4th Grade - Topical Model - Bundle 1
Structures and Functions of Organisms

This is the first bundle of the 4th Grade Topic Model. Each bundle has connections to the other bundles in the course, as shown in the Course Flowchart

Bundle 1 Question: This bundle is assembled to address the question "how do organisms receive and process information?"

Summary

The bundle organizes performance expectations around the theme of *structures and functions of organisms.* Instruction developed from this bundle should always maintain the three-dimensional nature of the standards, but recognize that instruction is not limited to the practices and concepts directly linked with any of the bundle performance expectations.

Connections between bundle DCIs

The idea that an object can be seen when light reflected from its surface enters the eyes (PS4.B as in 4-PS4-2) connects to the concept that different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain (LS1.D as in 4-LS1-2). These concepts about structures and sense receptors being used to gather certain kinds of information also connects to the idea that plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (LS1.A as in 4-LS1-1)

The engineering design idea that the success of a designed solution is determined by considering the desired features of a solution (ETS1.A as in 3-5-ETS1-1) could be applied to multiple concepts, such as that plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction (LS1.A as in 4-LS1-1) and that an object can be seen when light reflected from its surface enters the eyes (PS4.B as in 4-PS4-2). Connections could be made through engineering design tasks, such as by having students design a solution to a problem by mimicking internal or external structures of plants or animals that serve various functions in growth, survival, behavior, and reproduction, or by having students solve a problem in which some barrier exists, resulting in the inability to see an object. In both cases, before students begin their designs, they should identify what the desired features of a successful solution are—in other words, they should determine the criteria for success.

Bundle Science and Engineering Practices

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the practices of asking questions and defining problems (3-5-ETS1-1), developing and using models (4-PS4-2 and 4-LS1-2), and engaging in argument from evidence (4-LS1-1). Many other practice elements can be used in instruction.

Bundle Crosscutting Concepts

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the crosscutting concepts of Cause and Effect (4-PS4-2) and Systems and System Models (4-LS1-1 and 4-LS1-2). Many other crosscutting concepts elements can be used in instruction.

All instruction should be three-dimensional.

Performance Expectations	4-PS4-2 **Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.** [*Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.*] 4-LS1-1 **Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.** [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [*Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.*] 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.** [Clarification Statement: Emphasis is on systems of information transfer.] [*Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.*] 3-5-ETS1-1 **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.***
Example Phenomena	Falcons very high up in the air can spot very small animals on the ground. Eyes are located differently in the heads of deer versus mountain lions.
Additional Practices Building to the PEs	**Asking Questions and Defining Problems** • Identify scientific (testable) and non-scientific (non-testable) questions. Students could [brainstorm questions about] ***internal and external structures that serve various functions in growth, survival, behavior, and reproduction*** *and* [then] *identify* [which questions are] *scientific (testable) and* [which questions are] *non-scientific (non-testable)*. 4-LS1-1 **Developing and Using Models** • Develop and/or use models to describe and/or predict phenomena. Students could *develop a model to describe a phenomenon* [related to the idea that] ***an object can be seen when light reflected from its surface enters the eyes***. 4-PS4-2 **Planning and Carrying Out Investigations** • Make predictions about what would happen if a variable changes. Students could use the idea that ***animals are able to use their perceptions and memories to guide their actions*** [to] *make predictions about what would happen*—[e.g., how an animal would act]—*if a variable changes,* [such as when what the animal perceives changes]. 4-LS1-2 **Analyzing and Interpreting Data** • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Students could *analyze and interpret data, using logical reasoning, to make sense of a phenomenon* [related to the idea that] ***plants have external structures that serve functions in growth, survival, and reproduction***. 4-LS1-1

