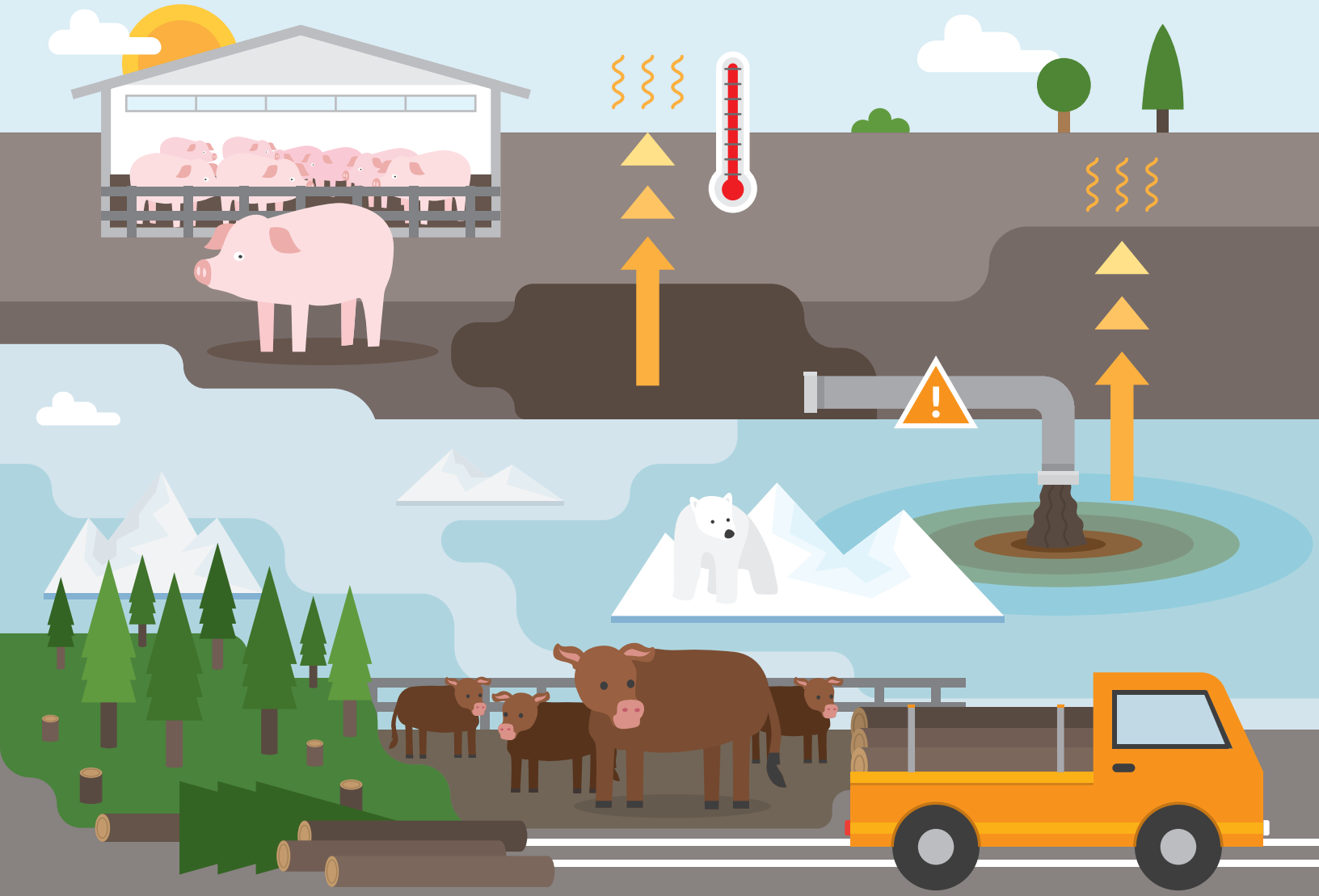
farmsanctuary
rescue • education • advocacy

MS Earth Science Lesson 1 Section 1

Global Warming & Our Food System: A Greenhouse Effect Inquiry Lab

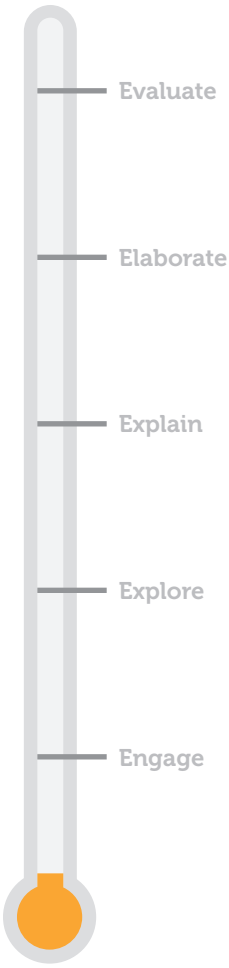
> *"For the first time [in history], we concluded anthropogenic warming has had an influence on many physical and biological systems."*
> **— Cynthia Rosenzweig, NASA's Goddard Institute for Space Studies**



Overview

The surface of the Earth is warmed by the sun's radiation. Greenhouse gases in the atmosphere of the Earth "trap" some of this radiation that would otherwise be released back into space, warming the planet. This is known as the greenhouse effect. Without the greenhouse effect, there would be no life on Earth.

- Students will develop a model to explore how the greenhouse effect works in an inquiry-based laboratory activity.
- Students will differentiate between the greenhouse effect, global warming, and climate change.
- Students will also investigate some of the factors that are increasing greenhouse gas emissions and resulting in global climate change such as clearing land for agriculture and raising animals for food.



Essential Questions:

- What is the greenhouse effect?
- How is the greenhouse effect related to global warming and climate change?

Lesson Time:

Section 1 = 60-75 minutes
Section 2 = 60-75 minutes

Student Learning Objectives:

Students will be able to...

- Discover how an environment can be warmed by the presence of certain molecules in its atmosphere (the greenhouse effect)
- Differentiate between the greenhouse effect, global warming, and climate change
- Use an inquiry-based lab to understand the science behind the greenhouse effect
- Identify some of the major contributing factors to global climate change

Resources:

- **Student Handout:** Inquiry Lab: Why is the Temperature Rising?
- **Teacher Reference:** Data Table
- **Teacher Reference:** Modeling Graph

Materials:

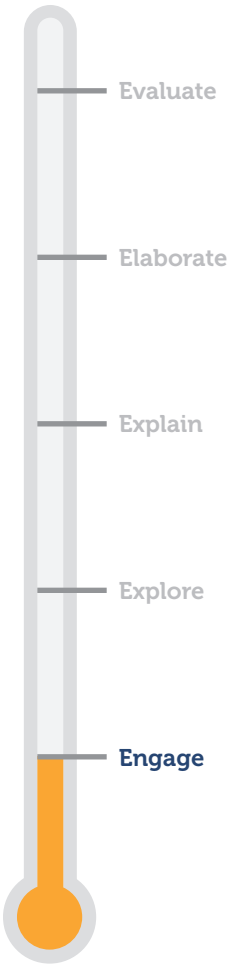
- 2 glass jars or 2 plastic soda bottles, with tops cut off, per student pair
- 2 thermometers per student pair
- Masking tape
- Cardboard
- 1 container of plastic wrap
- Scissors (1 per student pair)
- Soil (1 cup/student pair, approximately 15 cups of soil)
- Access to direct sunlight or sunlamp
- Colored pencils
- Measuring cups or paper cups for measuring soil
- Construction paper
- Aluminum foil
- Graph paper

Next Generation Science Standards

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.



