong>Practices</strong></td>
</tr>
<tr>
<td></td>
<td><strong>at grade level</strong></td>
</tr>
<tr>
<td>Some insects look like miniature adults when born from eggs, and they molt to grow (examples: grasshopper, cricket).</td>
<td>LS1.B. Opportunity to apply LS3.A</td>
</tr>
<tr>
<td>Some insects go through distinct stages of egg, larva, pupa, adult (examples: butterflies, ants).</td>
<td></td>
</tr>
<tr>
<td>• Social insects:</td>
<td>LS2.D</td>
</tr>
<tr>
<td>Most insects live solitary lives, but some are social (such as ants, honeybees, termites, wasps).</td>
<td></td>
</tr>
<tr>
<td>Ants: colonies</td>
<td></td>
</tr>
<tr>
<td>Honeybees: workers, drones, queen</td>
<td></td>
</tr>
</tbody>
</table>

III. The Human Body

CKLA Listening & Learning DOMAIN #10 - "The Human
## GRADE 2

### Core Knowledge Sequence: Science Content Guidelines

#### Aligned Disciplinary Core Ideas (DCIs)

<table>
<thead>
<tr>
<th>Body”</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. CELLS</strong></td>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
</tr>
<tr>
<td>- All living things are made up of cells, too small to be seen without a microscope.</td>
<td><strong>Engaging in Argument from Evidence</strong></td>
<td>Systems &amp; System Models</td>
<td>4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.</td>
</tr>
<tr>
<td><strong>LS1.A.</strong> Also contributes to LS1.C.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cells make up tissues.</td>
<td></td>
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</tr>
<tr>
<td><strong>Tissues make up organs.</strong></td>
<td><strong>Developing &amp; Using Models</strong></td>
<td>Energy &amp; Matter</td>
<td>MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. Also MS-LS1-6.</td>
</tr>
<tr>
<td><strong>LS1.A.</strong> Also contributes to LS1.C.</td>
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<tr>
<td>Organs work in systems.</td>
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</tr>
<tr>
<td><strong>B. THE DIGESTIVE AND EXCRETORY SYSTEMS</strong></td>
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</tbody>
</table>
## GRADE 2

### Core Knowledge Sequence: Science Content Guidelines

#### Aligned Disciplinary Core Ideas (DCIs)

<table>
<thead>
<tr>
<th>Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opportunities for integration¹:</strong></td>
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<tr>
<td><strong>Systems &amp; System Models</strong></td>
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<tr>
<td><strong>Developing &amp; Using Models</strong></td>
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<tr>
<td><strong>Engaging in Argument from Evidence</strong></td>
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</tbody>
</table>

### Grade 2 Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Core Ideas</th>
<th>Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Opportunities for integration¹:</strong></td>
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<tr>
<td><strong>Systems &amp; System Models</strong></td>
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<tr>
<td><strong>Developing &amp; Using Models</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Engaging in Argument from Evidence</strong></td>
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</tbody>
</table>

#### Key Concepts for Grade 2

- **Salivary glands, taste buds**
  - **LS1.A.** Also contributes to **LS1.D.**

- **Teeth: incisors, bicuspidis, molars**

- **Esophagus, stomach, liver, small intestine, large intestine**
  - **LS1.A**

- **Kidneys, urine, bladder, urethra, anus, appendix**

### C. TAKING CARE OF YOUR BODY: A HEALTHY DIET

- **The “food pyramid”**
  - Opportunity to connect **LS1.C** & **ETS2.B**

- **Vitamins and minerals**

### IV. Magnetism

---

¹ These guidelines offer an excellent opportunity to connect the core ideas re: food, matter, and energy to the applications of science and its effects on society (ETS2.B).
### GRADE 2

#### Core Knowledge Sequence: Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs)**

<table>
<thead>
<tr>
<th>Grade-level Links</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Knowledge Sequence: Science Content Guidelines</td>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
</tr>
</tbody>
</table>

**Opportunities for integration¹:**

- **PS2.B**
  - Magnetism demonstrates that there are forces we cannot see that act upon objects.

**Next Generation Science Standards:**

- **3-PS2-3.** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

**Gap &/or Opportunity Analysis²:**

Teachers: It may be useful to note the NGSS clarification statement re: **3-PS2-3:** "examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force."

- **PS1.A**
  - Lodestones: naturally occurring magnets

**Opportunity for application:**

- **2-PS1-2.** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*

---

¹ Opportunities for integration refer to ways in which science content can be integrated with other disciplines.

² Gap &/or Opportunity Analysis provides insights into how Next Generation Science Standards can be addressed or expanded upon.
### GRADE 2

<table>
<thead>
<tr>
<th>Core Knowledge Sequence: Science Content Guidelines</th>
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<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
<th>below or above grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Magnetic poles: north-seeking and south-seeking poles</td>
<td>PS2.B</td>
<td>Interdependence of Science, Engineering, &amp; Technology</td>
<td></td>
<td></td>
<td></td>
<td>The NGSS group the performance expectations related to PS2.A and PS2.B into a single topic called Forces and Interactions. Core Knowledge teachers have the opportunity to supplement their Magnetism domain in Grade 2 (as well as the Electricity domain in Gr1 and the Astronomy domain in Gr3) to introduce the early core ideas of PS2.A in a similar context as outlined and grouped by the NGSS topics.</td>
</tr>
<tr>
<td>- Magnetic field (strongest at the poles)</td>
<td></td>
<td>Asking Questions &amp; Defining... Problems</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- Law of magnetic attraction: unlike poles attract, like poles repel</td>
<td>PS2.B. Also contributes to the late progression of ESS2.A</td>
<td></td>
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<tr>
<td>- The earth behaves as if it were a huge magnet: north and south magnetic poles (near, but not the same as, geographic North Pole and South Pole)</td>
<td>ETS2.B</td>
<td></td>
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</tr>
<tr>
<td>- Orienteering: use of a magnetized needle in a compass, which will always point to the north</td>
<td></td>
<td>Influence of Eng., Tech., &amp; Sci. on Society &amp; the Natural World</td>
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</table>

### V. Simple Machines

| - Simple machines: | | | | | | |
| lever | Opportunity to apply and connect PS3.D, ETS1.A, ETS1.B, and/or ETS1.C | Planning & Carrying Out Investigations | Structure & Function | Energy & Matter | Opportunities to foreshadow future learning: 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. | Simple machines, such as the wheel-and-axle and gears, are explicit examples referenced by the Framework as part of the early elementary progression of the Structure & Function cross-cutting concept (pgs. 96-98). Core Knowledge teachers may also use this domain as an opportunity to... |
| pulley | | | | | | |
| wheel-and-axle – | | | | | | |
| gears: wheels with teeth and notches, how gears work, and familiar uses (for example, in bicycles) | | | | | | |
### GRADE 2

<table>
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<td></td>
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<td>Concepts</td>
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| inclined plane |          |          |          |               |                           |                              |
| wedge          |          |          |          |               |                           |                              |
| screw          |          |          |          |               |                           |                              |

• Friction, and ways to reduce friction (lubricants, rollers, etc.)

Opportunity to apply ETS1.A, ETS1.B, and/or ETS1.C

**Goal:**

Exploring and solidifying the second grade endpoints of the engineering design core ideas (ETS1.A-C).

**Activities:**

1. **PS3.3.** Ask questions and predict outcomes about the changes in energy that occur when objects collide.

2. **PS3.4.** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*

---

VI. Science Biographies
Anton van Leeuwenhoek
(invented the microscope) -
The Human Body Domain

<table>
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<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis(^2)</th>
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<tr>
<td></td>
<td></td>
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<td>Concepts</td>
<td>at grade level</td>
<td>below or above grade level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PS4.C, ETS2.A, &amp; ETS2.B. Also opportunity to apply ETS1.A, ETS1.B, &amp;/or ETS1.C</td>
<td>Developing &amp; Using Models</td>
<td>Cause &amp; Effect</td>
<td>Opportunities to foreshadow future learning: 4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.</td>
</tr>
</tbody>
</table>