Additional Practices Building to the PEs (Continued)	**Using Mathematical and Computational Thinking** • Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success. Students could *decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success* [in solving a problem related to an organism's ability to see]. 4-PS4-2 and 4-LS1-1 **Constructing Explanations and Designing Solutions** • Identify the evidence that supports particular points in an explanation. Students can *identify the evidence that supports particular points in an explanation* [that] ***an object can be seen when light reflected from its surface enters the eyes***. 4-PS4-2 **Engaging in Argument From Evidence** • Respectfully provide and receive critiques from peers about a proposed procedure, explanation or model by citing relevant evidence and posing specific questions. Students could *respectfully provide critiques to peers about a proposed model* [that describes the] ***various functions that plants' and animals' internal and external structures have*** *by citing relevant evidence and posing specific questions*. 4-LS1-1 **Obtaining, Evaluating and Communicating Information** • Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts. Students could *communicate technical information in writing* [about] ***the criteria and constraints of solutions*** [to a problem related to] ***light reflecting from objects and entering the eye***. 4-PS4-2 and 3-5-ETS1-1
Additional Crosscutting Concepts Building to the PEs	**Patterns** • Similarities and differences in patterns can be used to sort and classify natural phenomena. Students could identify *similarities and differences in patterns* [of] ***plants' and animals' internal and external structures*** [and] *use* [the patterns] *to sort and classify* [how these structures] ***serve various functions in growth, survival, behavior, and reproduction***. 4-LS1-1 **Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. Students could describe how *cause and effect relationships*—[like the relationship between] ***light reflecting from objects and the ability for objects to be seen—****are routinely identified, tested, and used to explain change*. 4-PS4-2 **Structure and Function** • Substructures have shapes and parts that serve functions. Students can describe the *shapes and parts* [of] ***plants' and animals' internal and external structures*** *that serve functions* ***in growth, survival, behavior, and reproduction***. 4-LS1-1

Connections to Nature of Science	**Scientific Knowledge is Based on Empirical Evidence** • Science findings are based on recognizing patterns. Students could describe how their *science findings* [about] ***plants' and animals' internal and external structures that serve various functions in growth, survival, behavior, and reproduction*** *were based on recognizing patterns*. 4-LS1-1 **Science Is a Way of Knowing** • Science is a way of knowing that is used by many people. Students could describe that *science is a way of knowing*, [with the example of how used science to learn that] ***an object can be seen when light reflected from its surface enters the eyes***. 4-PS4-2

4-PS4-2 Waves and Their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

4-PS4-2. **Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.** [*Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model to describe phenomena.	**PS4.B: Electromagnetic Radiation** • An object can be seen when light reflected from its surface enters the eyes.	**Cause and Effect** • Cause and effect relationships are routinely identified.

Observable features of the student performance by the end of the grade:			
1	Components of the model		
	a	Students develop a model to make sense of a phenomenon involving the relationship between light reflection and visibility of objects. In the model, students identify the relevant components, including:	
		i.	Light (including the light source).
		ii.	Objects.
		iii.	The path that light follows.
		iv.	The eye.
2	Relationships		
	a	Students identify and describe* causal relationships between the components, including:	
		i.	Light enters the eye, allowing objects to be seen.
		ii.	Light reflects off of objects, and then can travel and enter the eye.
		iii.	Objects can be seen only if light follows a path between a light source, the object, and the eye.
3	Connections		
	a	Students use the model to describe* that in order to see objects that do not produce their own light, light must reflect off the object and into the eye.	
	b	Students use the model to describe* the effects of the following on seeing an object:	
		i.	Removing, blocking, or changing the light source (e.g., a dimmer light).
		ii.	Closing the eye.
		iii.	Changing the path of the light (e.g., using mirrors to direct the path of light to allow the visualization of a previously unseen object or to change the position in which the object can be seen, using an opaque or translucent barrier between 1) the light source and the object or 2) the object and the eye to change the path light follows and the visualization of the object).

4-LS1-1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

4-LS1-1. **Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.** [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [*Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Engaging in Argument from Evidence
Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).

- Construct an argument with evidence, data, and/or a model.

Disciplinary Core Ideas

LS1.A: Structure and Function

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

Crosscutting Concepts

Systems and System Models

- A system can be described in terms of its components and their interactions.

