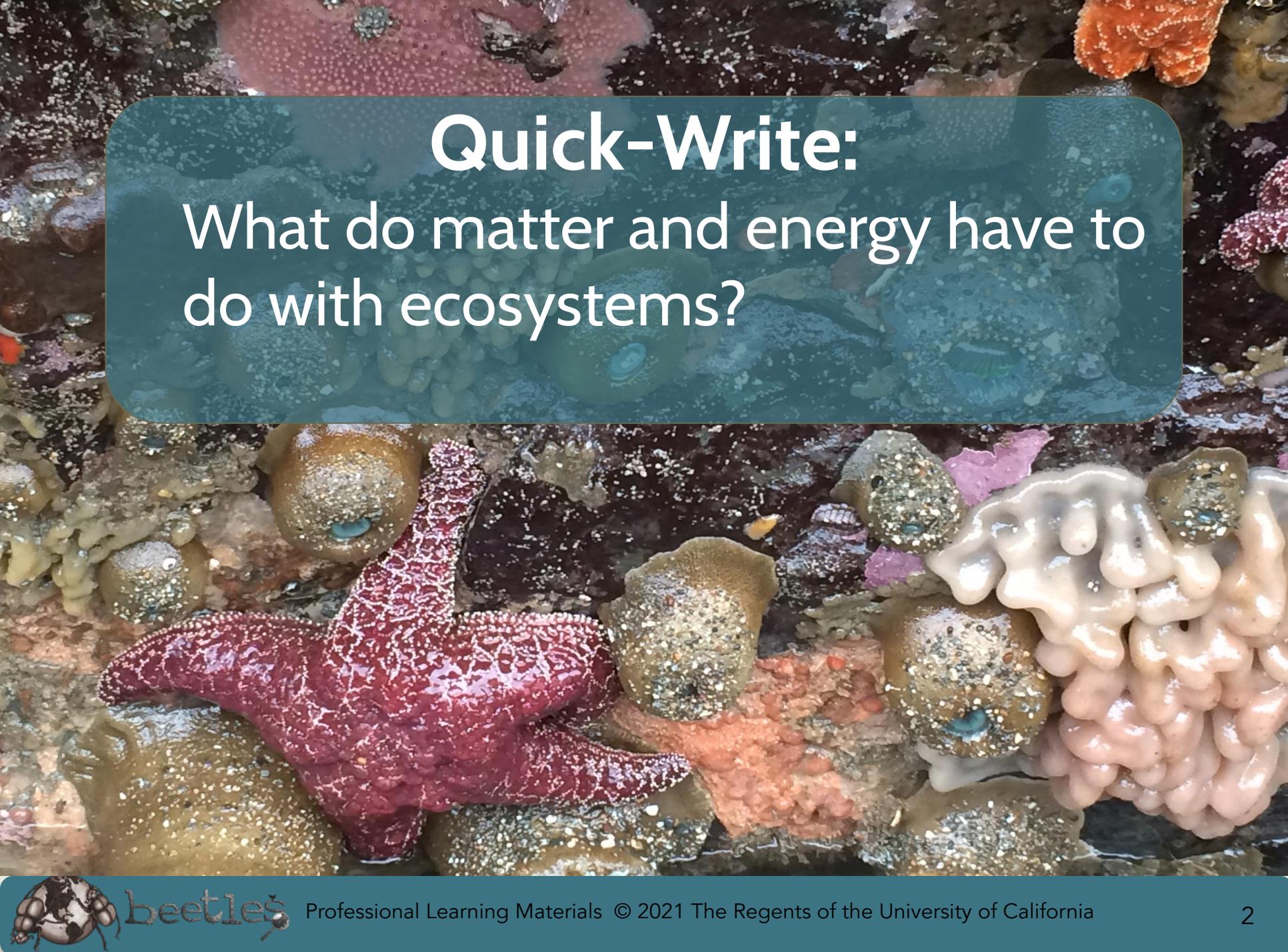


Matter and Energy in Ecosystems

Science Content Session

Guiding question: How can we improve our own scientific understanding of matter and energy to more effectively teach students about interactions in ecosystems?





Quick-Write:
What do matter and energy have to do with ecosystems?



Goals for the Session

- Improve scientific understanding and increase curiosity about this complex topic.
- Engage in activities and meaning-making discussions about matter and energy in ecosystems.
- Model some teaching strategies that can be used with students.
- Think about how to make effective instructional choices when teaching about the topic.



Matter and Energy is an important crosscutting concept in science.

