**Unit Essential Question:** *How does energy and matter flow within natural and designed ecosystems?*

**Introduction**

Every environment is made up of many different living and nonliving components, all of which play a very important role in the functioning of an ecosystem as a whole. Because environments share common characteristics and interactions, we can learn from one environment to teach us about how other environments might work. In this Lift-Off Task, students are introduced to a changing river environment, shown in an image from 200 years ago as well as an image from the present. After making their own observations, they are asked to generate a list of questions they would ask in order to learn more about how and why this river environment has changed over time. Students will return to this phenomenon and these questions throughout the unit as they seek to form a more cohesive understanding of how ecosystems function. This will help inform their culminating project—to build an aquaponics system that mimics the properties of an environment, like this changing river.

**Alignment Table**

Because the Lift-Off tasks focus on student-generated questions, we do not identify specific Disciplinary Core Ideas or Science and Engineering Practices in this table.

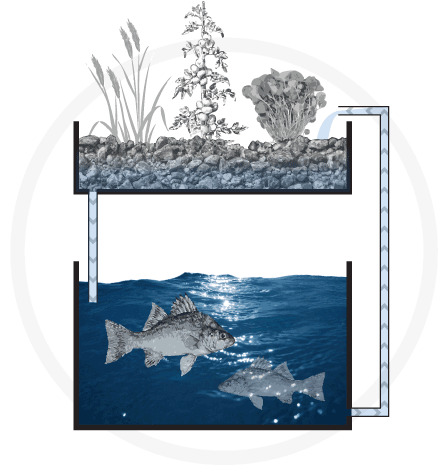
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| **Crosscutting Concepts (\*depending upon student-generated questions)**   * Patterns   + Macroscopic patterns are related to the nature of microscopic and atomic-level structure. * Energy and Matter   + Within a natural system, the transfer of energy drives the motion and/or cycling of matter.   + Matter is conserved because atoms are conserved in physical and chemical processes.   + The transfer of energy can be tracked as energy flows through a designed or natural system. * Stability and Change   + Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. |
| **Equity and Groupwork**   * Share and listen to broad and diverse student contributions. * Make connections between each other’s ideas. * Work together to co-construct a concept map. |
| **Language**   * Use connector words to link ideas. * Generate and write questions about the phenomenon. * Organize key questions in a concept map. |

**Learning Goals**

This learning task introduces students to the phenomenon of the changing river environment and asks them to begin generating questions that will guide them through the unit. More specifically, the purpose is to:

* Individually analyze past and present images of a river environment and generate a list of questions.
* Make connections between related questions.
* Generate possible answers to questions, using prior knowledge.
* Apply prior knowledge of ecosystems and observations from images to make a list of what they might want to include in their aquaponics system.

**Content Background for Teachers**

Every environment is made up of an abundance of living and nonliving things. Nonliving things include things like sunlight, temperature, soil, water, rocks, and air. Living things include plants, animals, fungus, and bacteria. All of this matter is constantly cycling, as energy flows between living and non-living things, allowing the environment to function properly. This is the premise for an aquaponics system, as shown to the right.

In this task, students engage their prior knowledge of environmental factors as they analyze pictures of a river environment. While identifying differences between the past and present river environment may be easy, the reasons for the differences may be new for students. As students identify differences they see in the river environment photos, they are beginning their exploration of deeper chemical and physical processes that they will learn more about in later tasks. For example, they may notice changes in the size of rocks, the size of the river, the size of living things like trees, or the presence/absence of living things like deer. These are all the result of various processes, such as growth due to photosynthesis, erosion, feeding, decomposition, etc. This will be essential knowledge to apply as they design their aquaponics system throughout the unit.

In this task, students create a concept map, which is a graphical tool that helps to organize and represent knowledge and questions, and is a successful academic language instruction tool. As students learn more about the reasons behind these environmental changes, they will add more questions and ideas to this concept map. If your students have not had previous experience making concept maps, please see the instructions in Part B below for strategies on teaching this skill.