Activities: Section One

Engage: The Two Glass Jars
(5 minutes)

In the opening engagement activity, students will be presented with a phenomenon involving a mini "greenhouse" in the form of a glass jar or plastic soda bottle covered with plastic wrap and asked to consider what is causing the increase in temperature.

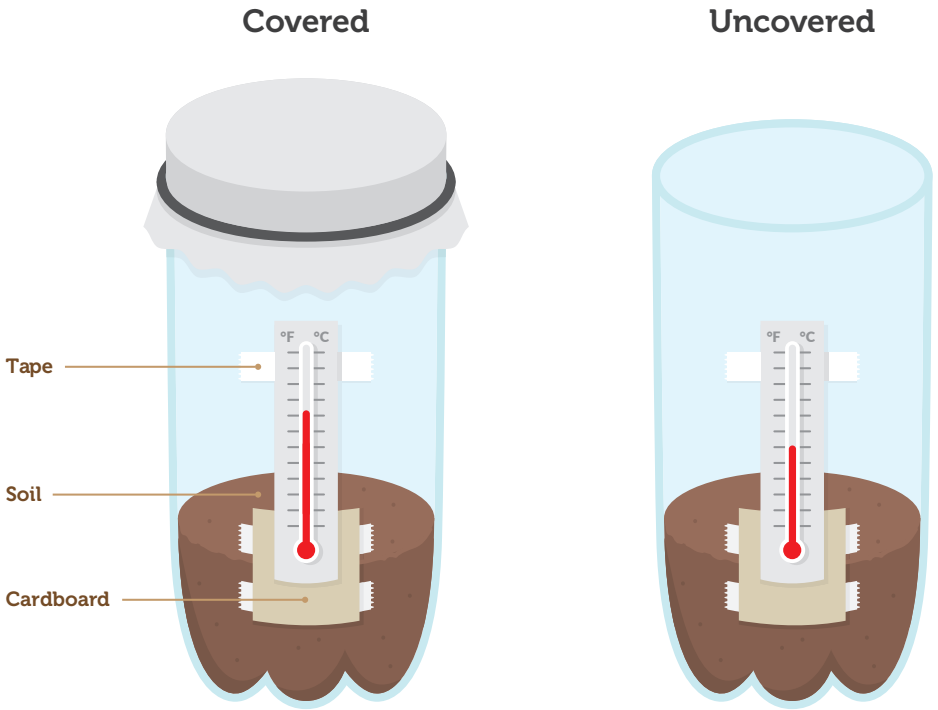
Teacher Preparation

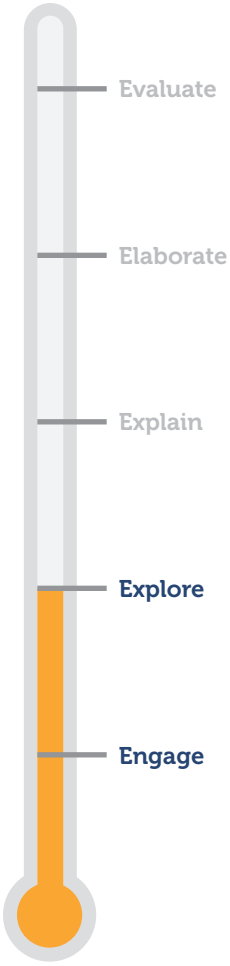
About an hour before class begins, set up two glass jars or two plastic soda bottles. Both containers should have a small amount (½ cup) of soil in the bottom. Only one of the containers will be covered in plastic wrap. A thermometer should be taped inside each of the containers, and both containers should be placed in direct sunlight or under a heat lamp. You may need to cover the thermometers with a small piece of cardboard in order to keep them out of direct sunlight (see diagram).

Procedure

1. Show students the two jars or bottles. Ask them to identify what is in each container and what the differences are between the two containers and their contents.
2. Ask a student to read the temperature in each container. The container with the plastic wrap should have a higher temperature.
3. Now, ask students why they think there is a temperature difference between the two containers. Answers might include that the plastic wrap got hot and heated up the air; the air that is trapped by the plastic wrap couldn't escape to cool down; the soil gives off heat that is trapped inside by the plastic wrap; etc. Don't identify which answers are correct yet!

Notes:





Notes:

Explore: Why is the temperature rising?
(55 minutes)

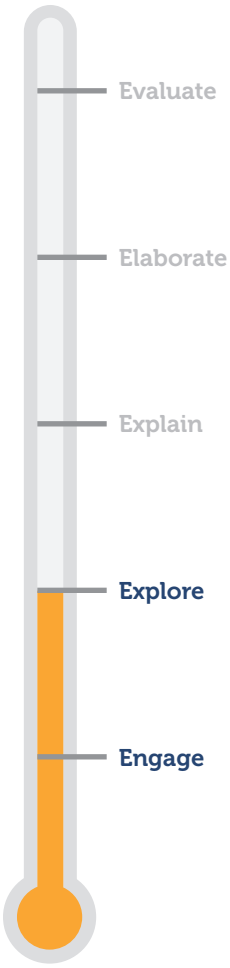
In the explore activity, students are tasked with determining the role that plastic wrap is playing in warming the air inside of a glass jar or plastic soda bottle.

Provide each student with the student handout: **Inquiry Lab: Why is the Temperature Rising?** Although students will be carrying out this activity in pairs, each student will need to complete their own handout as well as construct their own data table and graph.

In addition, each pair of students will need access to the following materials:

Materials

- [ ] 2 glass jars or 2 plastic soda bottles, with tops cut off
- [ ] 2 thermometers
- [ ] Masking tape
- [ ] 2 small pieces of cardboard
- [ ] Plastic wrap
- [ ] Scissors
- [ ] 1 cup of soil
- [ ] Access to direct sunlight
- [ ] Sunlamp (optional in case direct sunlight is not accessible)
- [ ] Colored pencils
- [ ] Graph paper
- [ ] Construction paper
- [ ] Aluminum foil

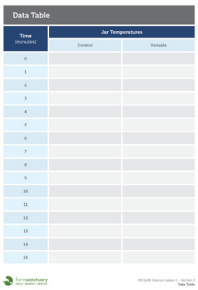


Designing the Model
(25 minutes)

Tell students that they will be working in pairs (or groups of three) to determine what role the plastic wrap is playing in warming the air inside of the jar or soda bottle.

Students will begin with a hypothesis and then design an experiment to test the hypothesis.

