5th Grade – Topic Model - Bundle 2
Matter and Energy in Ecosystems

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

Bundle 2 Question: This bundle is assembled to address the questions "What are we made out of?"

Summary

The bundle organizes performance expectations with a focus on helping students build an understanding of the flow and cycles of matter and energy. Instruction developed from this bundle should always maintain the three-dimensional nature of the standards, and is not limited to the practices and concepts directly linked with any of the bundle performance expectations.

Connections between bundle DCIs

The idea that matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die (LS2.B as in 5-LS2-1) connects to the idea that matter of any type can be subdivided into particles that are too small to see (PS1.A as in 5-PS1-1) because matter is subdivided into particles as it flows between organisms and the air and soil. The idea that matter flows also connects to the ideas that plants acquire their material for growth chiefly from air and water (LS1.C as in 5-LS1-1) and that food provides animals with the materials they need for body repair and growth (LS1.C in 5-PS3-1).

Just as matter flows, energy can flow as well. As such, the idea that matter can flow connects to the concept that the energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (PS3.D as in 5-PS3-1).

The engineering design concept that communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs (ETS1.B as in 3-5-ETS1-2) could connect to multiple science concepts, such as that a healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life (LS2.A as in 5-LS2-1) and that gases are made from matter particles that are too small to see and are moving freely around in space (PS1.A as in 5-PS1-1). The first connection could be made through having students share designs for solutions to improve the health of a given ecosystem. The second connection could be made by having students share design for a device that uses the understanding that gases are made from matter particles too small to see. In either case, students should have an opportunity to communicate with their peers throughout the design process and reflect on how sharing their ideas affected their designs.

Bundle Science and Engineering Practices

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the practices of developing and using models (5-PS1-1, 5-PS3-1, and 5-LS2-1); constructing explanations and designing solutions (3-5-ETS1-2); and engaging in argument from evidence (5-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 Scale, Proportion, and Quantity (5-PS1-1); Systems and System Models (5-LS2-1); and Energy and Matter (5-PS3-1 and 5-LS1-1). Many other crosscutting concepts elements can be used in instruction.

All instruction should be three-dimensional.

Performance Expectations 5-PS1-1 is partially assessable	5-PS1-1. **Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [*Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*] 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.** [Clarification Statement: Examples of models could include diagrams, and flow charts.] 5-LS1-1. **Support an argument that plants get the materials they need for growth chiefly from air and water.** [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.] 5-LS2-1. **Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.** [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.] 3-5-ETS1-2. **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.**
Example Phenomena	Some whales can eat more than 3,000 pounds of food per day, but humans can't eat that much. Leaves that fall from trees change form in a few weeks.
Additional Practices Building to the PEs	**Asking Questions and Defining Problems** • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Students could *ask questions* [and make predictions about the types of] ***environments in which organisms can survive*** *based on patterns such as cause and effect relationships.* 5-LS2-1 **Developing and Using Models** • Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Students could *collaboratively develop a model based on evidence that shows the relationships among variables for frequent and regular occurring events,* [such as] ***organisms obtaining gases, and water, from the environment***. 5-LS2-1 **Planning and Carrying Out Investigations** • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Students *could conduct an investigation collaboratively – using fair tests in which variables are controlled and the number of trials considered – to produce data to serve as the basis for evidence* [that] ***gases are made from matter particles that are too small to see***. 5-PS1-1 **Analyzing and Interpreting Data** • Represent data in tables and/or various graphical displays to reveal patterns that indicate relationships. Students could *represent data in tables to reveal patterns that indicate relationships* [between organisms in] ***a healthy ecosystem in which multiple species of different types are each able to meet their needs***. 5-LS2-1

Additional Practices Building to the PEs (Continued)	**Using Mathematical and Computational Thinking** • Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems. Students could *describe, measure, estimate, and/or graph quantities,* [such as height,] *to address scientific questions* [about where] ***plants acquire their material for growth***. 5-LS1-1 **Constructing Explanations and Designing Solutions** • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. Students could *use evidence to construct or support an explanation* [that] ***the energy released from food was once energy from the sun***. 5-PS3-1 **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 about a proposed model* [that] ***food provides animals with the materials they need for body repair and growth*** [in the form of] ***particles that are too small to see,*** *citing relevant evidence and posing specific questions*. 5-PS1-1 and 5-PS3-1 **Obtaining, Evaluating and Communicating Information** • Read and comprehend grade appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence. Students could *read and comprehend grade appropriate complex texts and other reliable media to describe how* [the idea that] ***plants acquire their material for growth chiefly from air and water*** *is supported by evidence*. 5-LS1-1
Additional Crosscutting Concepts Building to the PEs	**Scale, Proportion, and Quantity** • Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. Students could describe how *observable phenomena exist from the very small* [such as] ***energy for body warmth*** [in a tiny animal] *to the immensely large* [such as] ***energy from the sun***. 5-PS3-1 **Energy and Matter** • Matter is made of particles. Students could describe that *matter is made of particles* [in the context that] ***plants acquire their material for growth chiefly from air and water***. 5-LS1-1

