TEACHER GUIDE
ENGAGE LESSON 2

Food and Agriculture Center for Science Education

Module Question: *How does the dairy system produce dairy products and get them to our table?*

What We Figure Out:

We figure out that dairy products are produced differently now than in the past. We figure out that there are many steps to the system that get dairy products from the farm to our homes, schools, and stores. We aren't yet sure about what each of these steps is used for, so we will try to investigate further in upcoming lessons.

3D Learning Objective:	Time estimate:	Materials:
Students develop a model to illustrate the relationships between the inputs, outputs, and boundaries of the dairy food system.	50 minutes	Lesson 2 Student Guide Lesson 2 Dairy Production Video Chart paper

Targeted Elements

SEP:

Pre-Assessment

MOD-H3: Develop, revise, and/or use **a model** based on evidence **to illustrate** and/or predict **the relationships between** systems or between **components of a system.**

DCI:

Pre-Assessment

ETS2.B-H1: **Modern civilization depends on major technological systems, including those related to agriculture**, health, water energy, transportation, manufacturing, construction, and communications.

CCC:

Pre-Assessment

SYS-H2: When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

Directions

Part 1: Our Motivation

USE OF PHENOMENA

Students ended the previous lesson by asking questions that they wanted to figure out to understand more about the impact of the production of dairy foods on the environment. The first set of media claims from the Anchor Phenomenon that students will investigate are Claims 1, 4, 8, and 13. These claims also correspond to the question category from the Driving Question Board about the dairy system. Therefore, in this module, students will start by observing a module-level phenomenon that asks students to figure out how dairy products are made and get to our plates today. Figuring this Module Phenomenon out will help students progress on their questions about the overall Anchor Phenomenon for the unit: how the dairy system impacts the environment.

To begin the lesson and make the connection between the previous lesson and this one clear, return to the media claims list. Ask students, "Which of these claims do we want to investigate first?" Student responses may vary. Guide the conversation to acknowledge that though many of the claims are interesting, we won't be able to figure out how to evaluate them until we know how dairy is made. Knowing how dairy is made can help us better understand its impacts on our health and the environment, including climate, pollution, and impacts on plants and animals.

Next, as a class, revisit the questions in the Dairy Industry category on the Driving Question Board. Have the students read off selected questions to highlight student questions about how dairy is made, the steps in the process of creating a dairy product, or any other question that has to do with the dairy system or its pollution.

Students can record these questions and the claims they are trying to investigate in their Lesson 2 Student Guide Part 1: Our Motivation. This will help students understand how this lesson connects to what they were trying to figure out about the Anchor Phenomena. Example student questions or ideas could include:

- We weren't exactly sure how the dairy industry impacts the environment, so we wanted to know more about how dairy foods are made so we could figure out how that process impacts the environment.
- How does a dairy product get made?
- What are the steps in the process that might impact the environment?
- Does the dairy system pollute the environment?

Build off student questions and the selected media claims to confirm that students will next set out to figure out how the dairy industry is constructed so they can then figure out its role in environmental pollution and the health of people.

Part 2: Sharing Our Life Experiences

Students are presented with five dairy products in their Lesson 2 Student Guide Part 2: Sharing Our Life Experiences. Students can answer the questions that resonate the most with them.

STUDENT SUPPORT
All students will have differing life experiences when it comes to dairy products. Be sure to allow students to share if they feel comfortable doing so. This is an opportunity to continue to build on the norm for this unit that we will value the different experiences and opinions that students bring to the classroom. Emphasize that students will grow their thinking by being exposed to the ideas and experiences of their peers.

To discuss the responses as a class, use the Think-Pair-Share Routine:

1. Have students share their responses with a shoulder partner.
2. Ask pairs to share with the whole class one life experience they had in common and one that was different.
3. Student responses will vary in this activity, and that is okay. The purpose of this discussion is to share our background experiences with different dairy products.
    a. If responses are beyond the scope of this discussion (personal experience with dairy), lead students back to the questions in the Lesson 2 Student Guide Part 2: Sharing Our Life Experiences.

End the discussion by asking students what they need to investigate to figure out how dairy products get to their house/school. Facilitate the conversation to agree that students should take a closer look at how these products are made.

Part 3: Observing the Module Phenomenon

Introduce the video by telling students, “We’ll watch a video that shows two examples of systems by which we used to and currently produce dairy products.” As students watch, ask them to record what they observe about how the systems get dairy to their table now versus in the past. They can write responses in their Lesson 2 Student Guide Part 3: Observing the Module Phenomenon.
Show the Dairy Production Video found in the Lesson 2 folder.

Use a Think-Pair-Share Strategy to have students share what they noticed from the Dairy Production Video.