1. Students should first come up with one explanation for why the plastic wrap is heating up the air inside of the jar or soda bottle.
2. Next, they will use their explanation to write a hypothesis. They should be able to test their hypothesis using the materials provided. For example, if their explanation is, "the plastic wrap is simply serving as a cover to trap the air inside," then they should try another way to cover the jar, such as with construction paper or aluminum foil, and compare the results. Their hypothesis would then be, "The air in the container rises because the air is trapped. If we cover the container with paper, then the temperature will rise." If they think that the sunlight is heating the soil and therefore trapping the heat, they might set up one container without soil. Their hypothesis would then be, "Sunlight entering the container is heating up the soil. If there is soil in the container, the temperature will rise. Without soil, the temperature will not rise."
3. With their hypothesis students will now come up with an experimental setup. They will need to have two jars or two soda bottles with only one variable that is different between them so that they can test their hypothesis. Students should draw their experimental setup on paper.
4. Give students, in their pairs, about 10 minutes to work on their explanation, hypothesis, and experimental setup. Walk around the room to answer questions and provide guidance.
5. After 10 minutes, ask students to share their model ideas with the class. Let them know that they can revise their models as they listen to other student groups.
6. Next, have students answer the questions under Finalizing the Model on their inquiry lab handout.
7. Once student pairs have completed these questions, they need your approval before creating their data table and their physical model. (Let them know that they should plan on taking measurements for about 15 minutes.)

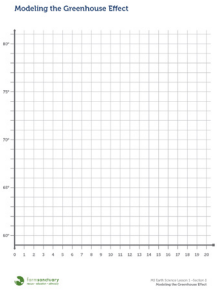

Data Table

Time (minutes)	Jar Temperatures	
	Control	Variable
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Data Collection
(18 minutes)

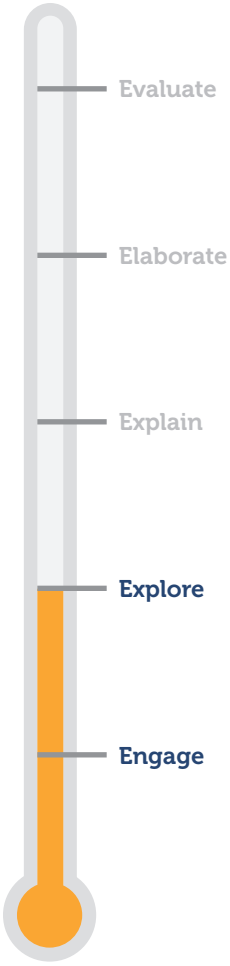
Students should collect their data in the form of temperature readings for both jars. They will need to construct a data table to record their results. Once students have gathered data for about 15 minutes, they will need to graphically represent their data. A linear graph including both the control data and variable data is a good format to use. Be sure students label both axes of their graph (the x-axis should be time in minutes and the y-axis should be temperature in degrees Fahrenheit).

Note: Reference documents for the **Data Table** and **Modeling Graph** are included in this lesson.


Modeling the Greenhouse Effect

Class Discussion
(7 minutes)

Each group should explain their experimental setup and results to the class. Try and identify that the jar or soda bottle needed to be covered in something clear in order to achieve the results we were looking for and why that might be (sunlight has to enter the container). Identify that the soil was a key component (it was heated up by the sun). Finally, recognize that something had to keep that heat in the jar or soda bottle (without the plastic wrap, the temperature didn't rise).



Results and Conclusions
(5 minutes)

Students should answer the questions under Results and Conclusions on their inquiry lab handout.

1. Did your model "work" in the way that you intended? Why or why not?

   Answers will vary.

2. If you have additional time and materials, how might you change your model to be more accurate?

   Answers will vary. Example: Cups of water in the containers could represent the oceans.

3. Why does the temperature rise in a glass jar or plastic soda bottle covered with plastic wrap?

   Plastic wrap allows heat from the sun or a heat lamp to enter the container and warm the soil, which then traps the heat inside the container and mimics the greenhouse effect.

References:

Climate change. (n.d.).
Retrieved from EPA website:
https://19january2017snapshot.epa.gov/climatechange_.html

Climate and environmental impacts. (n.d.).
Retrieved from the Environmental Working Group website:
http://www.ewg.org/meateatersguide/a-meat-eaters-guide-to-climate-change-health-what-you-eat-matters/climate-and-environmental-impacts/

Counting chickens. (2011, July 27).
Retrieved from:
https://www.economist.com/graphic-detail/2011/07/27/counting-chickens

Factory farming and the environment. (n.d.).
Retrieved from:
https://www.farmsanctuary.org/learn/factory-farming/factory-farming-and-the-environment/

Facts. (n.d.).
Retrieved from:
http://climate.nasa.gov/causes/

Koneswaran, G., & Nierenberg, D. (2008). Global farm animal production and global warming: Impacting and mitigating climate change. Environmental Health Perspectives, 116(5), 578-582.

Matthews, C. (2006, November 29). Livestock a major threat to environment.
Retrieved from FAO Newsroom website:
http://www.fao.org/newsroom/en/news/2006/1000448/index.html

Overview of greenhouse gases. (n.d.).
Retrieved from United States Environmental ProtectionAgency website:
https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Sources of greenhouse gas emissions. (n.d).
Retrieved from United States Environmental ProtectionAgency website:
https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#agriculture

What is the greenhouse effect? (n.d.).
Retrieved from:
http://climatekids.nasa.gov/greenhouse-effect/