“The ability to examine, characterize, and model the transfers and cycles of matter and energy is a tool that students can use across virtually all areas of science and engineering.”

A Framework for K–12 Science Education,
NRC, 2012



Guiding Questions for the Session

- How do organisms get the matter and energy they need to live and grow?
- How do organisms interact with living and nonliving parts of their environment as they use matter and energy?
- How do matter and energy stay in and/or leave an ecosystem?



Food Web/Matter and Energy Diagram

1. Make a diagram that includes a food web of organisms from the surrounding area.
2. Include other forms of matter and energy: air (matter), soil (matter), and sunlight (energy).
3. Link items with arrows pointed in the direction of the movement of energy and matter.
4. **Red arrows** show **energy** flow, and **blue arrows** show **matter** movement.



While you are discussing the diagram with your group:

- share your ideas.
- ask clarifying questions.
- try to build on the best thinking.
- offer suggestions but not quick answers or corrections.
- incorporate one another's ideas into the final product.





Discussion and Group Agreements

Listen actively and share ideas.

Share and ask for evidence.

Build on ideas of others.

Keep an open, curious mind.

Disagree respectfully to increase understanding.

Pay attention to participation.



Earth Ecosystem Diagram





Food, Build, Do, Waste Activity

- What *food* does an organism eat to get matter and energy?
- What does an organism *build* in its body from the matter in its food?
- What does an organism *do* with the energy in its food?
- What matter and energy *waste/exit* products are given off by an organism?



Diagramming Thinking

- What happens to the matter and energy when an ice cube melts?



Matter and Energy Thought Problem #1

- A tiny redwood seed can become an enormous redwood tree.
- Where does the mass of a tree come from?



Matter and Energy Thought Problem #2

- In one year, a rabbit weighing 8 pounds eats and drinks 400 pounds of plant material and water.
- About 140 pounds of waste is produced by the rabbit as feces and urine.
- What happened to the other 260 pounds?



Discussing and Diagramming in Small Groups

- Choose a question to discuss.
- Pick a facilitator for your group.
- Discuss the question and create a diagram that explains your thinking about matter and energy for your question.
- Try to show how matter and energy are moving in the system.



While you are discussing the problem with your group:

- share your ideas.
- ask clarifying questions.
- try to build on the best thinking.
- offer suggestions, but not quick answers or corrections.
- incorporate one another's ideas into the final product.



Discuss Diagrams with Another Group

- Explain how tracking matter and energy relate to the thought problem.
- Ask clarifying questions to try to discover how they are thinking about the problem.
- Offer suggestions but not quick answers or corrections.

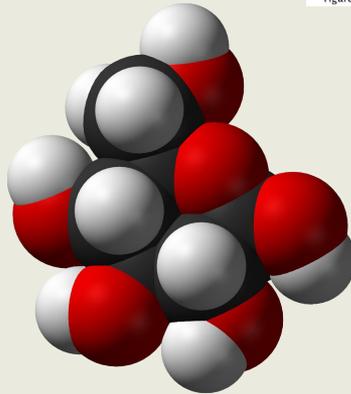
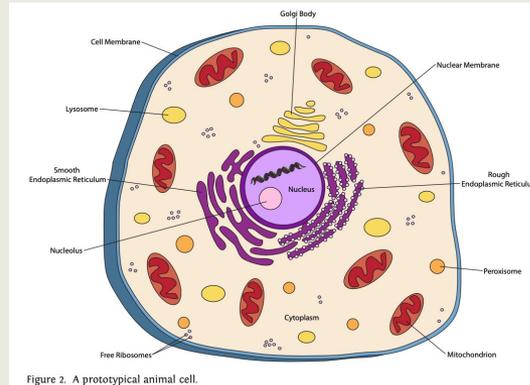


Getting Energy from Food

- How do your cells get energy from the food you eat?
- How do plant cells get the energy they need?
- How do the cells of a decomposer get energy to live and grow?



All cells get energy and matter from breaking down glucose (sugar).



glucose



energy to make cell
changes happen

matter to build cell
structures

Cellular Respiration

(getting energy from food)

glucose + oxygen  carbon dioxide + water
+ thermal energy (heat)

The overall process representing the many chemical reactions used by cells of most living organisms to get energy from food.



Photosynthesis

(making food)

carbon dioxide + water + light energy \longrightarrow glucose + oxygen

The overall process representing the many chemical reactions used by photosynthetic organisms to make glucose.