1. Students are given time to think independently about their responses.
2. Students find an elbow partner.
3. Students take turns sharing their thoughts with their partner. Each student should be given time to respond.

As students share, use a Domino Share Routine to have them build off each other's contributions.

1. Each group nominates a spokesperson.
2. As a student from group 1 shares, all other students serve in a "listener" role, noting patterns or ideas that emerge as the group continues to share.
3. Spokespersons from each group continue to share ideas until all groups have shared.
4. The facilitator holds a whole class discussion and invites the remaining students to share what they heard that was similar across all the responses or a unique response they want to elevate.

STUDENT SUPPORT

If students need additional support in comparing the two systems, consider:

- Ask students why they think systems have changed. What have they seen personally regarding dairy production?
- Allow brainstorming time if students need more time to ponder the new questions.

In student responses, look for the following ideas:

- The past system seemed simple, and the current system is very complicated.
- We don't know how the current system works / what is a part of it.
- Both systems are designed to achieve specific tasks: produce dairy for consumers, but they do so in very different ways.

Build off student responses to introduce the Module Question: "*How does the dairy system produce dairy products and get them to our table?"*

Part 4: Creating and Sharing Initial Models

In groups, students will create an initial model that answers the Module Question: "*How does the dairy system produce dairy products and get them to our table?"* They will create two models: One representing how dairy products were made in the past and one for how dairy products are made today. Share with the class that we will first model how dairy was produced in the past to agree on systems model conventions to use for class consistency.

Introduce the systems model conventions to students by writing the following on the board or chart paper. These include:

- Images, icons, and pictures visually represent different parts of the system.
- Arrows show the movement of matter from one component to another.

- A dashed line represents the boundary of the system.

Together with the class, create a Class Consensus Model on the board.

Ask questions to help students establish the Class Consensus Model.

1. Start by asking a question such as, “What parts do you think we should show in this model?” or “Can anyone suggest a feature of the model we should add to the class model? This could be any one part of the model, an arrow, a component, or any other single part we all seem to agree on.”
2. Draw the class consensus model on the board as the discussion is happening.
3. Repeat steps 1-2 for a handful of students until the below Class Consensus Model is established.

Sample Class Consensus Model

Share with students that they will now use these model conventions to create a systems model for how dairy products are made today and how they make it to our table. Allow students time to work in small groups to do so. Students can draw on their experiences and what they observed in the video to make this model.

- For example, students may know of a dairy farm in their community, have visited one before, or have seen something in popular media.

FORMATIVE ASSESSMENT OPPORTUNITY

Students develop a model to illustrate the relationships between the inputs, outputs, and boundaries of the dairy food system.

Assessment Artifacts:

- Students' models of how the dairy food system brings dairy products to consumers' tables (Lesson 2 Student Guide Part 4 Creating and Sharing Initial Models).

Look Fors:

- Models show components and interactions from the dairy production video. (MOD-H3) (ETS2.B-H1)
- Models include inputs, outputs, and may include boundaries. (MOD-H3) (SYS-H2)
- Models show the relationship of how the dairy system supports the needs of modern civilization to bring food to consumers. (ETS2.B-H1) (SYS-H1)

Assessment Rubric:

	Emerging	Developing	Proficient
Sample Student Response	Student model shows: One or more system components	Student model shows: Multiple system components Some components include system inputs and outputs.	Student model shows: Multiple system components The sequence of system components reflects how dairy products are brought to consumers (eg, cattle, processing, transit, consumer) Clear labels of inputs and outputs of each system component
How to Achieve This Level	Student completes 0 out of 3 Look Fors	Student completes 1-2 out of 3 Look Fors	Student completes 3 out of 3 Look Fors

To Provide Additional Support for Students:

As students work in groups, approach each group to look at their models. If students are struggling to identify what components and interactions to include:

- Ask questions such as:
  - What components are important to include to explain how dairy products are made?
  - Pick two components that you think interact with each other. What are some ways your model uses pictures or words to show this interaction?
  - How does your model show how the dairy system supports human needs?
  - Use systems language with questions such as, "What inputs and outputs exist for this component?" or "What things are a part of this system, and what things are outside of this system?"
- Focus students' attention on a part of the model they may be missing.
- Ask students to return to the videos and watch them again to identify system components they may have missed.

At the end of the initial creation of the small group models, each group will share their models with the class using the Stay and Stray Strategy.

1. After small group models are complete, ask groups to have one person "stay" at their table with the model they created to explain the model to classmates from other groups.
2. The rest of the team members "stray" to the other groups to learn about the other group's models, allot about 2 to 5 minutes per rotation.
3. During the rotation time, students can ask questions to help gain clarity on the decisions they made. Students can ask questions such as, "What parts of the models do we seem to agree on?"
4. At every signal to rotate to a new group, a different team member goes back to stay with the group's work, and everyone else (including the person who first stayed) moves on to view the next product. This allows everyone to see all but one product.
5. After visiting all groups, initial small groups regroup and share new information gathered.
6. Groups discuss new ideas and decide whether or not they will integrate them into their work.