Grade-level Links
| GRADE 2 |
|------------------|------------------|------------------|------------------|
| **Core Knowledge Sequence:** Science Content Guidelines | **Aligned Disciplinary Core Ideas (DCIs)** | **Opportunities for integration**: Practices | **Next Generation Science Standards**: at grade level | **Gap &/or Opportunity Analysis** |
| **Science Content Guidelines** | **ETS2.B. Also opportunity to apply ETS1.A, ETS1.B, &/or ETS1.C** | **Constructing Explanations & Designing Solutions** | **Energy & Matter** | **4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*** |
| **Simple Machines** | **ETS2.A & ETS2.B. Also opportunity to apply ETS1.A &/or ETS1.B** | **Asking Questions & Defining Problems** | **Cause & Effect** | **The Framework's discussion of the concept Cause and Effect: Mechanism and Prediction (pg. 87), includes the example of understanding disease transmission and the design of preventative measures, treatments, and cures. For early elementary students, the progression of this concept (pgs. 88-89) includes questions such as "How did that happen?" and "Why did that happen?"** |
| **Influence of Eng., Tech., & Sci. on Society & the Natural World** | **ETS2.A & ETS2.B. Also opportunity to apply ETS1.A &/or ETS1.B** | **Obtaining, Evaluating, & Communicating Information** | **Interdependence of Science, Engineering, & Technology** | **Influence of Eng., Tech., & Sci. on Society & the Natural World** |
| **Simple Machines** | **ETS2.A & ETS2.B. Also opportunity to apply ETS1.A &/or ETS1.B** | **Constructing Explanations & Designing Solutions** | **Influence of Eng., Tech., & Sci. on Society & the Natural World** | **Influence of Eng., Tech., & Sci. on Society & the Natural World** |
## GRADE 3

### Core Knowledge Sequence: Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs)**

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<th>Next Generation Science Standards:</th>
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<tbody>
<tr>
<td>Practices</td>
<td>at grade level</td>
</tr>
<tr>
<td>Concepts</td>
<td>below or above grade level</td>
</tr>
</tbody>
</table>

### I. Introduction to Classification of Animals

**CKLA Listening & Learning DOMAIN #2 - "Classification of Animals"

- Scientists classify animals according to the characteristics they share, for example:
  - Cold-blooded or warm-blooded
  - Vertebrates (have backbones and internal skeletons) or invertebrates (do not have backbones or internal skeletons)
- Different classes of vertebrates:
  - Fish: aquatic animals, breathe through gills, cold-blooded, most have scales, most develop from eggs that the female lays outside her body
  - Amphibians: live part of their lives in water and part on land, have gills when young, later develop lungs, cold-blooded, usually have moist skin
  - Reptiles: hatch from eggs, cold-blooded, have dry, thick, scaly skin

#### 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.


#### 4-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

- LS1.A & LS1.B. Analyzing & Interpreting Data

- LS1.B. Engaging in Argument from Evidence

- LS1.C. Developing & Using Models

- LS1.D. Patterns

### Gap &/or Opportunity Analysis²

Teachers: Note that this CK domain aligns directly to the Framework's progression for the Patterns concept (pgs. 85-87), which states that, "[E]lementary students...can investigate the characteristics that allow classification of animal types (e.g., mammals, fish, insects), of plants (e.g., trees, shrubs, grasses), or of materials (e.g., wood, rock, metal, plastic). These classifications will become more detailed and closer to scientific classifications in the upper elementary grades..." (e.g., Classifying Living Things is studied again in CK Grade 5 where this domain is studied alongside the biography of Carl Linnaeus.)
## Grade 3

### Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration:</th>
<th>Next Generation Science Standards:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds: warm-blooded, most can fly, have feathers and wings, most build nests, hatch from eggs, most baby birds must be fed by parents and cared for until they can survive on their own (though some, like baby chickens and quail, can search for food a few hours after hatching)</td>
<td><strong>LS1.A &amp; LS1.B.</strong> Opportunity to connect to LS3.A &amp; LS3.B.</td>
<td><strong>Opportunity for application:</strong> 3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.</td>
</tr>
<tr>
<td>Mammals: warm-blooded, have hair on their bodies, parents care for the young, females produce milk for their babies, breathe through lungs, most are terrestrial (live on land) though some are aquatic</td>
<td><strong>Developing &amp; Using Models</strong></td>
<td><strong>Systems &amp; System Models</strong></td>
</tr>
</tbody>
</table>

### II. The Human Body

**CKLA Listening & Learning DOMAIN #3 - "The Human Body"**

#### 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

**LS1.A**

**4-LS1-1.** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
### GRADE 3

<table>
<thead>
<tr>
<th>Core Knowledge Sequence: Science Content Guidelines</th>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration(^1): Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
<th>below or above grade level</th>
<th>Gap &amp;/or Opportunity Analysis(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C. THE NERVOUS SYSTEM</strong></td>
<td>LS1.A</td>
<td></td>
<td></td>
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<td></td>
<td>4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.</td>
</tr>
<tr>
<td>• Spinal column, vertebrae</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>• Joints</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Ribs, rib cage, sternum</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>• Scapula (shoulder blades), pelvis, tibia, fibula</td>
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<td></td>
</tr>
<tr>
<td>• Broken bones, x-rays</td>
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<tr>
<td><strong>D. VISION: HOW THE EYE WORKS</strong></td>
<td>LS1.A &amp; LS1.D</td>
<td>Developing &amp; Using Models</td>
<td></td>
<td></td>
<td></td>
<td>4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.</td>
</tr>
<tr>
<td>• Parts of the eye: cornea, iris and pupil, lens, retina</td>
<td></td>
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<tr>
<td>• Optic nerve</td>
<td>LS1.D</td>
<td>Cause &amp; Effect</td>
<td></td>
<td></td>
<td></td>
<td>Regarding Hearing: How the Ear Works, be sure to also refer to 4-LS1-1 and 4-LS1-2 above.</td>
</tr>
<tr>
<td>• Farsighted and nearsighted</td>
<td></td>
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<tr>
<td><strong>E. HEARING: HOW THE EAR WORKS</strong></td>
<td>PS4.A</td>
<td>Planning &amp; Carrying Out Investigations</td>
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<tr>
<td>• Sound as vibration</td>
<td></td>
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</tr>
<tr>
<td>• Outer ear, ear canal</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Eardrum</td>
<td>LS1.D</td>
<td></td>
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</tr>
<tr>
<td>• Three tiny bones (hammer, anvil, and stirrup) pass vibrations to the cochlea</td>
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<tr>
<td>• Auditory nerve</td>
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</tr>
</tbody>
</table>

\(^1\) Opportunities for integration include next generation science standards, disciplinary core ideas, and practices.

\(^2\) Gap &/or Opportunity Analysis includes how the standards fit within the grade level and the potential for integrating content across disciplines.

---

**Grade-level Links**

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## III. Light and Optics

### CKLA Listening & Learning

**DOMAIN #5 - "Light & Sound"**

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<tr>
<th>Opportunity for integration¹: Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Below or above grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>The speed of light: light travels at an amazingly high speed.</td>
<td>PS4.B</td>
<td><strong>Cause and Effect</strong></td>
<td><strong>1-PS4-2.</strong> Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.</td>
<td>Teachers: It is recommended that grades 1, 3, &amp; 4 work together to define how all of these teams will address the core ideas of PS4.A and PS4.B relative to their grade-level performance expectations. (Also, relative to the progression of these ideas in the Framework; see pgs. 132 &amp; 134.) At left, the Grade 1 standards have been listed, but teachers should also investigate the NGSS expectations of Grade 4 (Waves; see 4-PS4-2 above re: Vision), which are directly supported by this Grade 3 domain as well.</td>
</tr>
<tr>
<td>Light travels in straight lines (as can be demonstrated by forming shadows).</td>
<td>PS4.B</td>
<td><strong>Planning and Carrying Out Investigations</strong></td>
<td><strong>1-PS4-3.</strong> Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.</td>
<td>Opportunity for application: 1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.*</td>
</tr>
<tr>
<td>Transparent and opaque objects</td>
<td>PS1.A &amp; PS4.B</td>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>Influence of Engineering, Technology, and Science on Society and the Natural World</strong></td>
<td>Teachers: Be sure to read the recommendation immediately above, which also applies this domain re: Sound. These domains also support a key aspect of PS3.A,</td>
</tr>
<tr>
<td>Mirrors: plane, concave, convex</td>
<td>PS4.B</td>
<td>Uses of mirrors in telescopes and some microscopes</td>
<td>ETS2.A</td>
<td></td>
</tr>
<tr>
<td>The spectrum: use a prism to demonstrate that white light is made up of a spectrum of colors.</td>
<td>PS4.B</td>
<td><strong>Planning and Carrying Out Investigations</strong></td>
<td><strong>Cause and Effect</strong></td>
<td></td>
</tr>
<tr>
<td>Lenses can be used for magnifying and bending light (as in magnifying glass, microscope, camera, telescope, binoculars).</td>
<td>PS4.C, ESS1.A, &amp; ETS2.A</td>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>Influence of Engineering, Technology, and Science on Society and the Natural World</strong></td>
<td></td>
</tr>
</tbody>
</table>

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¹ Opportunities for integration: Practices - PS4.A & PS3.A

² Gap &/or Opportunity Analysis: Teachers should consider the grade-level performance expectations for Grades 1, 3, & 4 when planning and conducting investigations related to light and optics. Grades 1, 3, & 4 should work together to define how all of these teams will address the core ideas of PS4.A and PS4.B relative to their grade-level performance expectations. (Also, relative to the progression of these ideas in the Framework; see pgs. 132 & 134.) At left, the Grade 1 standards have been listed, but teachers should also investigate the NGSS expectations of Grade 4 (Waves; see 4-PS4-2 above re: Vision), which are directly supported by this Grade 3 domain as well.