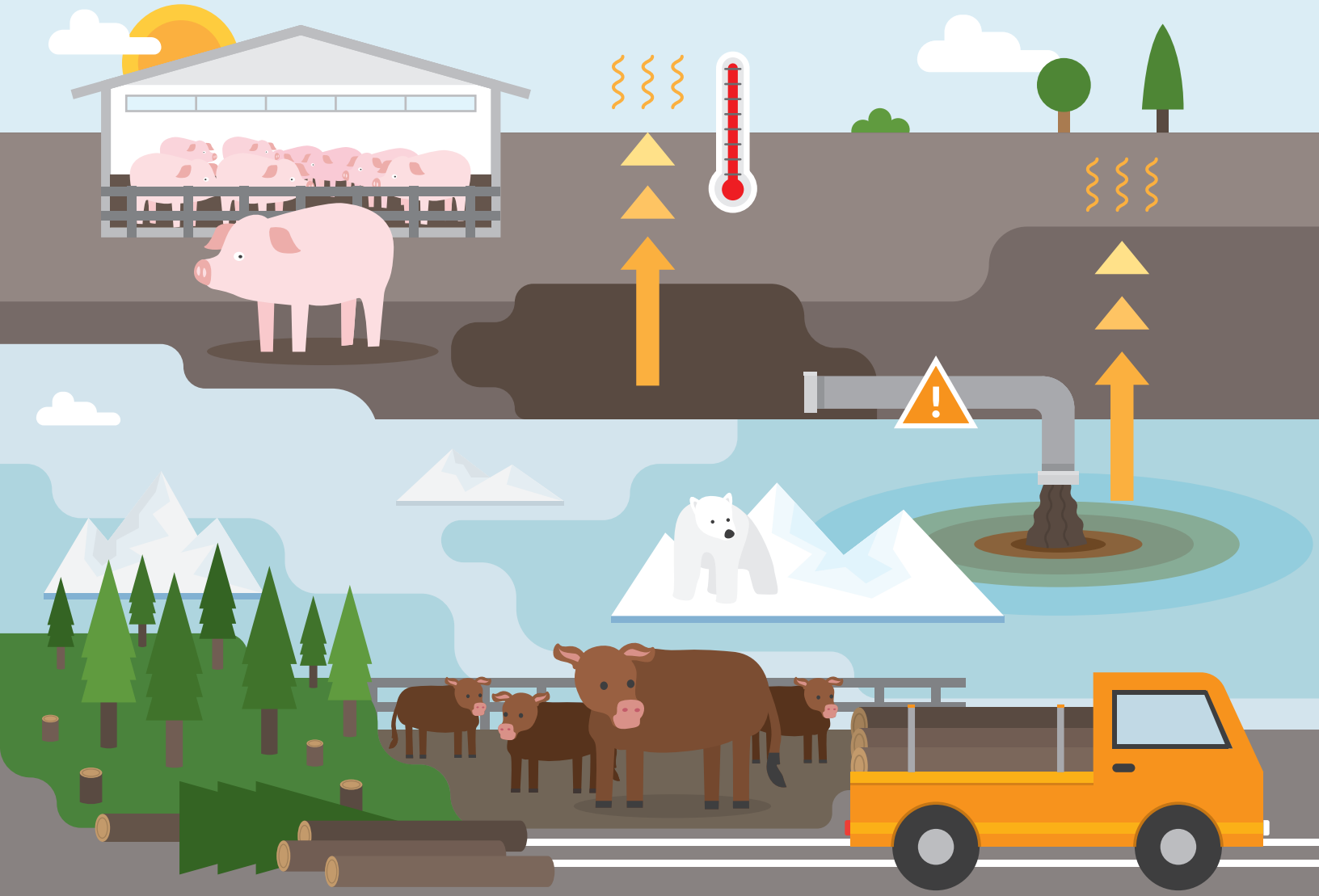
Notes:

farmsanctuary
rescue • education • advocacy

MS Earth Science Lesson 1 Section 2

Global Warming & Our Food System: A Greenhouse Effect Inquiry Lab

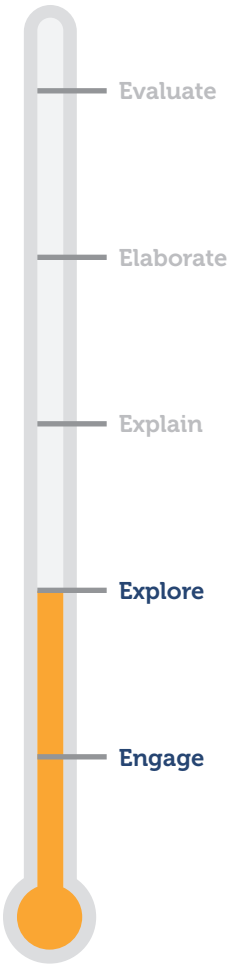
> *"For the first time [in history], we concluded anthropogenic warming has had an influence on many physical and biological systems."*
> **— Cynthia Rosenzweig, NASA's Goddard Institute for Space Studies**



Overview

The surface of the Earth is warmed by the sun's radiation. Greenhouse gases in the atmosphere of the Earth "trap" some of this radiation that would otherwise be released back into space, warming the planet. This is known as the greenhouse effect. Without the greenhouse effect, there would be no life on Earth.

- Students will develop a model to explore how the greenhouse effect works in an inquiry-based laboratory activity.
- Students will differentiate between the greenhouse effect, global warming, and climate change.
- Students will also investigate some of the factors that are increasing greenhouse gas emissions and resulting in global climate change such as clearing land for agriculture and raising animals for food.



Essential Questions:

- What is the greenhouse effect?
- How is the greenhouse effect related to global warming?

Lesson Time:

Section 1 = 60-75 minutes
Section 2 = 60-75 minutes

Student Learning Objectives:

Students will be able to...

- Discover how an environment can be warmed by the presence of certain molecules in its atmosphere (the greenhouse effect)
- Differentiate between the greenhouse effect, global warming, and climate change
- Use an inquiry-based lab to understand the science behind the greenhouse effect
- Identify some of the major contributing factors to global climate change

Resources:

- **Student Activity:** Student Sticky Note Exercise
- **Student Activity:** Terms and Definitions Activity
- **Student Handout:** Fact Sheet: The Connection Between Cow Farming and Climate Change
- **Student Handout:** Reading a Fact Sheet
- **Student Handout:** The Greenhouse Effect, Global Warming, and Climate Change
- **Teacher Key:** The Greenhouse Effect, Global Warming, and Climate Change

Materials:

- Sticky notes, one for each student
- Access to YouTube*

* If Internet access in school is not available, YouTube Red is a great resource that allows you to download a video when you have WiFi/Internet access and then be able to play the video when you do not have WiFi/Internet access.

Website: www.youtube.com/red/freetrial

Next Generation Science Standards

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.

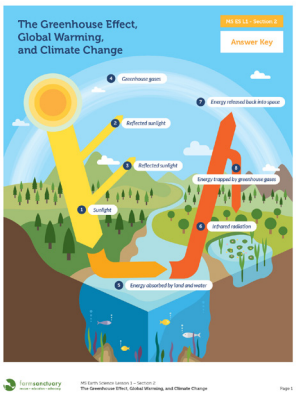
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Activities: Section Two

Evaluate
Elaborate
Explain
Explore
Engage

Explain: The Greenhouse Effect, Global Warming, and Climate Change
(15 minutes)

Provide students with the handout, **The Greenhouse Effect, Global Warming, and Climate Change**. There is a teacher key to support this handout. As a class, students will watch two short videos created by the U.S. Environmental Protection Agency and National Geographic and record their responses to the handout's questions as they watch.



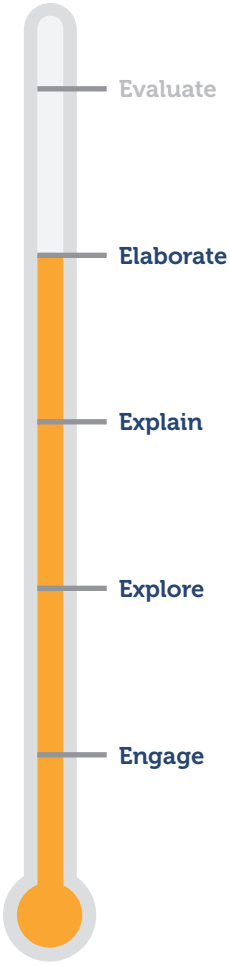
Videos

- **The Greenhouse Effect - EPA** (1:55):
  https://www.youtube.com/watch?v=VYMjSule0Bw
- **Causes and Effects of Climate Change - National Geographic** (3:04):
  https://www.youtube.com/watch?v=G4H1N_yXBiA

Procedure

1. Start by showing the first video on the greenhouse effect. After 15 seconds, stop the video and so students can define the greenhouse effect in their own words on their handout. Next, allow students to watch the first 15 seconds of the video again and let them add to their answer. Ask for volunteers to share their definition. From this video, students should understand that greenhouse gases, like carbon dioxide, trap heat in the Earth's atmosphere and keep the Earth warm, which is a good thing. Be sure to relate this new knowledge to the previous lab modeling activity.
2. Now show the next section of the video that has a diagram like the one on the student handout (up to the 46 second mark). As they watch, students should fill out the diagram on their handout. You might show the video a second time up to the same point if needed.
3. Finally, show the remainder of the video, pausing it as needed so that students can complete the first page of the handout.
4. The second video, on the causes and effects of climate change, pertains to the back of the student handout. Pause and rewatch the video as needed.