Additional Crosscutting Concepts Building to the PEs (Continued)	**Stability and Change** • Change is measured in terms of differences over time and may occur at different rates. Students could use examples of ***newly introduced species*** [that] ***damage the balance of an ecosystem*** [to demonstrate that] *change may occur at different rates*. 5-LS2-1
Additional Connections to Nature of Science	**Scientific Investigations Use a Variety of Methods** • Science investigations use a variety of methods, tools, and techniques. Students could describe the *methods, tools, and techniques* [scientists have used to investigate that] ***the energy released from food was once energy from the sun***. 5-LS3-1 **Science is a Way of Knowing** • Science is a way of knowing that is used by many people. Students could describe how many people learn and use the information that ***a healthy ecosystem is one in which multiple species of different types are each able to meet their needs*** [to provide an example of a way that] *science is a way of knowing that is used by many people*. 5-LS2-1

5-PS1-1 Matter and Its Interactions

Students who demonstrate understanding can:

5-PS1-1. **Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [*Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*]

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. • Use models to describe phenomena.	**PS1.A: Structure and Properties of Matter** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	**Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large.

Observable features of the student performance by the end of the grade:			
1	Components of the model		
	a	Students develop a model to describe* a phenomenon that includes the idea that matter is made of particles too small to be seen. In the model, students identify the relevant components for the phenomenon, including:	
		i.	Bulk matter (macroscopic observable matter; e.g., as sugar, air, water).
		ii.	Particles of matter that are too small to be seen.
2	Relationships		
	a	In the model, students identify and describe* relevant relationships between components, including the relationships between:	
		i.	Bulk matter and tiny particles that cannot be seen (e.g., tiny particles of matter that cannot be seen make up bulk matter).
		ii.	The behavior of a collection of many tiny particles of matter and observable phenomena involving bulk matter (e.g., an expanding balloon, evaporating liquids, substances that dissolve in a solvent, effects of wind).
3	Connections		
	a	Students use the model to describe* how matter composed of tiny particles too small to be seen can account for observable phenomena (e.g., air inflating a basketball, ice melting into water).	

5-PS3-1 Energy

Students who demonstrate understanding can:

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.** [Clarification Statement: Examples of models could include diagrams, and flow charts.]

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. • Use models to describe phenomena.	**PS3.D: Energy in Chemical Processes and Everyday Life** • The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). **LS1.C: Organization for Matter and Energy Flow in Organisms** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary)*	**Energy and Matter** • Energy can be transferred in various ways and between objects.

Observable features of the student performance by the end of the grade:			
1	Components of the model		
	a	Students use models to describe* a phenomenon that includes the idea that energy in animals' food was once energy from the sun. Students identify and describe* the components of the model that are relevant for describing* the phenomenon, including:	
		i.	Energy.
		ii.	The sun.
		iii.	Animals, including their bodily functions (e.g., body repair, growth, motion, body warmth maintenance).
		iv.	Plants.
2	Relationships		
	a	Students identify and describe* the relevant relationships between components, including:	
		i.	The relationship between plants and the energy they get from sunlight to produce food.
		ii.	The relationship between food and the energy and materials that animals require for bodily functions (e.g., body repair, growth, motion, body warmth maintenance).
		iii.	The relationship between animals and the food they eat, which is either other animals or plants (or both), to obtain energy for bodily functions and materials for growth and repair.
3	Connections		
	a	Students use the models to describe* causal accounts of the relationships between energy from the sun and animals' needs for energy, including that:	
		i.	Since all food can eventually be traced back to plants, all of the energy that animals use for body repair, growth, motion, and body warmth maintenance is energy that once came from the sun.
		ii.	Energy from the sun is transferred to animals through a chain of events that begins with plants producing food then being eaten by animals.

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

Students who demonstrate understanding can:

5-LS1-1. **Support an argument that plants get the materials they need for growth chiefly from air and water.** [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

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
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). • Support an argument with evidence, data, or a model.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • Plants acquire their material for growth chiefly from air and water.	**Energy and Matter** • Matter is transported into, out of, and within systems.

