Biology

Sample Science Learning Plan

Big Idea/ Topic

Interdependence of organisms, cycling of matter, cycling of energy, stability of an ecosystem, human impact

Standard Alignment

SB5. Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.

b. Develop and use models to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.

- Arranging components of a food web according to energy flow.
- Comparing the quantity of energy in the steps of an energy pyramid.
- Explaining the need for cycling of major biochemical elements (C, O, N, P, and H).

c. Construct an argument to predict the impact of environmental change on the stability of an ecosystem.
d. Design a solution to reduce the impact of a human activity on the environment. (Clarification statement: Human activities may include chemical use, natural resources consumption, introduction of non-native species, greenhouse gas production.)

Connection to other content areas:

ELAGSE9-10W1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

ELAGSE9-10W2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

ELAGSE9-10W7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

ELAGSE9-10L6: Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

ELAGSE9-10RI8: Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid, and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.

Engage:

Phenomena: Energy…where did you come from and where do you go?

Students should go outside when the sun is out and observe plants from a safe place in your neighborhood. What do you notice about the plants?

Then they should go outside either early in the morning or in the evening when the plants are not touched by the sun. What do you notice?

Students can use this **sheet** to record their observations and complete the next activity. Students should then go outside and gather several leaves from different trees in their area. Students should then compare the leaves from the different trees and see what patterns they notice. *Students should be as safe when they go outside to observe and gather leaves. Be sure to provide instruction about plants in your area that students should leave alone and what insects/animals and landforms to stay away from. It is different in each area of Georgia and the students will better understand if it is localized. *

Have students discuss patterns they notice with other students and create a class list of the patterns that are seen on the leaves.

Then help students narrow down the patterns to the following pattern- Darker color green on the top of the leaf that faces the sun and then a lighter color green on the bottom of the leaf that faces the ground.

Students should then begin to obtain information about the reason for the pattern. Students may require assistance in find sources that are reliable and provide information that will help them make sense of the pattern.

Students should then begin to construct an explanation about why the pattern exist and how it benefits the tree.

Unplugged: Provide students with the observation sheet. Provide students with safety information about pulling leaves from trees. Consider providing students with discussion questions to help them engage their parents, siblings, and other members of their household in looking at patterns in leaves. The teacher should then have a clear and consistent plan for getting the pattern that students should focus into the students hands- consider a sealed envelope with instructions about when to open or a phone call for discussion- always abide by your districts communication policy when communicating with students. Have a clear and consistent set of guidelines for providing feedback to students.

Explore:

Now Students should look more deeply into photosynthesis and how it impacts plants and ecosystems. Students should complete the **interactive or print version of this activity.** Then students should use their knowledge to develop a model that shows the process of photosynthesis. Students can use this **sheet** to work through the explore section.

Now, where does the energy go from photosynthesis? Have students obtain information about where the glucose and oxygen go from photosynthesis. Students should find information about cellular respiration and create a model about how the energy is moving throughout this process. Then students should connect photosynthesis and cellular respiration into a model that shows the cycle that energy flows though.

Now have students think bigger picture. Why is the energy cycle important? How does it impact ecosystems?

Students should go outside and observe nature from a safe area. Students should focus on animals in the area. Students should make a list of the organisms that they see in their environment. Then students should use those organisms to create a food web that would exist in the area that we live in. Students may need to fill in the gaps within the food web and may need to find information about organisms within the ecosystem/biome that we live in (which is the temperate deciduous forest).

Students should explain where the energy in their food web comes from and follow it though each path. Students should note that only 10% of energy moves from one trophic level to the next. Students should note that some energy is consumed for life processes and other energy is lost as heat.

Students should label each trophic level within their food chain model. Then students should take the food chain and turn it into an energy pyramid. This should show where the largest amount of energy is and how the amount of available energy is lessened as it moves up the food chain.

Unplugged: Provide students with the printer friendly version of this activity and the sheet to record their ideas. Students may need some resources to find other information about photosynthesis, cellular respiration, food webs and organisms in the environment. Have a clear and consistent way to provide students with feedback as they work throughout the lesson.

Explain:

Phenomena: Is energy the only thing that moves within an ecosystem?
Ask students what is cycling within the ecosystems besides energy. Here are some questions to help students discuss this:

- What are the products of photosynthesis?
- What are the products of cellular respiration?
- What do organisms need to survive?
- What makes up all things living and non-living?