Notes:



Elaborate: The Connection Between Cows and Climate Change
(20 minutes)

In this activity, students will read a fact sheet on the connection between animal agriculture and climate change. They will learn about the greenhouse gas, methane.

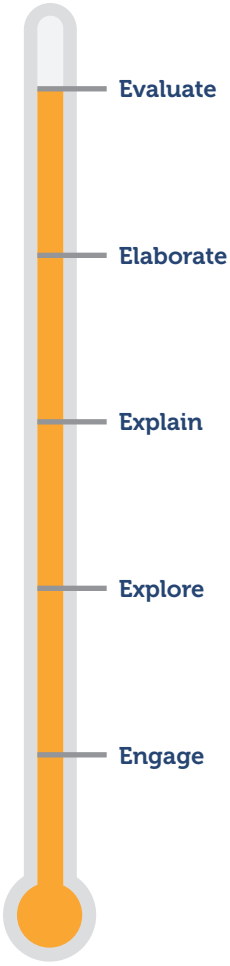
Procedure

1. Ask students to recall some of the human-related causes that are believed to be causing global warming. They might include the fact that excess CO_2 is being produced by humans through the burning of coal, oil, and gas.
2. Inform students that they will be reading about another factor that is warming up our atmosphere that has to do with cows.
3. Provide each student with the following handouts: **Fact Sheet: The Connection Between Cows and Climate Change** and **Reading a Fact Sheet**.
4. Tell students that they will be reading and interacting with the text in this activity. Inform students that there is a terms and definitions list attached to the fact sheet and that they will see vocabulary from this list underlined in the fact sheet itself.
5. Give students time to read through the article on their own silently. Have them circle or highlight the following: words or phrases that are unfamiliar to them; facts that surprise them; anything that stands out as especially interesting.
6. After this first reading, have students discuss with their neighbor/reading partner what they circled or highlighted. Did they highlight the same things? Did they find different things challenging or interesting?
7. Now, have students read through the article a second time. During this second read-through, have them write a one-sentence summary next to each section (sections are grouped under headings).
8. Once they are done, have them share their sentences with their partner. Did they come up with similar or different summaries?
9. Now it's time for students to "be the teacher"! Ask students, "If YOU were assigning this article to students, what questions would YOU ask? Come up with three questions (and their answers)." Students should now write out these three questions.
10. Have students turn to their neighbor or reading partner. Each of them should take turns asking the other their questions and seeing if they can answer each other's questions.

Notes:

Class Discussion

- **Vocabulary:** What were the unfamiliar words? Share definitions with the class.
- **Main Ideas:** What were the main ideas of this article?
- **Facts:** What facts were surprising or especially interesting?
- **Share:** What were some of the questions students asked each other?



Evaluate: Terms and Definitions Activity
(25 minutes)

This evaluation activity will review some of the important terms and concepts from this lesson. Students will be asked to rate the greenhouse effect along a continuum of "good" or "bad" to get students to realize that some issues are multifaceted in their effects.

Teacher Preparation

Print two copies of the **Terms and Definitions Activity**. One copy is your reference. With the second copy, cut out the terms and definitions and place them in an envelope or bag. One copy of this sheet contains 9 terms and 9 definitions, enough for 18 student pairs or 36 students. If you have less than 18 pairs, a few student pairs should draw a second term or definition so that all vocabulary is included in the activity.

Terms Included: Atmosphere, Carbon Dioxide, Climate, Climate Change, Fossil Fuels, Global Warming, Greenhouse Effect, Methane, and Ruminant.

Procedure

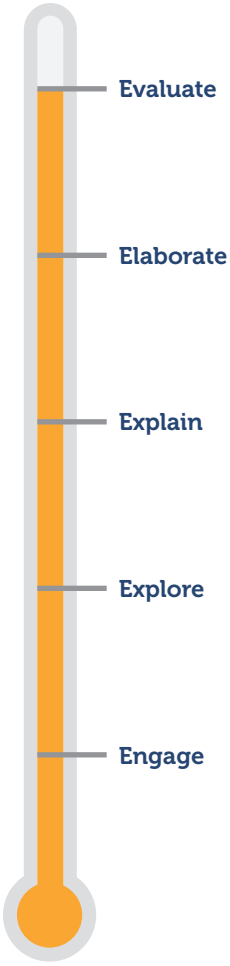
1. Each student pair should randomly pick a card from the bag or envelope and then walk around the room and find the match to their card.
2. Once all students have found what they think is their match, ask groups to sit together and share their cards with the class. Or, you might call on groups randomly to share their match.
3. Once groups have shared, read the correct matches of terms to definitions from your copy of the activity.
4. Now, ask students if they think the greenhouse effect is "good" or "bad." To do this, ask students to stand up and place themselves somewhere on a continuum in the classroom between two sides. For example, the left side of the room could be "bad," and the right side could be "good." (Note: Purposefully keep vague what "bad" and "good" are so students have to explain their views.) They can stand anywhere between these two poles.
5. Once students have moved, ask a few volunteers to explain why they moved to where they are. If everyone is standing at one pole, ask students if there are any reasons why the opposite might be true. For example, some might stand close to "good" because without the greenhouse effect life could not exist on Earth, while others might stand close to "bad" because too much heat being trapped could heat the Earth beyond the ability to support life. At the conclusion of the activity, students should ultimately understand why the greenhouse effect is "good" and "bad."

Notes:

Closure: Student Sticky Note Exercise
(5-10 minutes)

Please refer to **Student Activity: Sticky Note Exercise** for detailed instructions. Each student will write 1-2 sentences on a sticky note about what they consider to be the most important thing they learned in this lesson. The sticky notes should be completed anonymously. Students will then post their sticky notes on a board or wall and engage in a brief class discussion.

Time Permitting: Have the students group together sticky notes with similar ideas. Then ask students to come up with a title to describe each group of sticky notes. Finally, add titles to each group of sticky notes using an additional sticky note.



Conclude by taking a photo of the sticky notes, checking that each sticky note is legible in the photo. Please email the photo of the anonymous student sticky notes to Farm Sanctuary's Humane Educator Maddie Krasno at mkrasno@farmsanctuary.org.