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**Grade-level Links**
<table>
<thead>
<tr>
<th>Core Knowledge Sequence: Science Content Guidelines</th>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration: Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Next Generation Science Standards: below or above grade level</th>
<th>Gap &amp;/or Opportunity Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sounds travel through solids, liquids, and gases.</td>
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<td>4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.</td>
<td>Definitions of Energy (e.g., 4-PS3-2 re: sound and light are the transfer of energy over distance), which is a topic found beginning in Grade 4 of the NGSS.</td>
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<tr>
<td>• Sound waves are much slower than light waves.</td>
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<tr>
<td>• Qualities of sound</td>
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<td>PS4.A</td>
<td>Patterns</td>
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<tr>
<td>Pitch: high or low, faster vibrations = higher pitch, slower vibrations = lower pitch</td>
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<tr>
<td>Intensity: loudness and quietness</td>
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<tr>
<td>• Human voice</td>
<td></td>
<td>PS4.A &amp; LS1.A</td>
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<tr>
<td>Larynx (voice box)</td>
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<td>Vibrating vocal cords: longer, thicker vocal cords create lower, deeper voices</td>
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<tr>
<td>• Sound and how the human ear works</td>
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<td>PS4.A &amp; LS1.D</td>
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<tr>
<td>• Protecting your hearing</td>
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<td>ETS2.B</td>
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<tr>
<td>V. Ecology</td>
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<tr>
<td>CKLA Listening &amp; Learning</td>
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<tr>
<td>DOMAIN #11 - &quot;Ecology&quot;</td>
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<tr>
<th>GRADE 3</th>
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</thead>
<tbody>
<tr>
<td>Core Knowledge Sequence: Science Content Guidelines</td>
</tr>
<tr>
<td>• The concept of a “balance of nature” (constantly changing, not a static condition)</td>
</tr>
<tr>
<td>Ecosystems: how they can be affected by changes in environment (for example, rainfall, food supply, etc.), and by man-made changes</td>
</tr>
<tr>
<td>• Man-made threats to the environment —</td>
</tr>
<tr>
<td>Air pollution: emissions, smog</td>
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<tr>
<td>Water pollution: industrial waste, run-off from farming</td>
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<tr>
<td>• Measures we can take to protect the environment (for example, conservation, recycling)</td>
</tr>
<tr>
<td>VI. Astronomy</td>
</tr>
</tbody>
</table>

¹ Opportunities for integration include practices and concepts that can be integrated into the curriculum. ² Gap &/or Opportunity Analysis refers to the alignment of the Core Knowledge guidelines with the Next Generation Science Standards.
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<th>Next Generation Science Standards:</th>
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<td></td>
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<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
</tr>
<tr>
<td>• The “Big Bang” as one theory</td>
<td></td>
<td>ESS1.A</td>
<td>Developing &amp; Using Models</td>
<td>Systems &amp; System Models</td>
</tr>
<tr>
<td>• The universe: an extent almost beyond imagining</td>
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<tr>
<td>• Galaxies: Milky Way and Andromeda</td>
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<tr>
<td>• Our solar system</td>
<td>ESS1.B</td>
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</tr>
<tr>
<td>• Sun: source of energy (heat and light)</td>
<td>ESS1.A &amp; PS3.B. Also directly supports later study of LS ideas such as LS2.B</td>
<td>Planning &amp; Carrying Out Investigations</td>
<td>Energy &amp; Matter</td>
<td>4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.</td>
</tr>
</tbody>
</table>

Grade-level Links

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## GRADE 3

### Core Knowledge Sequence:
Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs)**

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<th>Practices</th>
<th>Concepts</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
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</thead>
<tbody>
<tr>
<td><strong>ESS1.B</strong></td>
<td><strong>Analyzing &amp; Interpreting Data</strong></td>
<td><strong>Patterns</strong></td>
<td><strong>Next Generation Science Standards:</strong></td>
<td><strong>Gap &amp;/or Opportunity Analysis</strong></td>
</tr>
<tr>
<td><strong>Developing &amp; Using Models</strong></td>
<td><strong>Systems &amp; System Models</strong></td>
<td><strong>Developing &amp; Using Models</strong></td>
<td><strong>Developing &amp; Using Models</strong></td>
<td><strong>Developing &amp; Using Models</strong></td>
</tr>
<tr>
<td><strong>5-ESS1-2.</strong> Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.</td>
<td><strong>MS-ESS1-1.</strong> Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.</td>
<td><strong>5-PS2-1.</strong> Support an argument that the gravitational force exerted by Earth on objects is directed down.</td>
<td><strong>MS-ESS1-2.</strong> Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.</td>
<td><strong>MS-ESS1-3.</strong> Analyze and interpret data to determine scale properties of objects in the solar system.</td>
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<tr>
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<td><strong>MS-ESS1-1.</strong> Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.</td>
<td><strong>5-PS2-1.</strong> Support an argument that the gravitational force exerted by Earth on objects is directed down.</td>
<td><strong>MS-ESS1-2.</strong> Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.</td>
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<td><strong>MS-ESS1-3.</strong> Analyze and interpret data to determine scale properties of objects in the solar system.</td>
</tr>
</tbody>
</table>

### Grade-level Links

[ Grade-level Links ]

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1. **Core Knowledge Sequence:** Science Content Guidelines
2. **Aligned Disciplinary Core Ideas (DCIs):**
   - **ESS1.B:** The eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune (Note: In 2006, Pluto was classified as a dwarf planet.)
   - **PS2.B:** Planetary motion: orbit and rotation
   - **Analyzing & Interpreting Data:** How day and night on earth are caused by the earth’s rotation
   - **Developing & Using Models:** Sunrise in the east and sunset in the west
   - **Analyzing & Interpreting Data:** How the seasons are caused by the earth’s orbit around the sun, tilt of the earth’s axis
   - **Engaging in Argument from Evidence:** Gravity, gravitational pull
   - **Engaging in Argument from Evidence:** Gravitational pull of the moon (and to a lesser degree, the sun) causes ocean tides on earth
   - **Engaging in Argument from Evidence:** Gravitational pull of “black holes” prevents even light from escaping
   - **Analyzing & Interpreting Data:** Asteroids, meteors (“shooting stars”), comets, Halley’s Comet

3. **Next Generation Science Standards:**
   - **5-ESS1-2:** Analyze and interpret data to determine scale properties of objects in the solar system.

4. **Gap &/or Opportunity Analysis:**
   - **MS-ESS1-2:** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
   - **5-PS2-1:** Support an argument that the gravitational force exerted by Earth on objects is directed down.
   - **MS-ESS1-3:** Analyze and interpret data to determine scale properties of objects in the solar system.
<table>
<thead>
<tr>
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<th>Concepts</th>
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<th>Next Generation Science Standards: below or above grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>• How an eclipse happens</td>
<td>ESS1.B</td>
<td>Developing &amp; Using Models</td>
<td>Patterns</td>
<td>MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.</td>
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</tr>
<tr>
<td>• Stars and constellations</td>
<td>ESS1.A</td>
<td>Analyzing &amp; Interpreting Data</td>
<td>Patterns</td>
<td>S-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.</td>
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<tr>
<td>• Orienteering (finding your way) by using North Star, Big Dipper</td>
<td>ETS2.B</td>
<td>Influence of Eng., Tech., and Sci. on Society and the Natural World</td>
<td>Interdependence of Science, Engineering, &amp; Technology</td>
<td></td>
<td>Note: The Framework specifies that re: PS4.C, and by the end of grade 5, students should understand that, &quot;lenses can be used to make eyeglasses, telescopes, or microscopes in order to extend what can be seen. The design of such instruments is based on understanding how the path of light bends at the surface of a lens.&quot;</td>
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<tr>
<td>Observation through telescopes</td>
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<td>Recessions and satellites: from unmanned to manned flights</td>
<td>ETS2.A &amp; ETS2.B</td>
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<td>GRADE 3</td>
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<tr>
<td><strong>Gap &amp;/or Opportunity Analysis</strong></td>
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<tr>
<td>Apollo 11, first landing on the moon: “One small step for a man, one giant leap for mankind.”</td>
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<td>ETS2.A &amp; ETS2.B</td>
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<tr>
<td>Influence of Eng., Tech., and Sci. on Society and the Natural World</td>
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<tr>
<td><strong>VII. Science Biographies</strong></td>
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<tr>
<td>Alexander Graham Bell (invented the telephone)</td>
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<td>Patterns</td>
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<tr>
<td>Constructing Explanations &amp; Designing Solutions</td>
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<tr>
<td>Opportunity to foreshadow future learning: 4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.*</td>
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<tr>
<td><strong>Copernicus (had new sun-centered idea about the solar system) - Astronomy Domain</strong></td>
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<tr>
<td>ESS1.B</td>
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<tr>
<td>Analyzing &amp; Interpreting Data</td>
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<td>5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.</td>
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<tr>
<td><strong>Mae Jemison (astronaut and medical pioneer)</strong></td>
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<tr>
<td>Also refer to the standards aligned to the Core Knowledge Light &amp; Sound domain found above.</td>
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<tr>
<td>Jemison’s career does not directly connect to a DCI, however her biography is important as she is a prominent female, African American scientist and doctor.</td>
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<td><strong>John Muir (conservationist who helped create many national parks)</strong></td>
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<td>LS4.D &amp; ESS3.C</td>
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<tr>
<td>Opportunity for application: 3-LS4-4. Make a claim about the merit of a solution to...</td>
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<td>Grade-level Links</td>
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<td>Core Knowledge Sequence: Science Content Guidelines</td>
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<tr>
<td>Opportunities for integration(^1): Practices</td>
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<tr>
<td>Next Generation Science Standards: at grade level</td>
<td>below or above grade level</td>
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<tr>
<td>Gap &amp;/or Opportunity Analysis(^2)</td>
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</tbody>
</table>