Students can use this sheet to work though the explain section. Assist students in concluding that matter moves along with the movement of energy.
Students should then obtain information about the cycling of water, carbon, and nitrogen. Students should use the following interactives to investigate the cycling of matter:

- Carbon cycling
- Nitrogen Cycling
- Water cycle

Students should then develop models of their own that show cycling of matter using organisms in the ecosystem that they live in. Then students should construct an explanation about why the cycling of matter and energy in an ecosystem are important to the success of life within the ecosystem.

Unplugged: Students will need the sheet to work through the lesson. Students will also need some copies of the cycles and some other information about the different cycles of matter. Have a clear and consistent way to provide feedback to students as they move through the lesson. The teacher may want to suggest places that students can observe the cycling of matter such as rainstorms, burning of fossil fuels in cars, predation, and the decay of dead organisms. The teacher should be sure to provide safety statements to students when going outside to observe the cycling of matter.

Elaborate:

Phenomena: How are ecosystems impacted by abiotic factors and humans?

Students should research events or other things that could cause changes in the environment. Some questions to help students identify things that would change environments are:

- How does it impact the animal life?
- How does it impact the plant life?
- How does it impact the abiotic factors in the ecosystem?

Students should consider natural disasters, weather events and human impact as things that could change the environment.
Next students should evaluate the following **scenarios** and construct an argument about the impact on the stability of the environment. Be sure to emphasize that students should include information about the cycling of matter and energy within the ecosystem.
Then students should focus on one of the human impact **scenarios**. Students should attempt to design a solution to the human impact problem presented in the scenario.

Unplugged: The teacher should consider providing students with articles about things that could cause changes in the environment. The teacher should consider providing students with suggestions of places in their neighborhood that they could go and observe changes in the environment. The teacher should provide students with the scenarios. Teachers may need to provide an example of the information that they want the students to provide based on the scenarios.

Evaluation:

Students can use this **sheet** to do the following project. Students should research an environment that has a lot of change. These could include areas where humans are impact the environment, where natural disasters occur or where the environment is changing naturally. If students need guidance it could be something like this:

- Areas of active volcanoes
- Where there is significant deforestation
- Where there is significant new building
- Areas likely to have natural erosion/deposition
- Areas where glaciers are moving.

Students should then create a model of a food web that would exist with that area. Students should construct an explanation about how the changes in the area are impacting the food web. Students should also construct an argument about how the cycling of matter is impacted as the environment changes.

Unplugged: Students will need the project sheet. The teacher should consider providing a rubric for students as it will help students understand the requirements of the project and allow students to self-evaluate prior to turning it in. The teacher should consider providing students with articles and information to help them with their project. These articles and information may need to include ecosystems, environments, organisms, food chains and any other information that might be necessary.

Lesson Goals Checklist

Standards:

SB5. Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.

b. Develop and use models to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.

- Arranging components of a food web according to energy flow.
- Comparing the quantity of energy in the steps of an energy pyramid.
- Explaining the need for cycling of major biochemical elements (C, O, N, P, and H).

c. Construct an argument to predict the impact of environmental change on the stability of an ecosystem.

d. Design a solution to reduce the impact of a human activity on the environment. (Clarification statement: Human activities may include chemical use, natural resources consumption, introduction of non-native species, greenhouse gas production.)

- ☐ Develop and use models that explains the cycling of matter and energy within ecosystems.
  - Explain how photosynthesis and cellular respiration part of the cycling of matter and energy within an ecosystem are vital to the ecosystem's existence.
  - Put organisms in a food web in order based on the energy flow.
  - Compare the energy available in each step of a food web by designing an energy pyramid.
  - Explain the need for cycling of matter.
- ☐ Predict the impact of environmental change on an ecosystem.
- ☐ Design a solution to reduce human impact on out ecosystems.

Evidence of Student Success

Student mastery is assessed throughout this unit using formative and summative components. Student discussion, explanations and products should reflect the understanding indicated in the Evaluate section above. Each activity in the segment functions as an assessment opportunity as well to plan targeted supports or provide extension items. Formative options using the self-evaluation checklist and the activities at various points during the segment.