Teacher Survey and Student Feedback

Teachers who have implemented one complete lesson plan from Farm Sanctuary's Sustainable Future Curriculum are eligible for a **$50 Amazon gift card** by completing our teacher survey and submitting a photo of the anonymous student sticky notes to Farm Sanctuary. Please e-mail Maddie Krasno at mkrasno@farmsanctuary.org for the survey and to submit the photograph of the student sticky notes.

References:

Climate change. (n.d.).
Retrieved from EPA website:
https://19january2017snapshot.epa.gov/climatechange_.html

Climate and environmental impacts. (n.d.).
Retrieved from the Environmental Working Group website:
http://www.ewg.org/meateatersguide/a-meat-eaters-guide-to-climate-change-health-what-you-eat-matters/climate-and-environmental-impacts/

Counting chickens. (2011, July 27).
Retrieved from:
https://www.economist.com/graphic-detail/2011/07/27/counting-chickens

Factory farming and the environment. (n.d.).
Retrieved from:
https://www.farmsanctuary.org/learn/factory-farming/factory-farming-and-the-environment/

Facts. (n.d.).
Retrieved from:
http://climate.nasa.gov/causes/

Koneswaran, G., & Nierenberg, D. (2008). Global farm animal production and global warming: Impacting and mitigating climate change. Environmental Health Perspectives, 116(5), 578-582.

Matthews, C. (2006, November 29). Livestock a major threat to environment.
Retrieved from FAO Newsroom website:
http://www.fao.org/newsroom/en/news/2006/1000448/index.html

Overview of greenhouse gases. (n.d.).
Retrieved from United States Environmental Protection Agency website:
https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Sources of greenhouse gas emissions. (n.d).
Retrieved from United States Environmental Protection Agency website:
https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#agriculture

What is the greenhouse effect? (n.d.).
Retrieved from:
http://climatekids.nasa.gov/greenhouse-effect/

Notes:

farmsanctuary
rescue • education • advocacy

Name: _____

Date: _____

Class/Teacher: _____

Inquiry Lab: Why is the temperature rising?

In the lab activity, your task is to determine the role that plastic wrap is playing in warming the air inside glass jars or plastic soda bottles.

Materials List

Each lab pair or group should have access to the following materials:

- 2 glass jars or 2 plastic soda bottles with tops cut off
- 2 thermometers
- Masking tape
- Small pieces of cardboard
- Plastic wrap
- Scissors
- 1 cup of soil
- Access to direct sunlight or a lamp
- Colored pencils
- Graph paper
- Measuring cups or paper cups for measuring soil
- Construction paper
- Aluminum foil

Design the Experimental Setup

1. **What are some possible explanations for why the temperature rises in a container that is covered with plastic wrap?**

2. **Choose one of your explanations. Write a hypothesis to test this explanation. You might write your hypothesis in "If...then..." format.**

3. **Using the materials list and your hypothesis, work together in your lab pair or group to design an experimental setup. You will need to have two containers with only one variable that is different between them so that you can test your hypothesis.**
   Draw a diagram of your model.

Finalize Your Model

Before you build your model and gather data, be sure you can answer the following questions.

1. How will you know that your model "works"? What will be your control and your variable?

2. What measurements will you take? How will you record your measurements?

Gather Data

- Once your teacher has signed off on your model, construct a data table on graph paper for recording your measurements. Be sure to label each axis.
- Next, gather your materials and build your model.
- Finally, gather data as needed.
- Once you have gathered your data, find a way to graphically represent it so that your results are easy to understand. You may choose to construct a bar graph or a chart.
- **When you are done with all of the above, answer the questions below.**

Results and Conclusions

1. Did your model "work" in the way that you intended? Why or why not?

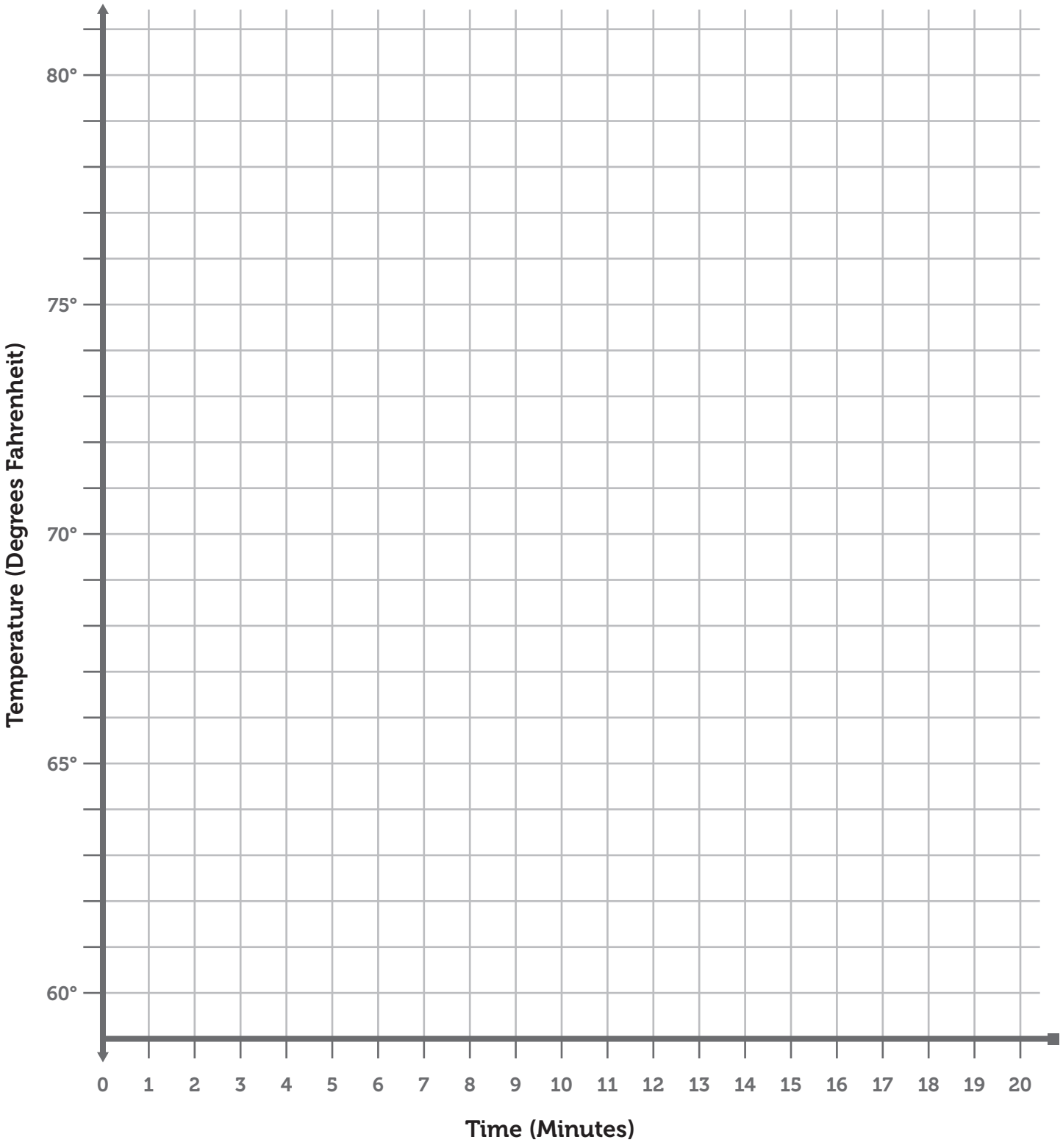
2. If you had additional time and materials, how might you change your model to be more accurate?