| Systems & System Models |
| a problem caused when the environment changes and the types of plants and animals that live there may change. |
## GRADE 4

### Core Knowledge Sequence: Science Content Guidelines

**Core Knowledge Sequence:**

- **Science Content Guidelines**

**Aligned Disciplinary Core Ideas (DCIs)**

### Opportunities for integration:

- **Practices**
- **Concepts**

### Next Generation Science Standards:

- **at grade level**
- **below or above grade level**

### Gap &/or Opportunity Analysis

#### I. The Human Body

**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**

**B. THE RESPIRATORY SYSTEM**

- Process of taking in oxygen and getting rid of carbon dioxide

---

**Gap &/or Opportunity Analysis**

- **See Grade 3 of the CK Sequence re: 4-PS4-2. "Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen."**

- **The Grade 3 Core Knowledge topics of Light & Optics and Sound are also well aligned to 4-LS1-2.**
### GRADE 4

#### Core Knowledge Sequence: Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs)**

- Nose, throat, voice box, trachea (windpipe)
- Lungs, bronchi, bronchial tubes, diaphragm, ribs, alveoli (air sacs)
- Smoking: damage to lung tissue, lung cancer

#### Opportunities for integration

**Practices**

- Developing and Using Models

**Concepts**

- Scale, Proportion, and Quantity

#### Next Generation Science Standards:

**at grade level**

- 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

**Below or above grade level**

#### Gap &/or Opportunity Analysis

- The NGSS spiral the topic of Matter and Its Interactions within the standards of grades 2, 5, and MS. The CK Sequence, however, returns to and expands upon the concepts of matter, properties, and interactions in grades K, 1, 2, 4, 5, 6, 7, and 8. This ‘tighter’ spiral of CK continuously builds rich background knowledge with regards to chemistry and matter, similar to the description found in Chapter 9 of the NRC’s Framework (specifically pgs. 230-238).

---

**II. Chemistry: Basic Terms and Concepts**

**A. ATOMS**

- All matter is made up of particles too small for the eye to see, called atoms.
- Scientists have developed models of atoms; while these models have changed over time as scientists make new discoveries, the models help us imagine what we cannot see.
- Atoms are made up of even tinier particles: protons, neutrons, electrons.
- The concept of electrical charge:
  - Positive charge (+): proton
  - Negative charge (-): electron
  - Neutral (neither positive nor negative): neutron
  - “Unlike charges attract, like charges repel” (relate to magnetic attraction and repulsion)
### GRADE 4

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<tr>
<td><strong>B. PROPERTIES OF MATTER</strong></td>
<td></td>
<td>Planning and Carrying Out Investigations</td>
<td>Scale, Proportion, and Quantity</td>
<td></td>
<td></td>
<td>Note: The clarification statement and assessment boundary of this standard (5-PS1-3) both state that density is not intended as an identifiable property and distinguishing mass versus weight will not be included in assessment in this grade band.</td>
</tr>
<tr>
<td>• Mass: the amount of matter in an object, similar to weight</td>
<td>PS1.A</td>
<td></td>
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</tr>
<tr>
<td>• Volume: the amount of space a thing fills</td>
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</tr>
<tr>
<td>• Density: how much matter is packed into the space an object fills</td>
<td>PS1.A. Also contributes to late study of PS4.B</td>
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<tr>
<td>• Vacuum: the absence of matter</td>
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<tr>
<td><strong>C. ELEMENTS</strong></td>
<td></td>
<td>Developing and Using Models</td>
<td>Scale, Proportion, and Quantity</td>
<td></td>
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<tr>
<td>• Elements are the basic kinds of matter, of which there are a little more than one hundred.</td>
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<tr>
<td>There are many different kinds of atoms, but an element has only one kind of atom.</td>
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<tr>
<td>Familiar elements, such as gold, copper, aluminum, oxygen, iron</td>
<td>PS1.A</td>
<td></td>
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<tr>
<td>Most things are made up of a combination of elements.</td>
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</tr>
<tr>
<td><strong>D. SOLUTIONS</strong></td>
<td></td>
<td>Using Mathematics and Computational Thinking</td>
<td>Scale, Proportion, and Quantity</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>• A solution is formed when a substance (the solute) is dissolved in another substance (the solvent), such as when sugar or salt is dissolved in water; the dissolved substance is present in the solution...</td>
<td>PS1.A</td>
<td></td>
<td></td>
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</table>

¹ Opportunities for integration
² Gap &/or Opportunity Analysis
### GRADE 4

#### Core Knowledge Sequence: Science Content Guidelines

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<tbody>
<tr>
<td>even though you cannot see it.</td>
<td>Planning and Carrying Out Investigations</td>
<td>Cause and Effect</td>
<td>5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.</td>
</tr>
</tbody>
</table>

#### III. Electricity

- **PS1.B**

- Concentration and saturation (as demonstrated through simple experiments with crystallization) **Contributes to late study of PS1.A & PS1.B**

- **PS2.B**
  - Electricity as the charge of electrons: Also linked to PS1.A & PS1.B.
  - Static electricity: PS2.B
  - Electric current: PS2.B & PS3.A

- **PS3.A**
  - Electric circuits, and experiments with simple circuits (battery, wire, light bulb, filament, switch, fuse): Opportunity to connect PS3.D
  - Closed circuit, open circuit, short circuit: Opportunity to connect PS3.A & ETS1.A

- **ETS2.A & B**
  - Electromagnets: how they work and common uses: Also the late study of PS2.B.

---

¹ Opportunities for integration with other grade levels or concepts.
² Notes and analysis for specific standards.
### GRADE 4

**Core Knowledge Sequence:** Science Content Guidelines

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<tr>
<td>• Using electricity safely</td>
<td>ETS2.B</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>IV. Geology: The Earth and Its Changes</strong></td>
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</tr>
<tr>
<td><strong>Gr4 CKLA DOMAIN - &quot;Geology&quot;</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>A. THE EARTH’S LAYERS</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>• Crust, mantle, core (outer core and inner core)</td>
<td>ESS2.A. Also contributes to ESS2.B and ESS1.C.</td>
<td>Analyzing and Interpreting Data</td>
<td>Patterns</td>
<td>4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth’s features.</td>
<td></td>
</tr>
<tr>
<td>• Movement of crustal plates</td>
<td>ESS2.B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Earthquakes</td>
<td>ESS1.C &amp; ESS2.B</td>
<td>Developing and Using Models</td>
<td>Patterns</td>
<td>4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.</td>
<td></td>
</tr>
<tr>
<td>Faults, San Andreas fault</td>
<td>ESS2.B</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Measuring intensity: seismograph and Richter scale</td>
<td>PS4.A</td>
<td>Constructing Explanations and Designing Solutions</td>
<td>Patterns</td>
<td>Opportunities for application: Earthquakes - 4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.</td>
<td></td>
</tr>
<tr>
<td>• Volcanoes</td>
<td>ESS2.B &amp; ESS3.B</td>
<td></td>
<td></td>
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**Grade-level Links**

