**Unit Essential Question:** *How have natural processes and human activities created the ecosystems we see today?*

**Introduction**

In the last two tasks, students have been focused on nonliving parts of ecosystems, such as the geologic features or natural resources present in a region. In this task, students continue to consider non-living things, but begin to incorporate living organisms into their schema of an ecosystem. Beginning with the mystery of “The Year Without Summer”, students explore how living and nonliving parts of an ecosystem must interact to create a well-functioning ecosystem. Students first use their own prior knowledge of ecosystems to form an idea of how parts of an ecosystem interact; they then read an article to construct a revised model that clearly shows how matter is cycled and energy flows through living and nonliving things. By the end of this task, students will not only be able to explain the initial mystery of “The Year Without Summer”, they will also be able to envision their culminating project arena as a whole—both the living and nonliving components as well as their interactions.

**Alignment Table**

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Expectations** | **Science and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.** [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.] | **Developing and Using Models**   * Develop a model to describe phenomena. | **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**   * Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. | **Energy and Matter**   * The transfer of energy can be tracked as energy flows through a natural system. |
| **Supplementary Crosscutting Concepts**   * System and System Models   + Systems may interact with other systems; they may have sub-systems and be part of a larger complex system.   + Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. | | | |
| **Equity and Groupwork**   * Work in group roles to co-construct a model. | | | |
| **Language**   * Read and annotate a text. * Construct a model using new scientific vocabulary. * Write a paragraph or draw a flowchart to demonstrate conceptual understanding. | | | |

**Learning Goals**

This learning task asks students to explore how matter and energy are cycled through an ecosystem by living things. More specifically, the purpose is to:

* Engage prior knowledge to make a hypothesis about the case of the Mount Tambora eruption.
* Use prior knowledge to co-construct a model of ecosystem interactions.
* Read and annotate an article about parts of ecosystems and their interactions.
* Revise and finalize a model that shows flow of energy and cycling of matter in an ecosystem.
* Use new knowledge to explain the case of the Mount Tambora eruption.
* Apply knowledge of cycling of matter and energy to inform the arena design.

**Content Background for Teachers**

In this task, students are asked to consider the cycle of matter and energy transfer in ecosystems. Students already know that living things, like plants and animals, need certain things in order to survive. This task helps them to explore how these essential non-living things are constantly cycled amongst living organisms to keep an ecosystem functioning properly.

In an ecosystem, there are producers, consumers, and decomposers. Producers create all the energy for the ecosystem by converting sunlight into energy the plant can use. Primary consumers then eat these plants to get the energy they need to survive and grow. Secondary consumers then get their energy by eating these primary consumers, and so on. Decomposers, an essential but often forgot about category of organisms, recycle all the nutrients from dead plant or animal matter back to the soil so it can be reused by plants. Thus, students not only see how living things cycle matter throughout an ecosystem, they can also track the flow of energy that drives these processes.

By only talking about energy and consumption, however, this leaves out other crucial types of nonliving matter that are cycling in an ecosystem. In order to do photosynthesis, plants also use carbon dioxide and water from their environment and release oxygen back into the air. Animals can then use this oxygen, as well as the glucose they get from plants, to create energy through cellular respiration. This process releases water and carbon dioxide back into the environment, which can then again be used by plants.

In order for students to represent all these complex interactions, it is helpful for them to create a model that is not just a food web (which only shows living organisms and feeding relationships). In this task, students take the food webs model a step further to include other non-living matter and energy sources that are significant to the functioning of an ecosystem. For more information on these concepts, reference the article used in the *Explain* portion of this task.

**Academic Vocabulary**

* Ecosystem
* Non-living
* Living
* Organism
* Matter
* Energy
* Producer
* Consumer
* Decomposer
* Food Web
* Oxygen
* Carbon Dioxide

**Time Needed (Based on 45-Minute Periods)**

4 Days

* Engage: 0.5 period
* Explore: 0.5 period
* Explain: 1.5 periods
* Elaborate: 0.5 period
* Evaluate and Reflection: 1 period

**Materials**

* Unit 1, Task 3 Student Version

Explore

* Poster Paper
* Ecosystem Cards (1 per group)
* Scissors (1 per group)
* Pencils

Explore

* Poster Paper (if needed for new drafts)
* Glue
* Markers
* Optional: Post-Its

Evaluate

* Project Organizer Handout

**Instructions**

**Engage**

1. Introduce Task 3: In the last two tasks, we learned about non-living parts of an ecosystem, such as geologic features like mountains and natural resources like coal. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
   * Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 3: However, every ecosystem also has living parts as well, like plants and animals. In this task, we will ask the question: How do all these different parts interact to keep the ecosystem functioning as a whole?
   * Now pass out their Task 3 student guide.
3. Students begin this task by thinking about the case study of the Mount Tambora eruption and “The Year Without Summer”. We recommend reading the case study aloud as an introduction. Then in pairs, students should discuss the case study and write a hypothesis for why they think so many plants and animals died.

* This allows students to begin to engage with the crosscutting concept of **Systems and System Models** as they consider how plants and animals may be separate sub-systems that interact as part of a larger complex system.
* Because this is just a hypothesis, there are no correct answers, but students should explain their reasoning.
* Share out a few hypotheses, using equity sticks to encourage more equitable participation (See “How To Use This Curriculum” for more details).

**Explore**

1. In order to understand what happened in the case of the Mount Tambora eruption, it is helpful for students to explore what a well-functioning ecosystem looks like. In this activity, students will begin to construct a preliminary model that shows parts of an ecosystem and their interactions.