Student Learning Supports

The goal for science education in the state of Georgia is as follows: All Students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields.
The learning experiences provided for students should engage them with fundamental questions about the world and with how scientists have investigated and found answers to those questions.
This lesson includes the disciplinary core ideas, science and engineering practices and crosscutting concepts to actively engage students in exploring science concepts with real world topics. As part of the vision we must support the inclusion of all students in science learning.
Some **general** ideas to assist in supporting students that struggle are as follows:

- Be sure that students can access the information that you they are learning. Make sure that you can answer the following questions:
  - Do students have what they need to get the information? This is about them having the book or internet access to get to the information.

    - Once students obtain the information, are students able to determine what information is important? This is about the students having materials on the appropriate grade level and that is in a format that students can understand.
    - Is the material presented in multiple ways that allows all students to interact with information in a way that works for them? Such as video, audio, and articles.
    - Consider read aloud as a potential option for students that have reading deficits as an option to assist students in accessing the material. This could be done using video or via phone.
- Students may need ideas about where to find information. Providing students with information about what a reliable source is and even where to find reliable sources may be beneficial for students.
- Some students may find it difficult to complete the entire lesson workload. Some students may benefit from a reduced workload (note: this should be used only when absolutely necessary). Be sure that the information that is removed will not negatively impact the student's understanding of the disciplinary core idea.
- Consider how students show their knowledge. Students need multiple ways and opportunities to show their knowledge. Things to consider:
    - Recording video or audio
    - Drawing
    - Writing
    - Typed
    - Verbal
- Provide students with a way to ask questions in a forum that does not cause anxiety. Frequently students do not want to ask questions in front of their peers because they are afraid of what their peers may think of them. So, be sure to provide students a way to ask questions that is private or anonymous.
- Consider materials that students need to complete the assignments.
    - Do students have needed materials?
    - What are some alternative mateirals that students may have available to them?
- Have a clear and consistent set of guidelines for providing consistent feedback to all students.
- Utilize graphic organizers such as those from the Wonderofscience.com
- Use high leverage and evidence-based practices to reach all students.

Some things to consider, **specific to this lesson**, when designing supports for students are as follows:

- Discuss with students what a pattern is and what they should be looking for.
    - Consider providing an example of a pattern.
- Consider providing students with sources to obtain information.
    - Consider teaching students how to find a reliable source.
    - Consider discussing with students what your process is when determining what information is important when looking at various sources.
- Consider going over the differences between an observation and inference.
- Use guiding questions as needed to help students make sense of the work, their ideas, and the concepts.
- Provide students with an avenue to have texts read aloud to them. These avenues could include video chat, phone call, text-to-speech features, or programs.
- Consider having discussions about interactives, articles, and concepts.
- Consider showing students models of a food web and discussing as they work.
- Consider providing students with a rubric. This will allow students to understand the expectations and self-evaluate as they work.
- Consider providing students with the opportunity to peer review.
- Discuss with students why a pyramid is the correct model to show energy within an ecosystem.

- Provide students with some examples of changing environments. Then discuss how the environment is changing and what the cause of the change is.
- The teacher should consider working out an example of evaluating scenarios.
- The teacher should consider providing students with examples of changing environments.

Engaging Families
Additional resources to support this segment can be found at GPB: Georgia Home Classroom.

Tree Leaf Observation

Directions: Go outside and observe plants in your environment twice in one day. Once when the sun is high in the sky and shining directly on the plants. Then later in the day when the plants are not in direct sunlight. Record the observations in the boxes below. Feel free to draw or write what you notice about the plants at different times in the boxes.

Direct Sunlight	Indirect Sunlight

1. Do you notice any differences? Similarities?
2. Why do you think these similarities and differences occur?

Now gather leaves from several different trees in your neighborhood. Be sure to follow all safety guidelines that your teacher has provided.

Sketch the leaves in the boxes below. Focus on a top view and a bottom view – see image below to make clear how it should appear.

Record your observations below:

	Top of Leaf	Bottom of Leaf
Leaf A		
Leaf B		
Leaf C		
Leaf D		

Look at your sketches and the leaves. Make some observations about patterns among the leaves. What patterns do you see (focus on similarities among all those leaves)?

_____

_____

_____

_____

After, discussing it with your classmates and teacher, list the pattern that the class is going to focus on below.

_____

Obtain information from reliable sources about how this pattern is important to the tree. Record information that you find below.

Based on the information that you found, write a basic explanation about why the pattern is important to the tree's function in the ecosystem.