Cellular Respiration

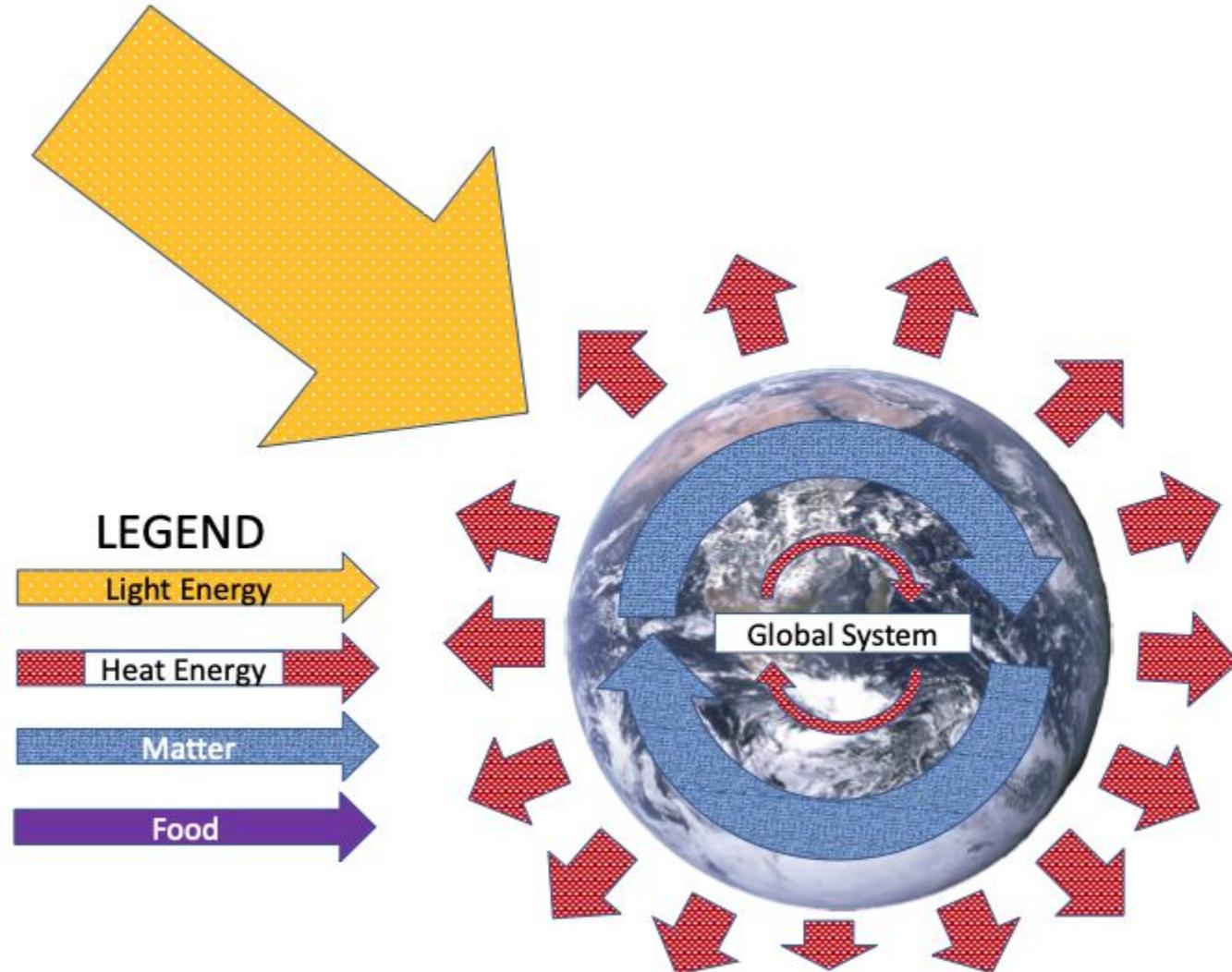
glucose + oxygen \longrightarrow carbon dioxide + water
+ thermal energy (heat)