* This asks students to begin practicing the science and engineering practice of **Developing and Using Models**, as they start to develop a model to describe cycling of matter and energy in an ecosystem.

1. Distribute a set of Ecosystem Cards, a pair of scissors, and poster paper to each group. Because this is a group activity, we recommend assigning roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Reporter.
   * Ask the Facilitator to read the directions and to make sure everyone understands the task.
   * Ask the Materials Manager to gather the materials needed to complete the task.
   * Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
   * Ask the Reporter to make sure the group is reporting ideas on the group poster.
2. Once groups have cut apart and analyzed the Ecosystem Cards provided, they should use the questions on their student guides to discuss how the different parts of the ecosystem interact.

* The discussion questions provided specifically emphasize the crosscutting concepts of **Energy and Matter** as students try to brainstorm how energy flows through the ecosystem and how non-living matter is used and released by living organisms.

1. Using whatever prior knowledge they have, they will then arrange the Ecosystem Cards and draw arrows and labels to describe interactions.
   * Remind students to do this activity in **pencil** and to not glue down any pieces because they will be revising their poster once they gather more information in the Explain.
   * By creating a model of an ecosystem that shows interactions and energy and matter flows, students are using the crosscutting concept of **Systems and System Models**.

**Explain**

1. In this section of the task, students individually read and annotate an article that tells them more about ecosystem interactions, which they will use to revise and finalize their initial models from the *Explore*.

* We recommend provided whatever annotation strategy students use most in your classroom. However, if you do not have an established strategy, an option is provided in the “How to Use This Curriculum” document.

1. Student groups are then ready to revise and create a final poster of their model. Distribute necessary materials for the final poster, including glue and markers.

* Because this is a group activity, we again recommend assigning roles to each group. You may use the same roles as the *Explore*, but switch up which student occupies each role.

1. Because students are revisiting their model from the *Explore*, this activity emphasizes the same science and engineering practice (**Developing and Using Models)** and the same crosscutting concepts (**Systems and System Models** and **Energy and Matter)** as above. See above for details on how these dimensions are addressed through this modeling activity.
2. We highly recommend conducting a gallery walk after groups have finished their poster models. Hang the posters around the room and have students view their peers’ work. Provide each student with two post-its so they can leave one positive comment and one “I wonder…” on one of the poster models around the room.

* These poster models are great options for formative assessment. Collect the posters to identify trends in students’ ability to develop models that show cycling of matter and flow of energy. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction

**Elaborate**

1. Now that students have a solid understanding of ecosystem interactions, they are ready to return to the case study of the Mount Tambora eruption. In this section, students individually explain why so many plants and animals died, using what they have learned throughout the task. They may write a paragraph or draw a flowchart to explain their ideas.

* This explanation asks students to continue to use the lens of **Systems and System Models** to think about how different sub-systems (solar, plants, animals) interact as part of a larger, more complex system.
* Sample student response: When Mount Tambora erupted, there was a lot of ash in the air, which blocked the sun. When plants don’t have sun, they can’t make energy and survive. Since they are the producers of energy for the whole ecosystem, this causes big problems. If plants die, then many of the animals that eat those plants don’t get their energy and they can die. This was the case for thousands of animals, including humans.

1. Optional: Give pairs of students time to discuss their explanations and then call on students using equity sticks to share out ideas. This encourages more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
2. Return to the whole-class concept map from the Lift-Off Task.
   * In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
     + Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
     + Draw circles around each question and boxes around each concept.
     + Write connector words to describe connections between the concept boxes.
     + For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how matter is cycled and energy flows through living matter in an ecosystem.
   * Have students analyze the additions to the class concept map for as many examples of this task’s crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:

* **Systems and Systems Models**: These could be phrases such as, “is a part of” “connects to,” “interacts with,” “is made up of,” “works together with,” etc.
* **Energy and Matter**: These could be phrases such as, “energy is transferred/flows,” “is conserved,” “is important for,” “is needed,” etc.
  + Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

**Evaluate: Connecting to the Culminating Project**

1. Students independently complete the Task 3 section of the Unit 1 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. Students have been tasked with creating an arena that mimics an environment they may see on Earth. Their prompt is as follows: Your arena already has its main geological features, but as we learned today, there are also other non-living factors and living factors that make up an environment. Design the landscape of your arena, focusing on the non-living things that will be needed to support life.
   * Draw a visual diagram showing how this non-living matter will cycle through your environment (you do not need to pick specific plants and animals for your arena yet; you can just draw example plants and animals for this diagram).
     + Be sure to label the examples of living and non-living matter and use arrows to show where they go.

**Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:

* At the beginning of this task, you wrote a hypothesis for the case of the Mount Tambora eruption. Look back at your initial response: were you correct? After learning everything you have about cycling of energy and matter, how could you revise or add to your hypothesis?
* In this task, we focused on the crosscutting concepts of **Systems and System Models**:Models can be used to represent systems and their interactions within and between systems; and **Energy and Matter**: The flow of matter and energy can be tracked through a natural system.Where did you see examples of **Systems and System Models** and **Energy and Matter** in this task?
* Now that you have learned more about how matter and energy cycle among living and nonliving parts of an ecosystem, what questions do you still have?

1. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

**Assessment**

1. You may collect students’ Project Organizer and assess using:

* *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
* This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

1. You may also give students time to make revisions with one of the two options:

* Students may make changes to their Project Organizer according to your comments OR
* Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.