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<tbody>
<tr>
<td>Active, dormant, or extinct volcanoes</td>
<td>Opportunity to connect ESS2.A &amp; ESS2.B</td>
<td>Science on Society and the Natural World</td>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
</tr>
<tr>
<td>Famous volcanoes: Vesuvius, Krakatoa, Mount St. Helens</td>
<td>Opportunity to apply ESS2.B and ESS1.C.</td>
<td>Constructing Explanations and Designing Solutions</td>
<td></td>
<td>Energy and Matter</td>
<td>Opportunities for application: Volcanoes, Lava and Lava Flow. 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.</td>
</tr>
<tr>
<td>• Hot springs and geysers: Old Faithful (in Yellowstone National Park)</td>
<td>ESS2.A</td>
<td></td>
<td></td>
<td>Energy and Matter</td>
<td>Tsunamis, lava flow, etc. 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.</td>
</tr>
<tr>
<td>• Theories of how the continents and oceans were formed: Pangaea and continental drift</td>
<td>ESS2.B</td>
<td>Opportunity to connect ESS1.C.</td>
<td>Asking Questions and Defining Problems</td>
<td>Energy and Matter</td>
<td></td>
</tr>
<tr>
<td>B. HOW MOUNTAINS ARE FORMED</td>
<td>Volcanic mountains, folded mountains, fault-block mountains, dome-shaped mountains</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Undersea mountain peaks and trenches (Mariana Trench)</td>
<td>ESS2.A</td>
<td>Opportunity to connect ESS1.C.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. ROCKS</td>
<td>Formation and characteristics of metamorphic, igneous, and sedimentary rock</td>
<td>ESS2.A, ESS1.C, ESS2.A &amp; ESS2.C.</td>
<td>Constructing Explanations and Designing Solutions</td>
<td>Patterns</td>
<td>4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.</td>
</tr>
<tr>
<td>D. WEATHERING AND EROSION</td>
<td>Physical and chemical weathering</td>
<td>ESS2.C</td>
<td>Planning and Carrying Out Investigations</td>
<td>Cause and Effect</td>
<td>4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of...</td>
</tr>
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### GRADE 4

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</thead>
<tbody>
<tr>
<td>V. Meteorology</td>
<td></td>
<td></td>
<td></td>
<td>Note: It is important to remember that CK students have opportunities to study Seasons and Weather and to prepare for the Grade 3 standards at left through the science domains of Grades K (Seasons &amp; Weather), Gr1 (Astronomy), Gr2 (Cycles in Nature), and Gr3 (Astronomy). (See also the guidelines for Geography for further opportunities to meet the Grade 3 standards on/before grade level.) Grade 4 teachers also have the opportunity to leverage previously learned content re: natural resources, such as Taking Care of the Earth (Kinder) and Ecology (Gr3), in order to fully meet 4-ESS3-1. “Obtain and combine information to describe that energy and fuels are derived from natural resources and their...</td>
</tr>
<tr>
<td>• The formation of soil: topsoil, subsoil, bedrock</td>
<td>ESS2.A &amp; ESS2.E</td>
<td></td>
<td>weathering or the rate of erosion by water, ice, wind, or vegetation.</td>
<td></td>
</tr>
<tr>
<td>• The water cycle (review from grade 2): evaporation, condensation, precipitation</td>
<td>ESS2.C &amp; PS1.A</td>
<td>Planning and Carrying Out Investigations</td>
<td>Opportunities for application: 4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. (See also “Weather and climate” on the next page.)</td>
<td></td>
</tr>
<tr>
<td>• Clouds: cirrus, stratus, cumulus (review from grade 2)</td>
<td>ESS2.C &amp; PS1.A</td>
<td>Cause and Effect</td>
<td>Opportunities for application: 4-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.</td>
<td></td>
</tr>
<tr>
<td>• The atmosphere</td>
<td>ESS2.A</td>
<td>Opportunity to connect/foreshadow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Troposphere, stratosphere, mesosphere, thermosphere, exosphere</td>
<td>ESS2.D</td>
<td></td>
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<tr>
<td>How the sun and the earth heat the atmosphere</td>
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<td></td>
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</tr>
<tr>
<td>• Air movement: wind direction and speed, prevailing winds, air pressure, low and high pressure, air masses</td>
<td>ESS2.A Also contributes to later study of connections between ESS2.C, ESS2.D, &amp; ESS3.B</td>
<td>Obtaining, Evaluating, and Communicating Information</td>
<td>Opportunities for application: 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.</td>
<td></td>
</tr>
<tr>
<td>• Cold and warm fronts: thunderheads, lightning and electric charge, thunder, tornadoes, hurricanes</td>
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</tr>
<tr>
<td>• Forecasting the weather: barometers (relation between changes in atmospheric pressure and weather), weather maps, weather...</td>
<td>ESS2.D Also contributes to later study of ESS2.C.</td>
<td></td>
<td>3-ESS2-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.</td>
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<tr>
<td>• Weather: current conditions, weather patterns,</td>
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<tr>
<td>• Climate: characteristics of Earth's climate,</td>
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<td></td>
</tr>
<tr>
<td>• The water cycle (review from grade 2): evaporation, condensation, precipitation</td>
<td>ESS2.C &amp; PS1.A</td>
<td>Cause and Effect</td>
<td>Opportunities for application: 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.</td>
<td></td>
</tr>
</tbody>
</table>

¹ Opportunities for integration

² Gap &/or Opportunity Analysis
### Grade 4

#### Core Knowledge Sequence: Science Content Guidelines

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<th>Next Generation Science Standards: at grade level</th>
<th>Gap &amp;/or Opportunity Analysis&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>satellites</td>
<td></td>
<td></td>
<td></td>
<td><em>uses affect the environment.</em></td>
</tr>
<tr>
<td>• Weather and climate: “weather” refers to daily changes in temperature, rainfall, sunshine, etc., while “climate” refers to trends that are longer than the cycle of the seasons.</td>
<td>ESS2.D</td>
<td>Patterns</td>
<td>Weather Satellites - 4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.</td>
<td>5-ESS2-2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.</td>
</tr>
</tbody>
</table>

#### VI. Science Biographies

**Benjamin Banneker (published almanac; reproduced plans to build Washington, D.C. entirely from memory)**

Opportunity to revisit ESS1.B (see note at far right) and discuss the following practices/concepts:

**Constructing Explanations and Designing Solutions**

According to the [Library of Congress](https://www.loc.gov/), Banneker built a clock entirely from wood in 1752, "the first ever built in America," and he successfully predicted a solar eclipse in 1789.

**Elizabeth Blackwell (first female to graduate from medical school in the United States)**

Opportunity to apply ETS2.B.

(Please refer to The Human Body Domain above)

**Charles Drew (pioneered work in blood research, blood transfusions, and the development of blood banks)**

LS1.A & ETS2.B

(Please refer to The Human Body Domain above)

**Michael Faraday (chemist and physicist whose work led to the development of the electric motor and electric generator)**


(Please refer to the Electricity Domain above)
### GRADE 5

#### Core Knowledge Sequence: Science Content Guidelines

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</table>

#### I. Classifying Living Things
- Scientists have divided living things into five large groups called kingdoms, as follows:

<table>
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<tr>
<th>Kingdom</th>
<th>Phylum</th>
<th>Class</th>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
<th>(Variety)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Fungus (mushrooms, yeast, mold, mildew)</td>
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<tr>
<td>Protist (algae, protozoans, amoeba, euglena)</td>
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<tr>
<td>Moneran, also called Prokaryote (bacteria, blue-green algae/cyano bacteria)</td>
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</tr>
</tbody>
</table>

- Each kingdom is divided into smaller groupings as follows:

|------------------------------------------------------------------|------------------------------------------------------------------|----------|----------|

**MS-LS4-2.** Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

**MS-LS4-3.** Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
## GRADE 5

### Core Knowledge Sequence: Science Content Guidelines

**Aligned Disciplinary Core Ideas (DCIs)**

- When classifying living things, scientists use special names made up of Latin words (or words made to sound like Latin words), which help scientists around the world understand each other and ensure that they are using the same names for the same living things.

  Homo sapiens: the scientific name for the species to which human beings belong (genus Homo, species sapiens)

  **Taxonomists:** biologists who specialize in classification

- Different classes of vertebrates and major characteristics: fish, amphibians, reptiles, birds, mammals (review from grade 3)

  Teachers: Introduce an example of how an animal is classified, in order for students to become familiar with the system of classification, not to memorize specific names. For example, a collie dog is classified as follows:

  - **Kingdom:** Animalia
  - **Phylum:** Chordata
    (Subphylum: Vertebrata)
  - **Class:** Mammalia (mammal)
  - **Order:** Carnivora (eats meat)
  - **Family:** Canidae (a group with doglike characteristics)