Photosynthesis

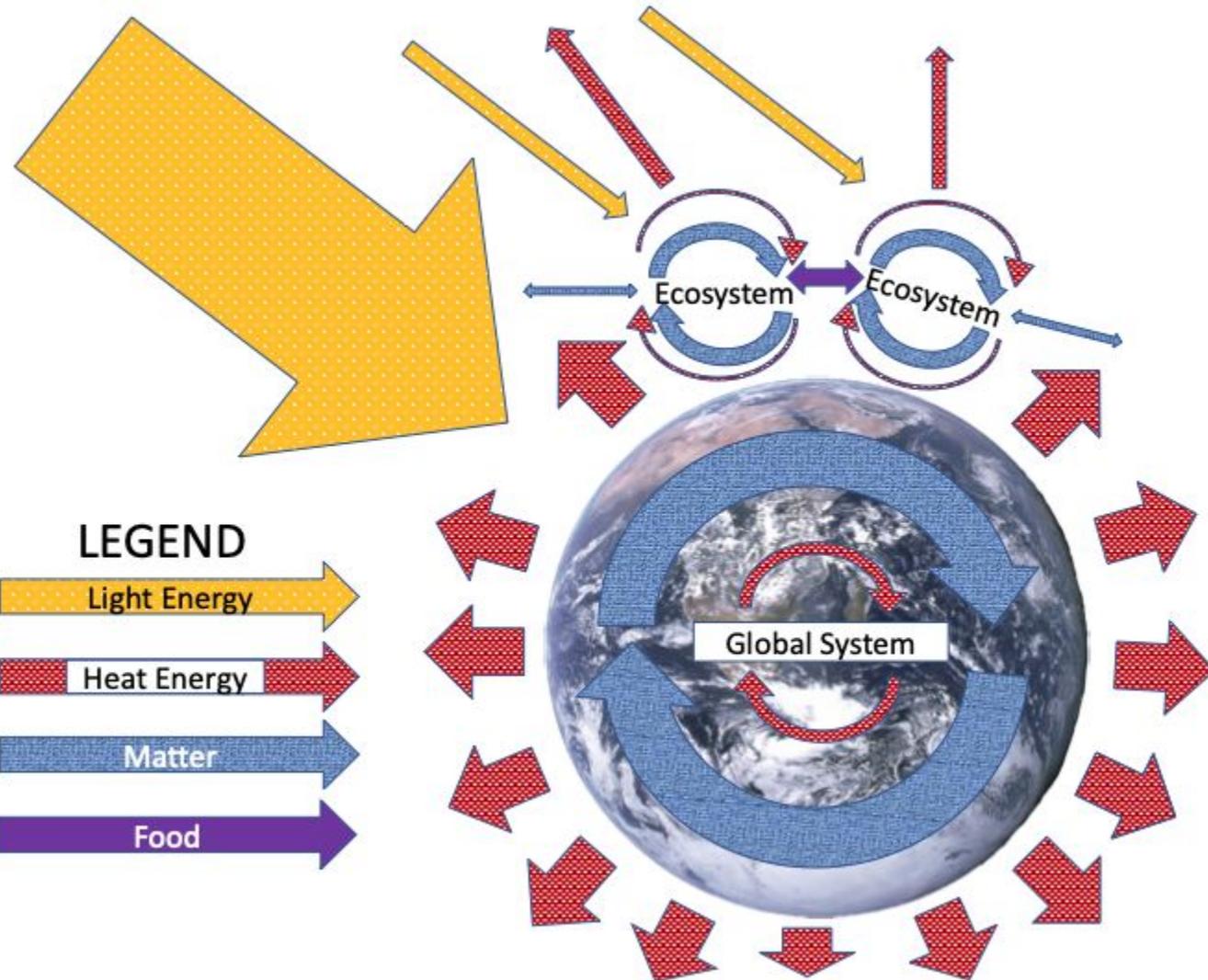
carbon dioxide + water \longrightarrow glucose + oxygen
+ light energy