**Academic Vocabulary**

* Environment
* Ecosystem
* Artificial
* Aquaponics System
* Sustainable
* Energy
* Matter
* Flow
* Cycle
* Properties

\*Additional academic vocabulary will vary by class

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

2 Days

* Introduction, Part A and Part B: 1 period
* Class Concept Map, Project Overview, and Project Organizer: 1 period

**Materials**

* Unit 3, Lift-Off Task Student Version
* Optional: Projector to project River Environment Images or printed sets of River Environment Images for each student

Part B

* Poster paper and markers
* Post-Its (Optional)

Part C

* Class Poster Paper and markers
* \*See Instructions below for other optional materials to use for the class concept map

Connecting to the Culminating Project

* Culminating Project Handout
* Project Organizer Handout

**Instructions**

1. Introduce students to the unit by reading or projecting the Unit Essential Question aloud.
2. Read the introduction on page 1 of the student guide aloud, which introduces the phenomenon for the unit: the changing river environment. Then have students analyze the past and present images of the river environment and make observations of what they notice.

* You may want to project the images as a class or provide each student an enlarged set of the images to keep as a reference throughout the unit.

**Part A**

1. In this Lift-Off task, students will be generating questions to help them make sense of the phenomenon.
2. Have students complete this section individually in their student guide.

* For students who need more support, encourage them to look at specific places where the images look different and consider any questions they have.
* Here is a list of some potential questions students might generate: “What is different between the two environments? What other differences are there that I can’t see in the picture? What is the climate in the region? What kinds of plants and animals live there? Why is there a deer in the first photo but not the second? Why are there birds in one photo but not the other? What happened to the tree? Why do plants seem to move? Why do the sizes of things seem to change (plants, animals, river, rocks)?”

**Part B:**

1. In this part of the task, students create a concept map as a group.

* Remind students to refer to the directions on their student guide to help them make their concept map. First, students should compare each member’s list of questions and record/connect key questions on a piece of poster paper. They will then draft possible answers to the questions, using prior knowledge.
* Remind students that there are no right or wrong questions or predictions, so students feel encouraged to contribute any and all questions and ideas they think of.
* Because this is a collaborative task, it is recommended that you remind students of group work norms and assign group roles, such as Resource Manager, Facilitator, Recorder, and Harmonizer (See “How to Use this Curriculum” for more details).

1. Students will post their posters on a wall and then walk around and look at each group’s ideas. One suggestion for gallery walks is for students to interact with the posters in some way. For example, students are required to initial or leave post-its on three questions that they are also excited about on other posters.

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| **How to Concept Map**  For students who have not had a lot of experience making concept maps, we have detailed a strategy below for introducing concept mapping using more familiar content. An example is also provided, but this will vary depending on what your students come up with as you make your own model.   1. Macintosh HD:Users:laurenstoll:Downloads:Sample Concept Map (1).jpgWrite the phenomenon in the middle of the poster, in this case “Humans breathe harder when they exercise.” 2. Ask students to share questions they might ask to make sense of this phenomenon and make a list of these questions on the board. 3. Model the process of reviewing the list and finding similarities amongst the questions.    * Place these key questions on the concept map poster, modeling how to put similar questions near each other on the poster. Circle these to signify that these are questions, not content knowledge. 4. Ask students to look at the key questions and see if any of the questions are connected: Would answering one question lead to one of the other questions? Model making these connections by drawing arrows between the circles. 5. In this Lift-Off task, students will only be drafting possible answers to the questions, not actually gathering and recording learned concepts. However, throughout the unit, they will be adding content they have learned. Model this by recording a student’s prior knowledge to one of the questions, using boxes to signify that these are pieces of content knowledge rather than questions.    * Use connector words to identify the relationships between the content boxes (See image above for an example). 6. Optional: To emphasize crosscutting concepts using a concept map, make a key of different colors for the crosscutting concepts emphasized in this unit. Identify questions that clearly show evidence of the different crosscutting concepts and circle them with the corresponding colors. Explain to students how you made that choice by pointing out the language that hints at that crosscutting concept. \*Note: not all boxes and circles will necessarily have a crosscutting concept. |

**Part C**

1. Construct a whole-class concept map that begins to help students make sense of the phenomenon of the changing river environment.