TEACHER SUPPORT

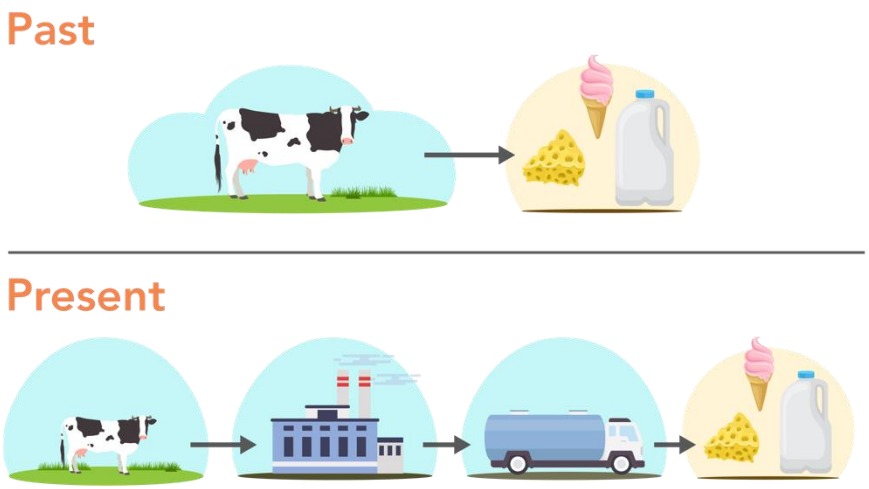
Using the Stay and Stray Strategy allows students to compare and contrast their models with other groups. This will help them self-evaluate the strengths and weaknesses of their model before implementing edits.

LOOK FOR

As you walk around to groups sharing their models, look for features of the models that have a beginning and end point and a transportation component. Students may also have a variety of other components in their models, which is to be encouraged at this time as

students will gather evidence throughout the module to revise their models. To prepare for the whole-class share-out, choose 3-4 groups to share during a class consensus discussion. Deliberately choose groups with differing views from basic to complex to encourage cross-talk as students share their models.

Example Group Model



After the groups all share, students work together to make a Class Consensus Model. The aim is to look across your class's models and represent the most common areas of agreement on a class model. Walk students through the class consensus discussion steps below so they can create an initial Class Consensus Model. Students can write areas of agreement and disagreement on their Lesson 2 Student Guide Part 4: Creating and Sharing Initial Modules.

1. Deliberately pick a few group models to share with the whole class and choose models that help the class answer the Module Question, "*How does the dairy system produce dairy products and get them to our table?"*
2. The first group will share their model.
3. Based on what the presenting group shared, ask questions to help establish the consensus class model. You can build this model with the class by asking questions such as, "What parts of the models do we seem to agree on?" or "Can anyone suggest a feature of the model we should add to the class model? This could be any one part of the model, an arrow, a component, or any other single part we all seem to agree on."
4. Draw the class consensus model on the board as the discussion is happening.

5. Repeat steps 2-4 for each group sharing their initial model.

As you are building the class model, if you find disagreements, follow these steps to help resolve the disagreement:

- Summarize the two sides of the disagreement.
- Ask the students to pause and reflect on their reasonings to be on that side.
- Prompt students to re-discuss the area of disagreement.
- If students still disagree, suggest that we can represent areas of disagreement on the class model with question marks or other annotations of uncertainty.

Build on student responses to define the following terms:

- Input as matter, energy, or information that moves into a component of a system.
- Output as matter, energy, or information that moves into a component of a system.
- System boundaries as the dividing line between the parts of the system that we are focusing on and other parts or systems that we are not focusing on.