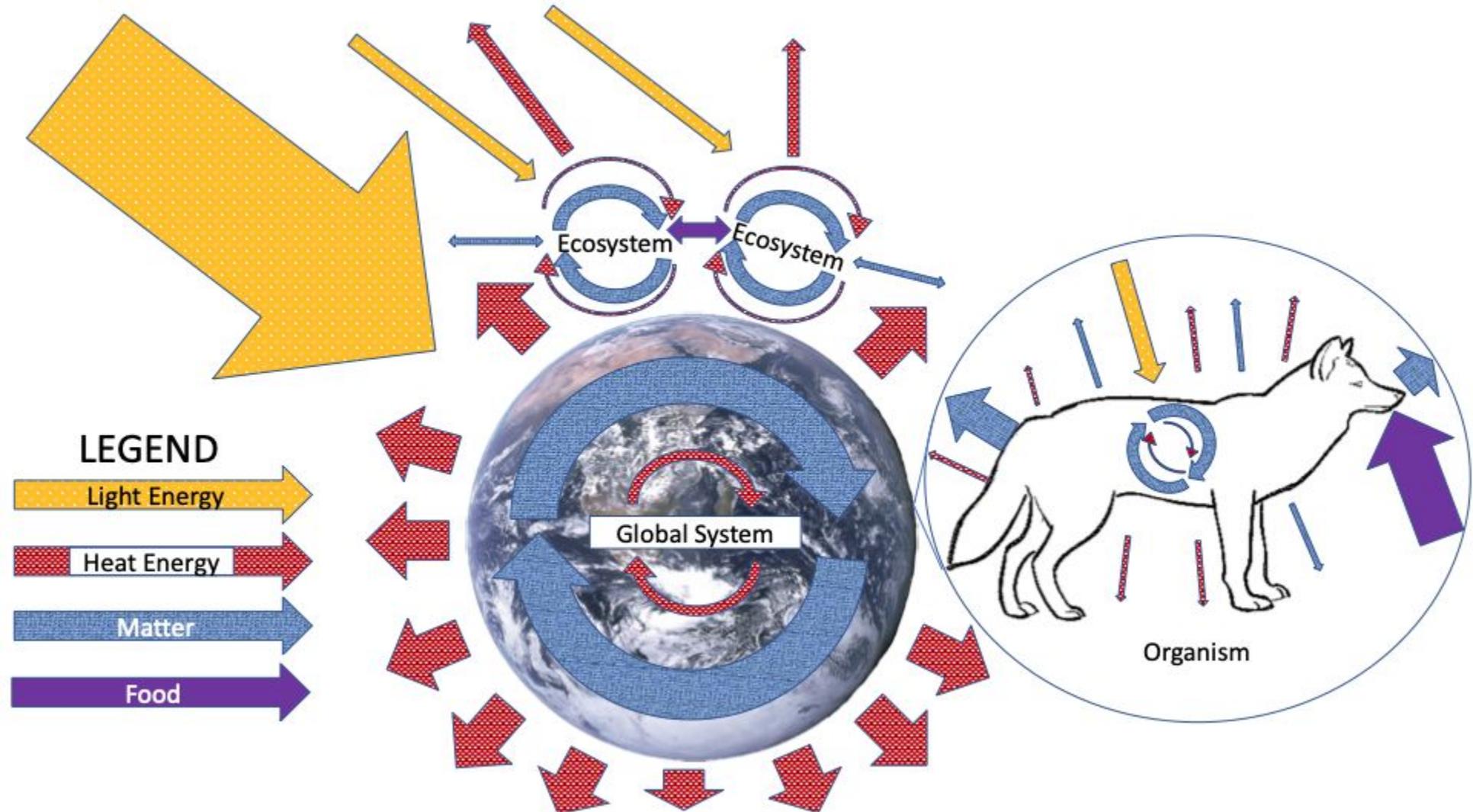
Matter and Energy at the Global System Level



Adding Matter and Energy at the Ecosystem Level

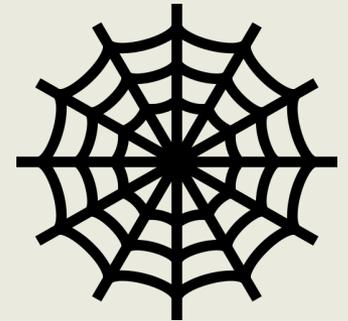
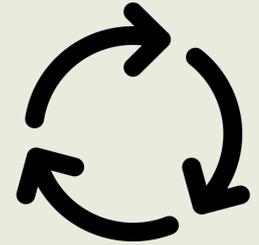
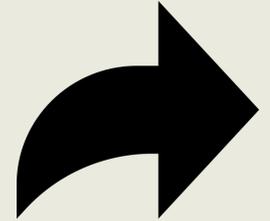


Adding Matter and Energy at the Individual Organism Level



Communicated more simply:

- **Energy flows:** it's what makes things happen.
- **Matter cycles:** it's the stuff everything is made of.
- **Life webs:** living things are connected and depend on each other to get the matter and energy they need to live and grow.

