

Lesson 7: Effects of System Changes

Introduction

In the last lesson, you explored how matter and energy interact within the biosphere system. In this lesson, you will consider what might happen to the system when one of the components is changed.

Lesson Question

Process and Procedure

1. Write your best ideas about the lesson focus question in the space below. Leave space to revise your ideas as you learn throughout this lesson. As you have new ideas, record them in a different color.

Effects of Rising CO₂ Levels on Plants

2. What happens to the components, inputs, and outputs of a system when one part of the system is changed? To think more about this question, you will consider the effects of increased carbon dioxide levels on plants.

As you learned in earlier lessons, carbon dioxide is an input molecule for the chemical reactions of photosynthesis. Carbon dioxide is also an output molecule of the chemical reactions of cellular respiration. You developed illustrations of system models to show the interactions of matter and energy in different systems.

What might be the effects of rising carbon dioxide levels on plants? Record your predictions in the space below. Be sure to include reasons for your predictions.

3. Scientists, policy makers, and farmers are very interested in the question, “What are the effects of rising CO₂ levels on plants?” Plants are not only an important food source for humans, they are also food for the animals that we eat. Different people have made claims about how rising CO₂ levels will affect the plants that we depend on. Consider the following claims:

Claim A: Rising carbon dioxide levels will benefit plants and humans because it will result in increased rates of photosynthesis and greater crop yields.

Claim B: Rising carbon dioxide levels will prove harmful to plants and humans because of the damaging effects of climate change.

You and your team will develop a scientific argument that will evaluate the two claims. A scientific argument is used to compare and evaluate competing explanations by analyzing the quality and relevance of the evidence and reasoning used to support the claim. Scientists may 1) determine that one explanation has stronger evidence and reasoning to support it, while the alternative explanation has weaker evidence and may be refuted; 2) determine that neither explanation has strong enough evidence and reasoning to support or refute it and more evidence is needed to answer the question; or 3) the evidence for several explanations may be combined to create an even stronger explanation.

A scientific argument includes two main parts: 1) a scientific explanation that provides evidence and reasoning to support a claim, and 2) a rebuttal that provides justification for why the alternative claim, evidence, and/or reasoning is insufficient, irrelevant, or inaccurate.

Which claim best matches with your team’s predictions from Step 2?

4. To consider the two claims about the effects of rising carbon dioxide levels on plants, your teacher will provide you with a handout of the article, "Ask the Experts: Does Rising CO₂ Benefit Plants?"

Half of your team will use the article to identify evidence that supports Claim A and critique the quality and strength of that evidence. The other half of your team will do the same for Claim B.

Question: What are the effects of rising carbon dioxide levels on plants?

<p style="text-align: center;">Claim A</p> <p>Rising carbon dioxide levels will benefit plants and humans because it will result in increased rates of photosynthesis and greater crop yields.</p>	<p style="text-align: center;">Claim B</p> <p>Rising carbon dioxide levels will prove harmful to plants and humans because of the damaging effects of climate change.</p>
<p>The evidence that supports this claim is...</p>	<p>The evidence that supports this claim is...</p>
<p style="text-align: center;">Critique</p> <p><i>Critique the quality and strength of the evidence that supports this claim.</i></p>	<p style="text-align: center;">Critique</p> <p><i>Critique the quality and strength of the evidence that supports this claim.</i></p>

5. Work with your team to decide if
- one claim (A or B) has stronger evidence and reasoning to support it, while the alternative claim has weaker evidence and may be refuted,
 - neither claim A or B has strong enough evidence and reasoning to support or refute it and more evidence is needed to answer the question, or
 - the evidence for both claims A and B may be combined to create an even stronger claim.

Using the criteria below, write a scientific argument that answers the question: Which claim about the effects of rising carbon dioxide levels on plants is best supported by evidence and reasoning? Your argument should include:

- your claim (either a, b, or c above)
- relevant evidence and reasoning that supports your claim
- scientific reasoning that critiques the evidence and evaluates your claim.
- a rebuttal that refutes the other two claims

Scientific Argument

Rebuttal

6. Scientists engage in argumentation to get feedback and revise their ideas. Scientists share their ideas with other scientists interested in the same question through presentations. Depending on their own ideas, the scientists in the group may agree, disagree, or question the argument that is being presented.

You will model aspects of this process. Check off each step as you complete it.

- Exchange your team's argument with a member of another team.
- Read your partner's argument.
- Ask questions to clarify your understanding of what your partner wrote.
- Provide feedback on sticky notes. Write at least two pieces of feedback on your partner's argument to help them improve their work. Place the sticky note near the place on their argument that generated your feedback idea.
- Return the argument and sticky notes to your partner.
- Share the feedback you received with your team. Work with your team to revise your argument based on the feedback your team received.

Synthesize and Summarize Ideas

7. The unit central question is **“How do matter and energy move through a system as living things interact with each other and the environment?”** Return to the first page of Lesson 1 and revise your ideas in a different color.

In the space below, write a reflection that summarizes the changes in your thinking and what caused your ideas to change. Be prepared to share your reflection with the whole class.

8. During this unit, you used the crosscutting concept of systems and system models to think about the interactions of matter and energy and to develop a scientific argument about the effects of rising carbon dioxide levels on plants. How did thinking about systems and system models help you understand interactions of matter and energy and develop a strong scientific argument (or not)?