Photosynthesis/Cellular Respiration Model Sheet

Directions: After completing the interactive about energy movement at the following link, Photosynthesis interactive, answer the following questions. Then create a model of photosynthesis and cellular respiration.

1. What do plants need to survive?
2. What benefits, within an ecosystem, when a plants needs are met?
3. Where does the water come from?
4. Where does the carbon dioxide come from?
5. What happens to plants without sunlight?
6. Create a model of photosynthesis in the box below.

7. Write the formula for photosynthesis below.
8. Why is photosynthesis important to ecosystems?
9. Now take some time to find information about where the energy goes and how it is made usable by the cell. Record the information that you find about where energy goes and how it is converted in the box below.

10. Where does the energy go from the plant?
11. How is energy converted into something usable?
12. Why is the energy cycle important? How does it impact the ecosystems?

Food Webs and Energy

Directions: Go outside, find a safe place to stand and observe organisms in your environment. Record the names of the organisms that you see while observing nature. Then construct a food web using the organisms that you saw and organisms that occur in the biome/ecosystem that you live in.

1. Record observations below.

2. Now find other organisms that could be included in your food web (They must live in our area).

3. Construct your food web below.

4. Now answer the following questions:
    a. Where does the energy come from?
    b. What happens to the energy within the ecosystems?
    c. What happens to the energy that is not used by the organism?

5. Now go back to your food web. Put the organisms in the following categories based on where the fall within the food web. Keep in mind that some organisms may fall into more than one category.

Producer	Primary Consumer	Secondary Consumer	Tertiary Consumer	Quaternary Consumer

6. Justify your placement of the organisms.

7. Now take the organisms and your knowledge of energy transfer and create a model that shows how much energy is available at each trophic level.

Cycling of Matter

Directions: Answer the following questions, use the interactives to investigate further and then develop a model of the different cycles that you are investigating.

1. What are the products of photosynthesis?
2. What are the products of Cellular respiration?
3. How do photosynthesis and cellular respiration relate to one another?
4. What is moving in photosynthesis and cellular respiration besides energy?
5. What makes up all living things?

Now complete the interactives at each of the following links:

- Carbon cycling
- Nitrogen Cycling
- Water cycle

Now develop models of the following cycles in the boxes below.

Nitrogen	**Water**
Carbon	

Environmental Change Scenarios

Directions: Evaluate the following scenarios. Identify impacts on the ecosystem (think cycling of energy and cycling of matter). Then predict what will happen to the ecosystem that is being impacted and determine if the ecosystem will remain stable. Justify.

1. In the Artic, polar bears roam and are an apex predator. Now, the ice that polar bears walk on is melting and the number of polar bears has decreased dramatically.

2. A big retail establishment and parking lot are being added to what was once a 12-acre field. It was one of the only grass fields for several miles. So, the grass population is being reduced in the area.

3. A drought is impacting the temperate forest. The drought is severe and pine trees are dying due to lack of water.

4. A farmer put fertilizer on his field right before a big rain. After the rain, the farmer noticed that the fertilizer washed into the pond in the nearby park. Fertilizer and water life do not mix well and consequently many fish have died in the pond and are washing onto the shore.

Human Impact Scenarios

Directions: Evaluate the following scenarios. Choose one of the scenarios, identify the human impact and develop a solution to try to minimize the impact on the environment.

1. Frequently, cities around the world must issue air quality alerts because of the amount of pollution in the air.

2. Many of the fish species in the ocean are being overfished and it is causing many fish species to be seen less frequently by humans.

3. When walking by the local creek several plastic bottles, straws and other trash is visible.

4. Tropical rainforests are being cut down to build buildings and create farmland. This deforestation is causing many problems.

Environmental Change Project

Directions: Research an environment that has a lot of change. These could include areas where humans are impact the environment, where natural disasters occur or where the environment is changing naturally. Some things to consider when identifying an area of frequent environmental change:

- Areas of active volcanoes
- Where there is significant deforestation
- Where there is significant new building
- Areas likely to have natural erosion/deposition
- Areas where glaciers are moving

Then create a model of a food web that would exist with that area. This may mean that you need to do some research about animals and plants are in the area you choose. Construct your food web below:

Next, you should construct an explanation about how the changes in the area are impacting the food web you have identified and designed.

Then you should construct an argument about how the cycling of matter is impacted as the environment changes.

Now, was this environment impacted by humans in any way? Justify.