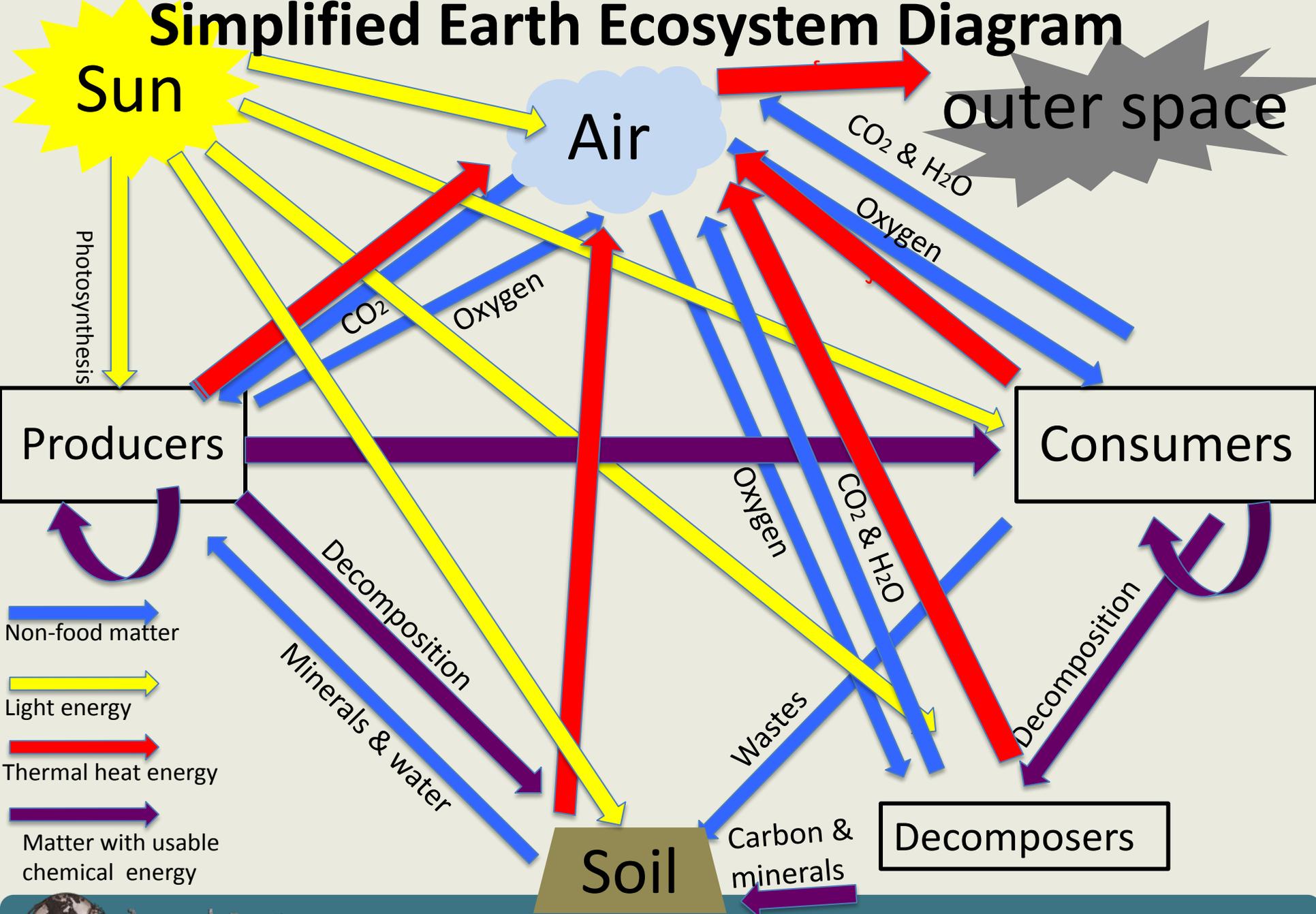


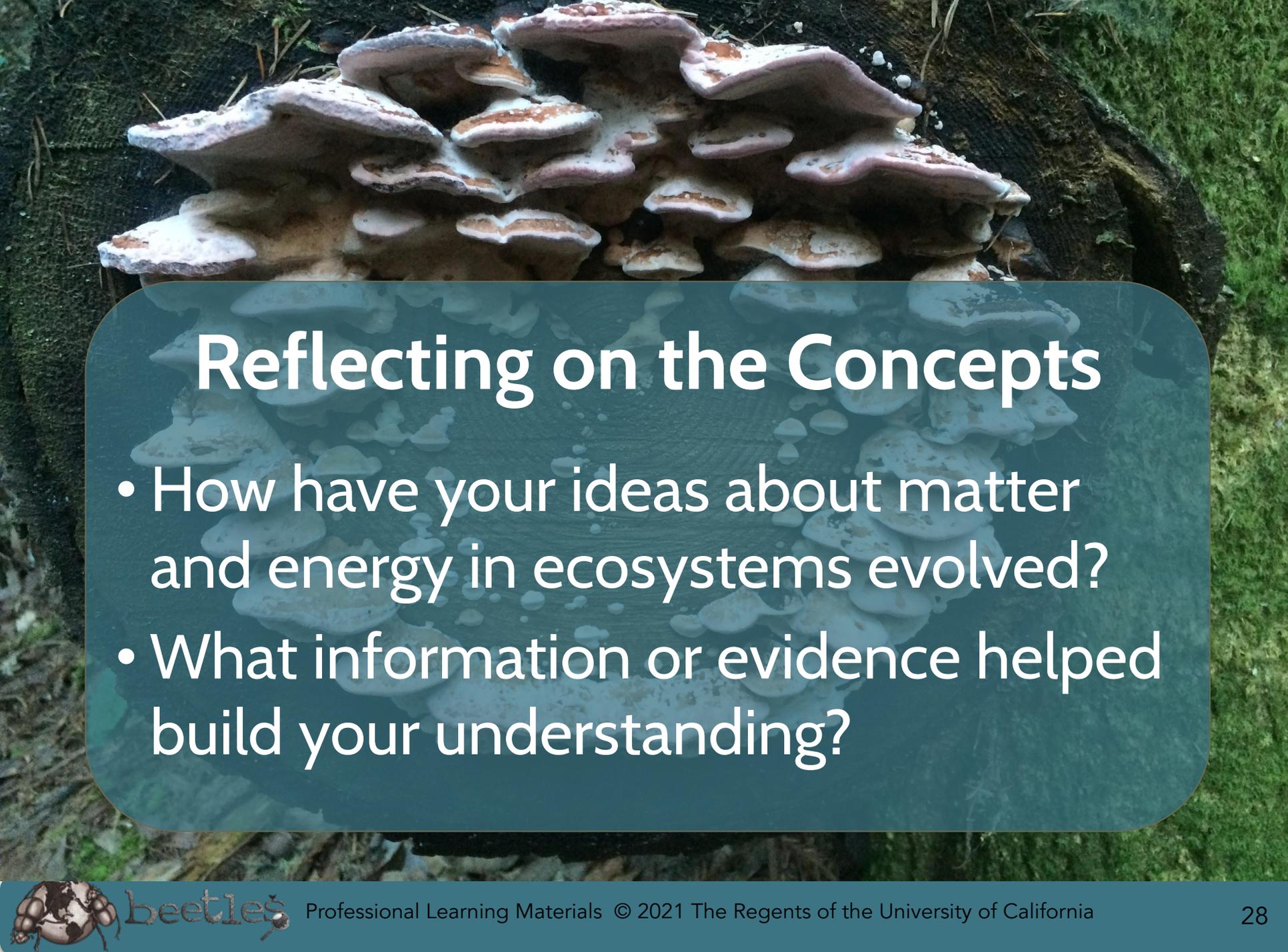
What's wrong with these statements?

- Plants take sunlight and turn it into food.
- Energy enters and then just keeps cycling round and round in Earth's systems.
- Animals burn off matter, turning it into energy.
- When things decompose, the matter and energy that was in them disappears.



Simplified Earth Ecosystem Diagram





Reflecting on the Concepts

- How have your ideas about matter and energy in ecosystems evolved?
- What information or evidence helped build your understanding?

NGSS 5th Grade Performance Expectations

- 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.]

The performance expectations above were 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 models to describe phenomena. (5-PS3-1)
- Develop a model to describe phenomena. (5-LS2-1)

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. (5-LS1-1)

Connections to Nature of Science

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

- Science explanations describe the mechanisms for natural events. (5-LS2-1)

Disciplinary Core Ideas

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). (5-PS3-1)

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 to 5-PS3-1*)
- Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

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. (5-LS2-1)

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

Crosscutting Concepts

Systems and System Models

- A system can be described in terms of its components and their interactions. (5-LS2-1)

Energy and Matter

- Matter is transported into, out of, and within systems. (5-LS1-1)
- Energy can be transferred in various ways and between objects. (5-PS3-1)



Disciplinary Core Ideas

- **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. Plants acquire their material for growth chiefly from air and water.
- **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

Energy and Matter

- Matter is transported into, out of, and within systems. (5-LS2-1)
- Energy can be transferred in various ways and between objects. (5-PS3-1)

Systems and System Models

- A system can be described in terms of its components and their interactions. (5-LS2-1)

Students need deep understandings of nature for performance expectations.