* Start with the phenomenon in the middle.
* Then ask students to share out the questions that were most common across all the posters in the classroom. As you record questions on the poster, organize them based on connections you see. Draw circles around each question (as you add to the concept map throughout the unit, you’ll also be adding concepts learned, which can be written in boxes to distinguish them from the questions).
* Ask students to identify any connections they see between the questions and record these as lines between the questions.
  + Recommended: Give pairs of students think time to come up with 1-2 connections to add to the class concept map and call on pairs using equity sticks. This encourages more equitable participation in this class-wide activity.
* 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.
* This whole class concept map will be revisited at the end of each subunit, asking students questions like: Are there any new questions you have about the phenomenon? Are there any connections you want to add or change? What is your reason for that addition/revision? Are there more connections we can make between the questions/ideas already on the map? Do you want to add any new ideas/concepts to the map?

1. Because this concept map will be added to and revised throughout the unit, here are some practical options for implementation.

* If you have access to white board paper, we encourage you to use these for class posters since it will allow you and your students to make revisions throughout the unit.
* Another option is to use smaller pieces of paper for each class and project using a document camera; this will save space as opposed to doing large class posters.
* We highly recommend students keep their own version of this concept map in their notebooks, adding questions and concepts as they go through the unit.

1. Once the draft concept map is complete, introduce students to the crosscutting concepts for this unit. We recommend posting posters of each crosscutting concept in your classroom (See beginning of teacher guide for templates).

* The crosscutting concepts for this unit are: Patterns; Energy and Matter; and Stability and Change. Assign a color for each crosscutting concept that can be used throughout the unit.
* Have students analyze the class concept map for as many examples of the crosscutting concepts as they can find. Depending on the questions they have, they may be able to find an example of each of the crosscutting concepts or perhaps just some.
* We recommend modeling this process by picking a question, identifying the crosscutting concept, and tracing the circle in the corresponding color. Explain the key words that helped you identify the crosscutting concept in this question. Some identifying words that students might look for are:
  + **Patterns**: These could be phrases such as, “is the same as”, “has in common with”, “is similar to”, “shares” etc.
  + **Energy and Matter**: These could be phrases such as, “energy is transferred/flows,” “is conserved,” “is important for,” “is needed,” etc.
  + **Stability and Change**: These could be phrases such as, “remains the same”, “is changed by”, “is disrupted by”, “changes”, “disrupts,” etc.

**Connecting to the Culminating Project**

1. Hand out the Culminating Project Task Card and read the Challenge and Group Project Criteria for Success aloud as a class.
   * Take questions for clarification.
2. Optional: Display some examples of what real aquaponics systems look like.
3. Pass out their Project Organizer and explain that they will complete a section of this after each task in class. Students should independently complete the Lift-Off Task section of the Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
   * Students have been tasked with creating a sustainable aquaponics system that mimics the properties of the river environment they saw in this task. Their prompt is as follows: What did you see in the pictures that you might also want to include in your aquaponics system?

**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 made a list of all the questions you have about the river environment in the past vs. the present. Look back at your list: think about the questions your peers asked that you did not initially write down. How are their questions different from the ones you originally asked?
   * In this unit, we will be focusing on three crosscutting concepts: **Patterns**: Macroscopic patterns are related to microscopic structure; **Energy and Matter**: The transfer of energy can be tracked as it flows through a system, is conserved, and drives the cycling of matter; and **Stability and Change**: Stability and change can be explained by looking at changes over time and at different scales. Looking at your class concept map, give one example of how a crosscutting concept came up in today’s task.
   * Now that you understand what project you’ll be working on over the course of this unit, what else do you need to know? What additional questions do you have?

1. There are no right answers, but encourage students to look back at their initial list of questions and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their questions and ideas 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 the gathering of knowledge and skills for their final project.