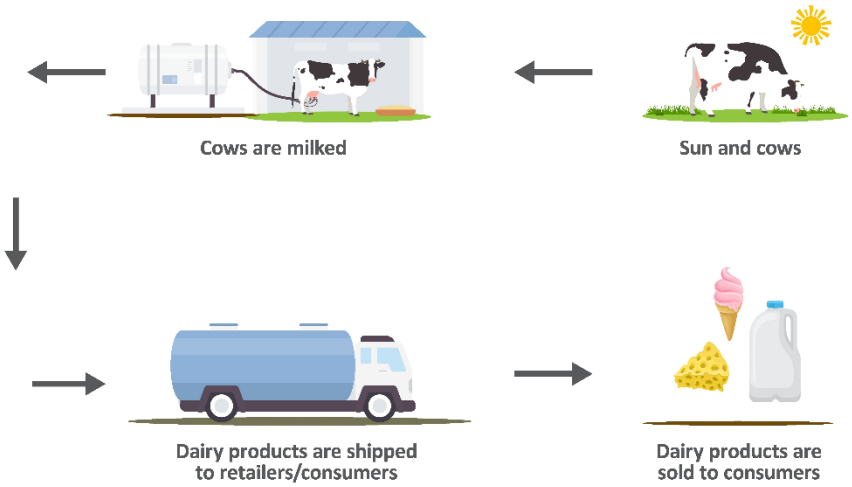
CCC SUPPORT

SYS-H2: When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

In middle school, students analyzed the design of systems by determining that systems can have inputs and outputs, can have sub-systems or components, and can be a part of larger systems. In this module, students build on this idea by using their knowledge of a system's interactions to identify the function of the system, including the relationship between its design and the intended and unintended effects the system design has on the environment. In this lesson and the remainder of Module 1, students progress towards the high school grade band of this CCC by now not only defining a system and its interactions, but also by determining a system's boundaries and recognizing that a system's boundaries can be set as needed based on the problem being analyzed.

Here is one example of what a Class Consensus Model may look like, though you will want to follow the ideas of your class rather than drive them to this exact model. Students will copy the final Class Consensus Model into their Lesson 2 Student Guide Part 4: Creating and Sharing Initial Models.

Example Class Consensus Model



Before continuing, ask students, "What do our models show so far about the task(s) the dairy system was designed to accomplish? How does it help or harm humans?" Here, we hope to have students discuss how the dairy system is primarily designed to get dairy products from the farm to consumers safely and in large quantities, yet doing so requires several steps that may have impacts on the environment.

SEP SUPPORT

MOD-H3: Develop, revise, and/or use **a model** based on evidence **to illustrate** and/or predict the **relationships between** systems or between **components of a system**.

In middle school, students develop models of phenomena that demonstrate the relationships between variables at different scales. In this lesson, students begin progressing towards the high school grade band of this SEP. By the end of the unit, students build on the middle school understanding to show that that models can illustrate not just relationships between two variables at different scales, but also relationships between entire systems or multiple components of a system.

DCI SUPPORT

ETS2.B-H1: **Modern civilization depends on major technological systems, including those related to agriculture**, health, water energy, transportation, manufacturing, construction, and communications.

In middle school, students learned that humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. This unit builds on this middle school knowledge by expanding students' understanding of the economic, social, and environmental consequences of resource extraction. Here, students begin to progress towards proficiency with this high school DCI by sharing their prior knowledge of how people depend on resources, such as food, for life.

Students will then record what gaps or areas of disagreement they think are present in the Class Consensus Model. At this point, there will be obvious gaps in the model, which will be addressed throughout the rest of this module. Guide this activity by asking questions like, "Take a closer look at the class model. What seems to be missing from the model?"

In student responses, look for the following ideas:

- It looks like I am missing a step that gets milk to other products like ice cream and cheese.
- What is needed before the cows are milked?
- How do the different steps impact the environment?

STUDENT SUPPORT

If students need additional support in finding gaps in the models, consider:

- Have students verbally describe the system and, as they do so, consider if any steps might logically be missing. Tell them, "Talk me through how milk gets to your table without looking at the model." This allows them to visualize the system and see if there are gaps present.
- Remind them that we are in the beginning stages of the module, and they will learn more and have time to edit their model later in the module.

CCSS SUPPORT

SL 9-10.1(d): Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.
The goal of this standard is to challenge students to respond to diverse perspectives. At this point in the unit, students may still disagree about the components of the model and recognize that there may be gaps in the model developed by the class. This model will continue to

be added to throughout the module and is just a starting point. Students who disagree or have another perspective will have additional opportunities to share with their classmates throughout the module.

TEACHER SUPPORT
At this point, there will be obvious gaps in the model. Students will gather evidence throughout this module and later revisit their models to update them with their new understandings.

Part 5: Asking New Questions

As a final step in this lesson, students will create a new list of questions to help them determine what additional information they need to know to help them figure out how dairy gets to their tables. They can write these questions on their Lesson 2 Student Guide Part 5: Asking New Questions. Add these questions to the Dairy Industry category of the Driving Question Board so they can continue to be referenced in the coming lessons.

To facilitate students asking questions, use the Question Formulation Technique.

1. With their group, students take 5 minutes to brainstorm questions about what they need to know about how dairy foods are created and distributed.
2. Students then look at all their questions and choose the 3-5 questions they think are most important to be answered to help them figure out the Module Question.
3. A representative from each group will then share their prioritized questions with the whole class. As students share their prioritized questions, they will add them to the Driving Question Board.

LOOK FOR
In student responses, listen for the following ideas:

- When/where do they make the different dairy products?
- Are there steps we are missing?
- How does [step] impact the environment?