Observable features of the student performance by the end of the grade:			
1	Supported claims		
	a	Students make a claim to be supported about a phenomenon. In the claim, students include the idea that plants and animals have internal and external structures that function together as part of a system to support survival, growth, behavior, and reproduction.	
2	Identifying scientific evidence		
	a	Students describe* the given evidence, including:	
		i.	The internal and external structures of selected plants and animals.
		ii.	The primary functions of those structures
3	Evaluating and critiquing evidence		
	a	Students determine the strengths and weaknesses of the evidence, including whether the evidence is relevant and sufficient to support a claim about the role of internal and external structures of plants and animals in supporting survival, growth, behavior, and/or reproduction.	
4	Reasoning and synthesis		
	a	Students use reasoning to connect the relevant and appropriate evidence and construct an argument that includes the idea that plants and animals have structures that, together, support survival, growth, behavior, and/or reproduction. Students describe* a chain of reasoning that includes:	
		i.	Internal and external structures serve specific functions within plants and animals (e.g., the heart pumps blood to the body, thorns discourage predators).
		ii.	The functions of internal and external structures can support survival, growth, behavior, and/or reproduction in plants and animals (e.g., the heart pumps blood throughout the body, which allows the entire body access to oxygen and nutrients; thorns prevent predation, which allows the plant to grow and reproduce).
		iii.	Different structures work together as part of a system to support survival, growth, behavior, and/or reproduction (e.g., the heart works with the lungs to carry oxygenated blood throughout the system; thorns protect the plant, allowing reproduction via stamens and pollen to occur).

4-LS1-2 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

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.** [Clarification Statement: Emphasis is on systems of information transfer.] [*Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Use a model to test interactions concerning the functioning of a natural system.

Disciplinary Core Ideas

LS1.D: Information Processing

- Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.

Crosscutting Concepts

Systems and System Models

- A system can be described in terms of its components and their interactions.

Observable features of the student performance by the end of the grade:		
1	Components of the model	
	a	From a given model, students identify and describe* the relevant components for testing interactions concerning the functioning of a given natural system, including:
		i. Different types of information about the surroundings (e.g., sound, light, odor, temperature).
		ii. Sense receptors able to detect different types of information from the environment.
		iii. Brain.
		iv. Animals' actions.
2	Relationships	
	a	Students describe* the relationships between components in the model, including:
		i. Different types of sense receptors detect specific types of information within the environment.
		ii. Sense receptors send information about the surroundings to the brain.
		iii. Information that is transmitted to the brain by sense receptors can be processed immediately as perception of the environment and/or stored as memories.
		iv. Immediate perceptions or memories processed by the brain influence an animal's action or responses to features in the environment.
3	Connections	
	a	Students use the model to describe* that:
		i. Information in the environment interacts with animal behavioral output via interactions mediated by the brain.
		ii. Different types of sensory information are relayed to the brain via different sensory receptors, allowing experiences to be perceived, stored as memories, and influence behavior (e.g., an animal sees a brown, rotten fruit and smells a bad odor — this sensory information allows the animal to use information about other fruits that appear to be rotting to make decisions about what to eat; an animal sees a red fruit and a green fruit — after eating them both, the animal learns that the red fruit is sweet and the green fruit is bitter and then uses this sensory information, perceived and stored as memories, to guide fruit selection next time).
		iii. Sensory input, the brain, and behavioral output are all parts of a system that allow animals to engage in appropriate behaviors.
	b	Students use the model to test interactions involving sensory perception and its influence on animal behavior within a natural system, including interactions between:
		i. Information in the environment.

		ii.	Different types of sense receptors.
		iii.	Perception and memory of sensory information.
		iv.	Animal behavior.

3-5-ETS1-1 Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K- 12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World

- People's needs and wants change over time, as do their demands for new and improved technologies.

Observable features of the student performance by the end of the grade:		
1	Identifying the problem to be solved	
	a	Students use given scientific information and information about a situation or phenomenon to define a simple design problem that includes responding to a need or want.
	b	The problem students define is one that can be solved with the development of a new or improved object, tool, process, or system.
	c	Students describe* that people's needs and wants change over time.
2	Defining the boundaries of the system	
	a	Students define the limits within which the problem will be addressed, which includes addressing something people want and need at the current time.
3	Defining the criteria and constraints	
	a	Based on the situation people want to change, students specify criteria (required features) of a successful solution.
	b	Students describe* the constraints or limitations on their design, which may include:
		i. Cost.
		ii. Materials.
		iii. Time.