Performance Expectation 5-LS2-1:

- Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Matter and Energy–Related Topics Often Taught in Outdoor Science:

- food chains and predator/prey relationships
- food webs
- food pyramids
- relationships between organisms in ecosystems
- decomposition
- photosynthesis



Matter and Energy in Ecosystems—Related BEETLES Student Activities

- *You Are What You Eat*
- *Decomposition Mission*
- *What Lives Here?*
- *Food, Build, Do, Waste*
- *Matter and Energy Diagram*
- *Case of the Disappearing Log*
- *Food Web* (classroom post-activity)
- *Ecosystems (and Matter) Theme Field Experiences* (For sequencing and leading coherent experiences on the theme)



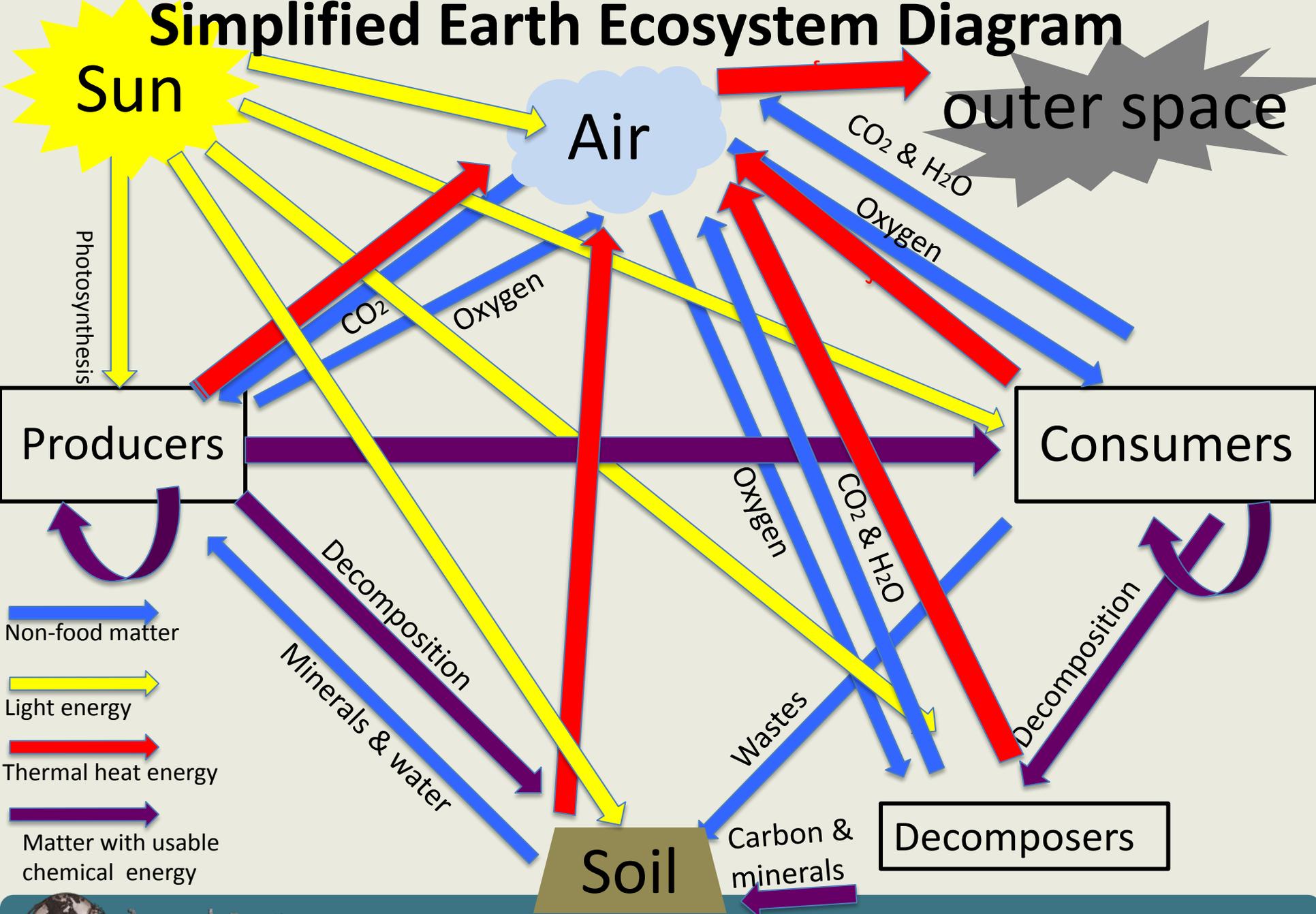
- About ecosystems, matter, and energy, with a focus on energy.
- Written at a level appropriate for **grade 4–5** students to read independently.
- Can be used for older and younger students as part of a guided learning experience.



<http://store.lawrencehallofscience.org>



Simplified Earth Ecosystem Diagram



Reflection

How can you apply content from this session to your instruction with students?



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