Observable features of the student performance by the end of the grade:			
1	Supported claims		
	a	Students identify a given claim to be supported about a given phenomenon. The claim includes the idea that plants acquire the materials they need for growth chiefly from air and water.	
2	Identifying scientific evidence		
	a	Students describe* the given evidence, data, and/or models that support the claim, including evidence of:	
		i.	Plant growth over time.
		ii.	Changes in the weight of soil and water within a closed system with a plant, indicating:
			1. Soil does not provide most of the material for plant growth (e.g., changes in weight of soil and a plant in a pot over time, hydroponic growth of plants).
			2. Plants' inability to grow without water.
		iii.	Plants' inability to grow without air.
		iv.	Air is matter (e.g., empty object vs. air filled object).
3	Evaluating and critiquing evidence		
	a	Students determine whether the evidence supports the claim, including:	
		i.	Whether a particular material (e.g., air, soil) is required for growth of plants.
		ii.	Whether a particular material (e.g., air, soil) may provide sufficient matter to account for an observed increase in weight of a plant during growth.
4	Reasoning and synthesis		
	a	Students use reasoning to connect the evidence to support the claim with argumentation. Students describe* a chain of reasoning that includes:	
		i.	During plant growth in soil, the weight of the soil changes very little over time, whereas the weight of the plant changes a lot. Additionally, some plants can be grown without soil at all.
		ii.	Because some plants don't need soil to grow, and others show increases in plant matter (as measured by weight) but not accompanying decreases in soil matter, the material from soil must not enter the plant in sufficient quantities to be the chief contributor to plant growth.
		iii.	Therefore, plants do not acquire most of the material for growth from soil.
		iv.	A plant cannot grow without water or air. Because both air and water are matter and are transported into the plant system, they can provide the materials plants need for growth.
		v.	Since soil cannot account for the change in weight as a plant grows and since plants take in water and air, both of which could contribute to the increase in weight during plant growth, plant growth must come chiefly from water and air.

5-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

5-LS2-1. **Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.**[Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

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 models and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop a model to describe phenomena.

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Connections to the Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Science explanations describe the mechanisms for natural events.

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.

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	Students develop a model to describe* a phenomenon that includes the movement of matter within an ecosystem. In the model, students identify the relevant components, including:
		i. Matter.
		ii. Plants.
		iii. Animals.
		iv. Decomposers, such as fungi and bacteria.
		v. Environment.
2	Relationships	
	a	Students describe* the relationships among components that are relevant for describing* the phenomenon, including:
		i. The relationships in the system between organisms that consume other organisms, including:
		1. Animals that consume other animals.
		2. Animals that consume plants.

		3. Organisms that consume dead plants and animals.
		4. The movement of matter between organisms during consumption.
		ii. The relationship between organisms and the exchange of matter from and back into the environment (e.g., organisms obtain matter from their environments for life processes and release waste back into the environment, decomposers break down plant and animal remains to recycle some materials back into the soil).
3	Connections	
	a	Students use the model to describe*:
		i. The cycling of matter in the system between plants, animals, decomposers, and the environment.
		ii. How interactions in the system of plants, animals, decomposers, and the environment allow multiple species to meet their needs.
		iii. That newly introduced species can affect the balance of interactions in a system (e.g., a new animal that has no predators consumes much of another organism's food within the ecosystem).
		iv. That changing an aspect (e.g., organisms or environment) of the ecosystem will affect other aspects of the ecosystem.

3-5-ETS1-2 Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

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
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.	**ETS1.B: Developing Possible Solutions** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.

Observable features of the student performance by the end of the grade:			
1	Using scientific knowledge to generate design solutions		
	a	Students use grade-appropriate information from research about a given problem, including the causes and effects of the problem and relevant scientific information.	
	b	Students generate at least two possible solutions to the problem based on scientific information and understanding of the problem.	
	c	Students specify how each design solution solves the problem.	
	d	Students share ideas and findings with others about design solutions to generate a variety of possible solutions.	
	e	Students describe* the necessary steps for designing a solution to a problem, including conducting research and communicating with others throughout the design process to improve the design [note: emphasis is on what is necessary for designing solutions, not on a step-wise process].	
2	Describing* criteria and constraints, including quantification when appropriate		
	a	Students describe*:	
		i.	The given criteria (required features) and constraints (limits) for the solutions, including increasing benefits, decreasing risks/costs, and meeting societal demands as appropriate.
		ii.	How the criteria and constraints will be used to generate and test the design solutions.
3	Evaluating potential solutions		
	a	Students test each solution under a range of likely conditions and gather data to determine how well the solutions meet the criteria and constraints of the problem.	
	b	Students use the collected data to compare solutions based on how well each solution meets the criteria and constraints of the problem.	