### Opportunities for integration:

- **Practices**
- **Concepts**

#### Obtaining, Evaluating, & Communicating Information

- **Patterns**

#### Next Generation Science Standards:

**at grade level**

#### Gap &/or Opportunity Analysis

- domain Eukarya because all of these organisms have nucleated cells. While the latter two domains further divide the kingdom of Monerans (which is found in the 5-Kingdom system) into Bacteria which have no cell nucleus, but do contain other membrane-bound organelles, and Archaea which do not have any membrane-bound organelles. Also important to note is that the earliest taxonomists such as Aristotle and Carolus Linnaeus used only physical characteristics to group species, but with the relatively recent development of DNA sequencing, the systems of classification have continued to evolve as the physical similarities between organisms have been supplemented with additional evidence for evolutionary relatedness. Notice that the NGSS and the CK Sequence both focus early studies of classification on the physical, macroscopic...
| GRADE 5 |
|------------------|------------------|------------------|------------------|------------------|
| **Core Knowledge Sequence:** | **Aligned Disciplinary Core Ideas (DCIs)** | **Opportunities for integration:** | **Next Generation Science Standards:** | **Gap &/or Opportunity Analysis:** |
| Science Content Guidelines | Practices | Concepts | at grade level | below or above grade level |
| Genus: Canis (a coyote, wolf, or dog) | | | | traits of organisms to determine likeness/differences. |
| Species: familiaris (a domestic dog) | | | | |
| Variety: Collie | | | | |
| II. Cells: Structures and Processes | | | | The Core Knowledge Sequence has a significantly 'tighter' spiral with regards to the DCI of Structure and Function of living things. The Sequence outlines the study of body systems, cells, and cellular processes in all Grades K-8. The Human Body consistently returns each year as a domain of study with the complexity building up to Grades 7 and 8 such that these years include generalizable concepts such as genetics and respiration that apply to humans as well as other organisms. The NGSS focus on non-human examples in the younger years (e.g., see the assessment boundary for standard 3-LS3-1) while the CK Sequence establishes a course of |
| • All living things are made up of cells. | | | | |
| • Structure of cells (both plant and animal) | | | | |
| Cell membrane: selectively allows substances in and out | Planning and Carrying Out Investigations | Scale, Proportion, and Quantity | MS-LS1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. | |
| Nucleus: surrounded by nuclear membrane, contains genetic material, divides for reproduction | | | MS-LS1.2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. | |
| Cytoplasm contains organelles, small structures that carry out the chemical activities of the cell, including mitochondria (which produce the cell’s energy) and vacuoles (which store food, water, or wastes). | | | | |
| • Plant cells, unlike animal cells, have cell walls and chloroplasts. | | | | |
| • Cells without nuclei: monerans (bacteria) | | | | |
| • Some organisms consist of only a single cell: for example, amoeba, protozoans, some algae. | | | | |
| GRADE 5 |
|-----------------|-----------------|-----------------|-----------------|
| Core Knowledge Sequence: Science Content Guidelines | Aligned Disciplinary Core Ideas (DCIs) | Opportunities for integration | Next Generation Science Standards: |
| | | Practices | Concepts | at grade level | below or above grade level |
| | • Cells are shaped differently in order to perform different functions. | | | |
| | • Organization of cells into tissues, organs, and systems: | | | |
| | In complex organisms, groups of cells form tissues (for example, in animals, skin tissue or muscle tissue; in plants, the skin of an onion or the bark of a tree). | | | study that can leverage both human and non-human examples to comparatively study the structure and function of living things. |
| | Tissues with similar functions form organs (for example, in some animals, the heart, stomach, or brain; in some plants, the root or flower). | | | |
| | In complex organisms, organs work together in a system (recall, for example, from earlier studies of the human body, the digestive, circulatory, and respiratory systems). | | | |
| | III. Plant Structures and Processes | | | |
| | A. STRUCTURE: NON-VASCULAR AND VASCULAR PLANTS | | | |
| | • Non-vascular plants (for example, algae) | | | |
| | • Vascular plants | | | |
| | Vascular plants have tube-like structures that allow water and dissolved nutrients to move | | | |
| | LS1.A. Opportunity to connect LS1.C | Engaging in Argument from Evidence | Systems and System Models | MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. |
| | LS1.A | Energy and Matter | | |
| | 5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water. | | | |

**Grade-level Links**
| GRADE 5 |
|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Core Knowledge Sequence: Science Content Guidelines | Aligned Disciplinary Core Ideas (DCIs) | Opportunities for integration¹: Practices | Concepts | Next Generation Science Standards: at grade level | below or above grade level | Gap &/or Opportunity Analysis² |
| | | | | | | atmosphere interact. Teachers should also work to deepen the students’ understanding from Grades 1 & 3 regarding food webs and 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. |
| through the plant. | | | | | | |
| Parts and functions of vascular plants: roots, stems and buds, leaves | | | | | | |
| **B. PHOTOSYNTHESIS** | | | | | | |
| • Photosynthesis is an important life process that occurs in plant cells, but not animal cells (photo = light; synthesis = putting together). Unlike animals, plants make their own food, through the process of photosynthesis. | PS3.D & LS1.C | Developing and Using Models | Energy and Matter | 5-PS3-1. Use models to describe that energy in animals’ food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. | |
| • Role in photosynthesis of: energy from sunlight, chlorophyll, carbon dioxide and water, xylem and phloem, stomata, oxygen, sugar (glucose) | PS3.D, LS1.A, & LS1.C. | Developing and Using Models | Systems and System Models | Opportunities for application: 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. | 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. |
| **C. REPRODUCTION** | LS1.B. | Engaging in Argument from Evidence | Cause & Effect | Opportunity to foreshadow future learning: MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to... | | |
## GRADE 5

### Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration: Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Asexual reproduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Example of algae</td>
<td></td>
<td></td>
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<tr>
<td>Vegetative reproduction: runners (for example, strawberries) and bulbs (for example, onions), growing plants from eyes, buds, leaves, roots, and stems</td>
<td></td>
<td></td>
<td>• Support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.</td>
<td></td>
</tr>
<tr>
<td>• Sexual reproduction by spore-bearing plants (for example, mosses and ferns)</td>
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</tr>
<tr>
<td>• Sexual reproduction of non-flowering seed plants: conifers (for example, pines), male and female cones, wind pollination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sexual reproduction of flowering plants (for example, peas)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Functions of sepals and petals, stamen (male), anther, pistil (female), ovary (or ovule)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Process of seed and fruit production: pollen, wind, insect and bird pollination, fertilization, growth of ovary, mature fruit</td>
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</tr>
<tr>
<td>Seed germination and plant growth: seed coat, embryo and endosperm, germination (sprouting of new plant), monocots (for example, corn) and dicots (for example, beans).</td>
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</tr>
<tr>
<td>GRADE 5</td>
<td>Core Knowledge Sequence: Science Content Guidelines</td>
<td>Aligned Disciplinary Core Ideas (DCIs)</td>
<td>Opportunities for integration¹: Practices</td>
<td>Concepts</td>
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<tr>
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</tbody>
</table>
| IV. Life Cycles and Reproduction | A. THE LIFE CYCLE AND REPRODUCTION | • Life cycle: development of an organism from birth to growth, reproduction, death  
  Example: Growth stages of a human: embryo, fetus, newborn, infancy, childhood, adolescence, adulthood, old age  
  • All living things reproduce themselves. Reproduction may be asexual or sexual.  
  Examples of asexual reproduction: fission (splitting) of bacteria, spores from mildews, molds, and mushrooms, budding of yeast cells, regeneration and cloning  
  Sexual reproduction requires the joining of special male and female cells, called gametes, to form a fertilized egg. | Developing and Using Models | Energy and Matter | Opportunities for application: 5-PS3-1. Use models to describe that energy in animals’ food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. | 3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. |  |
| B. SEXUAL REPRODUCTION IN ANIMALS | • Reproductive organs: testes (sperm) and ovaries (eggs)  
  • External fertilization: spawning  
  • Internal fertilization: birds, mammals  
  • Development of the embryo: egg, zygote, embryo, growth... | Developing and Using Models | Patterns | 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. | Opportunity to foreshadow future learning: MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. |  |
## GRADE 5

<table>
<thead>
<tr>
<th>Core Knowledge Sequence: Science Content Guidelines</th>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹: Practices</th>
<th>Concepts</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Next Generation Science Standards: below or above grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>in uterus, fetus, newborn</td>
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</tbody>
</table>

### V. The Human Body

**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

**Opportunities for application:**

*MS-LS1-3.* Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

**MS-LS1-8.** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

It is important to note that the *CK Sequence* outlines the study of the human body in all grades leading up to Grade 5 and continues this study into Grades 6-8. In the middle school years, students have the continued opportunity to study the integration of the different body systems through units such as The Chemistry of Food and Respiration (Gr8). The NGSS focus on students' understanding of body systems as interacting subsystems of the whole (e.g., the assessment boundary of MS-LS1-3 states, "Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular,

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¹ Opportunities for integration
² Gap &/or Opportunity Analysis
Grade 5 Core Knowledge Sequence:
Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
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<tr>
<td></td>
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<tr>
<td>LS1.A &amp; LS1.D.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS1.A</td>
<td></td>
<td></td>
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<tr>
<td>LS1.B</td>
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</tr>
</tbody>
</table>

### Opportunities for integration¹:

1. Next Generation Science Standards: Gap &/or Opportunity Analysis²

### Practices

- 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)

- Adrenal glands: secrete a hormone called adrenaline, especially when a person is frightened or angry, causing rapid heartbeat and breathing
  - LS1.A & LS1.D

### Concepts

- 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

### Chemistry: Matter and Change

A. ATOMS, MOLECULES, AND COMPOUNDS

- Developing and Using Models: Scale, Proportion, and Quantity

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

Note: Grade 5 teachers have the opportunity to leverage previously learned content re: resources and the environment such as...
GRADE 5

Core Knowledge Sequence: Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Basics of atomic structure: nucleus, protons (positive charge), neutrons (neutral), electrons (negative charge)</td>
<td>Practices</td>
<td>Concepts</td>
<td></td>
</tr>
<tr>
<td>• Atoms are constantly in motion, electrons move around the nucleus in paths called shells (or energy levels).</td>
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<tr>
<td>• Atoms may join together to form molecules and compounds.</td>
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<tr>
<td>• Common compounds and their formulas: water H₂O</td>
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<td></td>
</tr>
<tr>
<td>salt NaCl</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>carbon dioxide CO₂</td>
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</tr>
</tbody>
</table>

B. ELEMENTS

• Elements have atoms of only one kind, having the same number of protons. There are a little more than 100 different elements.

• The Periodic Table: organizes elements with common properties

  Atomic symbol and atomic number

• Some well-known elements and their symbols:

  Hydrogen H
  Helium He
  Carbon C
  Nitrogen N
  Oxygen O

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¹ Opportunities for integration

² Gap &/or Opportunity Analysis

The domains of Taking Care of the Earth (Kinder) and Ecology (Gr3) in order to meet 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment. This broad standard could be applied within many of the CK science domains such as connecting it to the study of particular elements or compounds in the environment (Chemistry) or to the study of particular species that are affected by human interactions (Plants and/or Life Cycles). Grade 5 teachers also have the opportunity to leverage previously learned content regarding Solutions (Gr4) to meet 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.
### GRADE 5

**Core Knowledge Sequence:**
Science Content Guidelines

<table>
<thead>
<tr>
<th>Aligned Disciplinary Core Ideas (DCIs)</th>
<th>Opportunities for integration¹:</th>
<th>Next Generation Science Standards: at grade level</th>
<th>Gap &amp;/or Opportunity Analysis²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Na</td>
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<tr>
<td>Aluminum Al</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Silicon Si</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Chlorine Cl</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Iron Fe</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Copper Cu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver Ag</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gold Au</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Two important categories of elements: metals and non-metals</td>
<td><strong>PS1.A</strong></td>
<td><strong>PS1.B</strong></td>
<td><strong>5-PS1-3.</strong> Make observations and measurements to identify materials based on their properties.</td>
</tr>
<tr>
<td>Metals comprise about ⅔ of the known elements.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properties of metals: most are shiny, ductile, malleable, conductive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. CHEMICAL AND PHYSICAL CHANGE</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>• Chemical change changes what a molecule is made up of and results in a new substance with a new molecular structure. Examples of chemical change: rusting of iron, burning of wood, milk turning sour</td>
<td><strong>PS1.A</strong></td>
<td><strong>PS1.B</strong></td>
<td><strong>5-PS1-4.</strong> Conduct an investigation to determine whether the mixing of two or more substances results in new substances.</td>
</tr>
</tbody>
</table>

¹ Opportunities for integration:
- Practices
- Concepts

² Gap &/or Opportunity Analysis:
- at grade level
- below or above grade level
<table>
<thead>
<tr>
<th>GRADE 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Knowledge Sequence: Science Content Guidelines</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>• Physical change changes only the properties or appearance of the substance, but does not change what the substance is made up of. Examples of physical change: cutting wood or paper, breaking glass, freezing water</td>
</tr>
</tbody>
</table>

### VII. Science Biographies

Galileo (“Father of modern science” who provided scientific support for Copernicus’s sun-centered universe) - Astronomy/The Renaissance and the Reformation Domains

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>ESS1.B.</td>
<td>Opportunity to connect ESS1.A and/or PS2.B.</td>
</tr>
<tr>
<td>Engaging in Argument from Evidence</td>
<td>Cause and Effect</td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>Scale, Proportion, and Quantity</td>
</tr>
</tbody>
</table>

Opportunities for application: 5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.

5-ESS1-1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.

Grade 5 Teachers are recommended to work with Grades 1, 3 and 6 to plan how each grade level will support students' growing understanding of Astronomy to meet the standards of 5-PS2-1, 5-ESS1-1, and 5-ESS1-2. For example, Grade 3 students study the daily and seasonal changes observed on Earth due to its rotation on its axis and its orbit around the sun. Grade 5 students have...
### GRADE 5

**Core Knowledge Sequence:** Science Content Guidelines  
**Aligned Disciplinary Core Ideas (DCIs)**

<table>
<thead>
<tr>
<th>Opportunities for integration(^1):</th>
<th>Next Generation Science Standards:</th>
<th>Gap &amp;/or Opportunity Analysis(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practices</td>
<td>Concepts</td>
<td>at grade level</td>
</tr>
</tbody>
</table>

**Analyzing and Interpreting Data**

- **Patterns**

#### 5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

**Percy Lavon Julian** (biologist and inventor who developed synthetic cortisone to treat arthritis pain)  
**Opportunity to apply LS1.A & ETS2.B.**  
(Please refer to The Human Body Domain above)

**Ernest Just** (biologist and medical pioneer who specialized in studying cells and reproduction in marine animals)  
**Opportunity to apply LS1.A & LS1.B.**  
(Please refer to The Human Body Domain above)

**Carl Linnaeus** (botanist and “Father of taxonomy” who standardized the classification system)  
**Opportunity to apply LS1.A.**  
(Please refer to the Classification Domain above)
OTHER NOTES:

1 The NRC’s Framework for K-12 Science Education and the Next Gen. Science Standards (NGSS) both make it clear that the identified ways of integrating content, practices, and crosscutting concepts (here noted as Concepts) are not mandatory combinations. Rather these are logical groupings of the three dimensions that will guide the development of assessments for the classroom and for high-stakes testing. Teachers are encouraged to find and plan around further integration opportunities between the three dimensions to help provide context to rich learning experiences with the rigorous content of the CK Sequence.

2 The analysis notes are intended to provide further context to those differences found between the CK Sequence and the NGSS. For example, these comments identify opportunities to meet grade-specific NGSS at earlier or later grades by cross-referencing other grade-level content from the Sequence and revealing any apparently 'missing' content that is, in fact, studied by students within Core Knowledge schools and which meets the expectations set forth by the NRC’s Framework.

Guiding Questions for each Disciplinary Core Idea

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Core</th>
<th>Component</th>
<th>Topic (linked to the NRC’s Framework)</th>
<th>Guiding Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Sciences</td>
<td>PS</td>
<td>1</td>
<td>Matter &amp; Its Interactions</td>
<td>How can one explain the structure, properties, and interactions of matter?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Structure &amp; Properties of Matter</td>
<td>How do particles combine to form the variety of matter one observes?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 B</td>
<td>Chemical Reactions</td>
<td>How do substances combine or change (react) to make new substances? How does one characterize and explain the reactions and make predictions about them?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 C</td>
<td>Nuclear Processes</td>
<td>What forces hold nuclei together and mediate nuclear processes?</td>
</tr>
<tr>
<td></td>
<td>PS</td>
<td>2</td>
<td>Motion &amp; Stability: Forces &amp; Interactions</td>
<td>How can one explain and predict interactions between objects and within systems of objects?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 A</td>
<td>Forces &amp; Motion</td>
<td>How can one predict an object's continued motion, changes in motion, or stability?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 B</td>
<td>Types of Interactions</td>
<td>What underlying forces explain the variety of interactions observed?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 C</td>
<td>Stability &amp; Instability in Physical Systems</td>
<td>Why are some physical systems more stable than others?</td>
</tr>
<tr>
<td></td>
<td>PS</td>
<td>3</td>
<td>Energy</td>
<td>How is energy transferred and conserved?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 A</td>
<td>Definitions of Energy</td>
<td>What is energy?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 B</td>
<td>Conservation of Energy &amp; Energy Transfer</td>
<td>What is meant by the conservation of energy? How is energy transferred between objects or systems?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 C</td>
<td>Relationship between Energy and Forces</td>
<td>How are forces related to energy?</td>
</tr>
<tr>
<td>Grade-level Links</td>
<td>PS 3</td>
<td>D</td>
<td>Energy in Chemical Processes and Everyday Life</td>
<td>How do food and fuel provide energy? If energy is conserved, why do people say it is produced or used?</td>
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</tr>
<tr>
<td>PS 4</td>
<td>Waves and Their Applications in Technologies for Information Transfer</td>
<td>How are waves used to transfer energy and information?</td>
<td></td>
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</tr>
<tr>
<td>PS 4</td>
<td>A</td>
<td>Wave Properties</td>
<td>What are the characteristic properties and behaviors of waves?</td>
<td></td>
</tr>
<tr>
<td>PS 4</td>
<td>B</td>
<td>Electromagnetic Radiation</td>
<td>What is light? How can one explain the varied effects that involve light? What other forms of electromagnetic radiation are there?</td>
<td></td>
</tr>
<tr>
<td>PS 4</td>
<td>C</td>
<td>Information Technologies and Instrumentation</td>
<td>How are instruments that transmit and detect waves used to extend human senses?</td>
<td></td>
</tr>
<tr>
<td>Life Sciences</td>
<td>LS 1</td>
<td></td>
<td>How do organisms live, grow, respond to their environment, and reproduce?</td>
<td></td>
</tr>
<tr>
<td>LS 1</td>
<td>A</td>
<td>Structure &amp; Function</td>
<td>How do the structures of organisms enable life's functions?</td>
<td></td>
</tr>
<tr>
<td>LS 1</td>
<td>B</td>
<td>Growth &amp; Development of Organisms</td>
<td>How do organisms grow and develop?</td>
<td></td>
</tr>
<tr>
<td>LS 1</td>
<td>C</td>
<td>Organization of Matter &amp; Energy Flow in Organisms</td>
<td>How do organisms obtain and use the matter and energy they need to live and grow?</td>
<td></td>
</tr>
<tr>
<td>LS 1</td>
<td>D</td>
<td>Information Processing</td>
<td>How do organisms detect, process, and use information about the environment?</td>
<td></td>
</tr>
<tr>
<td>LS 2</td>
<td></td>
<td>Ecosystems Interactions, Energy, and Dynamics</td>
<td>How and why do organisms interact with their environment and what are the effects of these interactions?</td>
<td></td>
</tr>
<tr>
<td>LS 2</td>
<td>A</td>
<td>Interdependent Relationships in Ecosystems</td>
<td>How do organisms interact with the living and nonliving environments to obtain matter and energy?</td>
<td></td>
</tr>
<tr>
<td>LS 2</td>
<td>B</td>
<td>Cycles of Matter &amp; Energy Transfer in Ecosystems</td>
<td>How do matter and energy move through an ecosystem?</td>
<td></td>
</tr>
<tr>
<td>LS 2</td>
<td>C</td>
<td>Ecosystem Dynamics, Functioning, and Resilience</td>
<td>What happens to ecosystems when the environment changes?</td>
<td></td>
</tr>
<tr>
<td>LS 2</td>
<td>D</td>
<td>Social Interactions &amp; Group Behavior</td>
<td>How do organisms interact in groups so as to benefit individuals?</td>
<td></td>
</tr>
<tr>
<td>LS 3</td>
<td></td>
<td>Heredity: Inheritance &amp; Variation of Traits</td>
<td>How are the characteristics of one generation passed to the next? How can individuals of the same species and even siblings have different characteristics?</td>
<td></td>
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<tr>
<td>Grade-level Links</td>
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<tr>
<td><strong>LS</strong> 3 <strong>A</strong></td>
<td><strong>Inheritance of Traits</strong></td>
<td>How are the characteristics of one generation related to the previous generation?</td>
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<tr>
<td><strong>LS</strong> 3 <strong>B</strong></td>
<td><strong>Variation of Traits</strong></td>
<td>Why do individuals of the same species vary in how they look, function, and behave?</td>
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<tr>
<td><strong>LS</strong> 4 <strong>B</strong></td>
<td><strong>Biological Evolution: Unity &amp; Diversity</strong></td>
<td>How can there be so many similarities among organisms yet so many different kinds of plants, animals, and microorganisms? How does biodiversity affect humans?</td>
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<tr>
<td><strong>LS</strong> 4 <strong>A</strong></td>
<td><strong>Evidence of Common Ancestry &amp; Diversity</strong></td>
<td>What evidence shows that different species are related?</td>
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<tr>
<td><strong>LS</strong> 4 <strong>B</strong></td>
<td><strong>Natural Selection</strong></td>
<td>How does genetic variation among organisms affect survival and reproduction?</td>
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<tr>
<td><strong>LS</strong> 4 <strong>C</strong></td>
<td><strong>Adaptation</strong></td>
<td>How does the environment influence populations of organisms over multiple generations?</td>
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<tr>
<td><strong>LS</strong> 4 <strong>D</strong></td>
<td><strong>Biodiversity &amp; Humans</strong></td>
<td>What is biodiversity, how do humans affect it, and how does it affect humans?</td>
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<table>
<thead>
<tr>
<th>Earth &amp; Space Sciences</th>
<th>ESS 1</th>
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<th><strong>Earth's Place in the Universe</strong></th>
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<tbody>
<tr>
<td><strong>ESS</strong> 1 <strong>A</strong></td>
<td><strong>The Universe and Its Stars</strong></td>
<td>What is the universe, and what is Earth's place in it?</td>
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<tr>
<td><strong>ESS</strong> 1 <strong>B</strong></td>
<td><strong>Earth and the Solar System</strong></td>
<td>What is the universe, and what goes on in stars?</td>
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<td><strong>ESS</strong> 1 <strong>C</strong></td>
<td><strong>The History of Planet Earth</strong></td>
<td>What are the predictable patterns caused by Earth's movement in the solar system?</td>
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<thead>
<tr>
<th>Earth &amp; Space Sciences</th>
<th>ESS 2</th>
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<th><strong>Earth's Systems</strong></th>
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<tr>
<td><strong>ESS</strong> 2 <strong>A</strong></td>
<td><strong>Earth Materials &amp; Systems</strong></td>
<td>How and why is Earth constantly changing?</td>
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<td><strong>ESS</strong> 2 <strong>B</strong></td>
<td><strong>Plate Tectonics &amp; Large-Scale System Interactions</strong></td>
<td>How do Earth's major systems interact?</td>
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<td><strong>ESS</strong> 2 <strong>C</strong></td>
<td><strong>The Roles of Water in Earth's Surface Processes</strong></td>
<td>Why do the continents move, and what causes earthquakes and volcanoes?</td>
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<td><strong>ESS</strong> 2 <strong>D</strong></td>
<td><strong>Weather &amp; Climate</strong></td>
<td>How do the properties and movements of water shape Earth's surface and affect its systems?</td>
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<tr>
<td><strong>ESS</strong> 2 <strong>E</strong></td>
<td><strong>Biogeology</strong></td>
<td>What regulates weather and climate?</td>
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<tr>
<th>Earth &amp; Space Sciences</th>
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<th><strong>Earth &amp; Human Activity</strong></th>
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<tr>
<td><strong>ESS</strong> 3 <strong>A</strong></td>
<td><strong>Natural Resources</strong></td>
<td>How do Earth's surface processes and human activities affect each other?</td>
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<tr>
<td><strong>ESS</strong> 3 <strong>B</strong></td>
<td><strong>Natural Hazards</strong></td>
<td>How do humans depend on Earth's resources?</td>
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<td><strong>ESS</strong> 2 <strong>E</strong></td>
<td><strong>Biogeology</strong></td>
<td>How do living organisms alter Earth's processes and structures?</td>
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<tr>
<td><strong>ESS</strong> 3 <strong>A</strong></td>
<td><strong>Natural Resources</strong></td>
<td>How do natural hazards affect individuals and societies?</td>
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<table>
<thead>
<tr>
<th>ESS</th>
<th>3</th>
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<th>Human Impacts on Earth Systems</th>
<th>How do humans change the planet?</th>
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<tr>
<td>ESS</td>
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<td>Global Climate Change</td>
<td>How do people model and predict the effects of human activities on Earth's climate?</td>
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<td>ETS</td>
<td>1</td>
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<td>Engineering Design</td>
<td>How do engineers solve problems?</td>
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<td>ETS</td>
<td>1</td>
<td>A</td>
<td>Defining &amp; Delimiting an Engineering Problem</td>
<td>What is design for? What are the criteria and constraints of a successful solution?</td>
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<td>ETS</td>
<td>1</td>
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<td>Developing Possible Solutions</td>
<td>What is the process for developing potential design solutions?</td>
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<td>1</td>
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<td>Optimizing the Design Solution</td>
<td>How can the various proposed design solutions be compared and improved?</td>
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<td>ETS</td>
<td>2</td>
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<td>Links among Engineering, Technology, Science, &amp; Society</td>
<td>How are engineering, technology, science, and society interconnected?</td>
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<td>A</td>
<td>Interdependence of Science, Engineering, &amp; Technology</td>
<td>What are the relationships among science, engineering, and technology?</td>
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<tr>
<td>ETS</td>
<td>2</td>
<td>B</td>
<td>Influence of Engineering, Technology, &amp; Science on Society &amp; the Natural World</td>
<td>How do science, engineering, and the technologies that result from them affect the ways in which people live? How do they affect the natural world?</td>
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