3. Why does the temperature rise in a glass jar or plastic soda bottle covered with plastic wrap?

Data Table

Time (minutes)	Jar Temperatures	
	Control	Variable
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Modeling the Greenhouse Effect



The Greenhouse Effect, Global Warming, and Climate Change

Name: _____

Date: _____

Class/Teacher: _____

Video: The Greenhouse Effect (U.S. Environmental Protection Agency)

As you watch the video, answer the following questions:

1. What is the greenhouse effect?

Fill in the diagram on page 1 to show how the greenhouse effect works.

2. What is global warming?

3. What is causing global warming?

4. What is climate change?

Video: Causes and Effects of Climate Change (National Geographic)

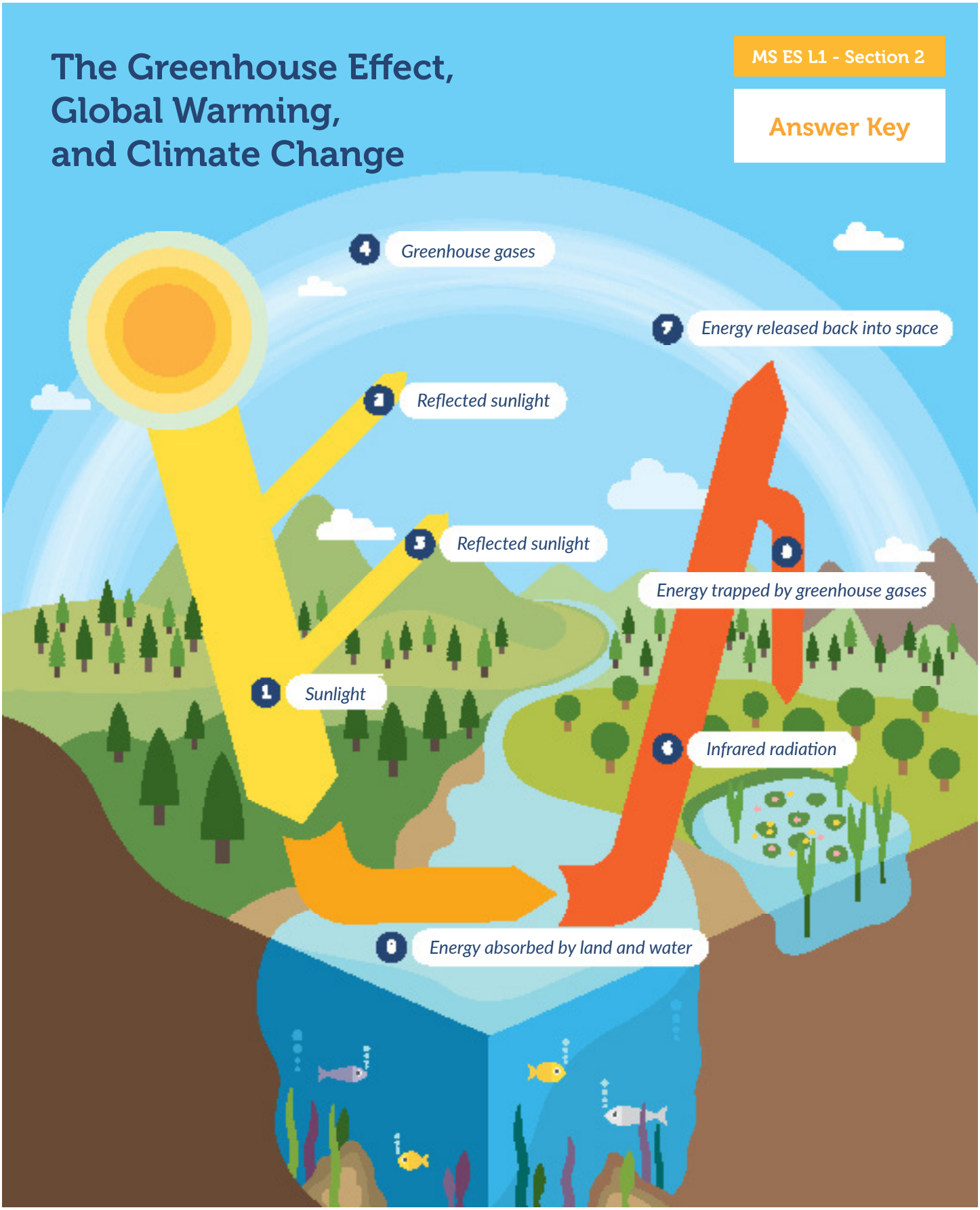
As you watch the video, answer the following question:

5. List three things we can expect if the planet keeps getting warmer.

The Greenhouse Effect, Global Warming, and Climate Change

MS ES L1 - Section 2

Answer Key



Video: The Greenhouse Effect (U.S. Environmental Protection Agency)

As you watch the video, answer the following questions:

1. What is the greenhouse effect?

Greenhouse gases, like carbon dioxide, trap heat in the earth's atmosphere and keep the earth warm.

Fill in the diagram on page 1 to show how the greenhouse effect works.

2. What is global warming?

Extra greenhouse gases trap more heat, which makes the whole planet warmer.

3. What is causing global warming?

Excess carbon dioxide is being produced by humans through the burning of coal, oil, and gas.

4. What is climate change?

The warmer temperatures caused by global warming lead to effects like changing rain and snow patterns, rising sea level, and melting glaciers and ice sheets.

Video: Causes and Effects of Climate Change (National Geographic)

As you watch the video, answer the following question:

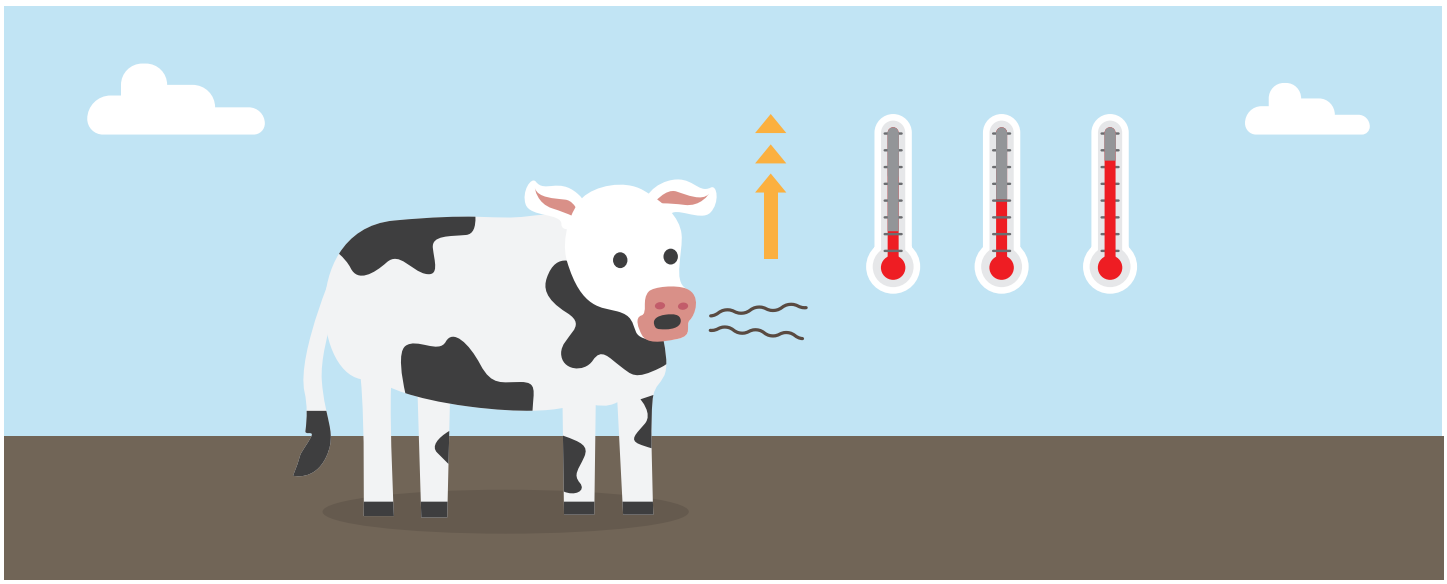
5. List three things we can expect if the planet keeps getting warmer.

Answers may include: *Ice sheets continuing to melt causing sea levels to rise, higher temperatures mean more extreme weather, longer and more frequent droughts, growing crops may become more difficult in certain regions, regions where animals can live will shift, warmer temperatures in urban areas mean increased levels of smog which can lead to more health issues like asthma, heart disease, and lung cancer.*

Fact Sheet: The Connection Between Cow Farming and Climate Change

Burping and Climate Change

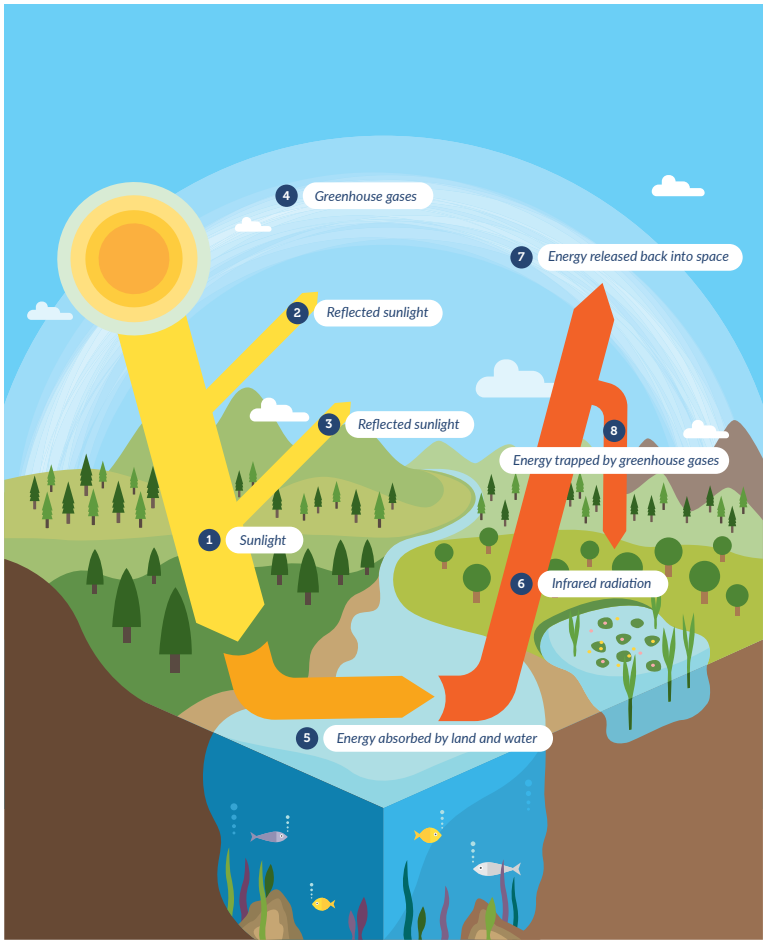
You've probably heard of climate change. Maybe you know someone who drives a hybrid car. You're probably aware that burning gas, as cars do, contributes to the warming climate. But have you heard that burping contributes to climate change? It's hard to imagine burping and the climate could be connected—but they are! And in ways that are important for us to understand.



The Greenhouse Effect

Let's begin with the greenhouse effect. Maybe you've seen a greenhouse before. The roof and sides of these buildings are usually made of glass and the spaces inside are filled with plants. Greenhouses allow plants to survive—and thrive—even when it's cold outside. They allow the warm energy from the sun into the greenhouse, while some of the sun's energy escapes back out. But a lot of this energy is trapped within the greenhouse, keeping it warm and creating a favorable environment for plants.

The Earth stays warm in a similar way. First, like the greenhouse, the Earth gets energy from the sun in the form of sunlight. The earth absorbs some of this energy, while some energy radiates back out to space. But before all the warmth escapes, the gases in the atmosphere absorb some of it and keep the warmth in the atmosphere in the same way that the greenhouse structure keeps the warmth inside. As the atmosphere warms, the Earth's surface become warmer.



Greenhouse Gases

The gases in the atmosphere, like carbon dioxide (CO_2) and methane (CH_4), absorb this energy and keep this energy in the atmosphere.[3] This is good for the most part. It would be too cold to live on earth without any greenhouse effect. However, in recent decades, we have released even more carbon dioxide, methane, and other gases into the atmosphere. That means the atmosphere isn't just staying warm *enough*; it's actually getting *warmer* from the increased amount of gases in the atmosphere that are trapping heat. The increased warming effect leads to climate change and the problems associated with it.

Carbon dioxide has been the star of the climate change discussion so far. But another gas, methane, is also a big player. While methane stays in the atmosphere for a much shorter period of time than carbon dioxide, methane is much more powerful when it comes to trapping heat, trapping more heat than carbon dioxide can in a much shorter period of time.[3]

Now let's talk about burping...

Cows and Methane

Methane comes from many different places. One source is the burping from cows. Yes, when cows burp, methane is released into the atmosphere. But how can burping make that much of a difference? When it's one, two, or even twenty cows, it wouldn't.

But when you consider that there are an estimated 1.4 billion cows raised for beef and dairy worldwide, you can see how the amount of methane in the atmosphere adds up.[1] Scientists have found that raising cows for food contributes significantly to the emission of greenhouse gases into the atmosphere.[2,4]

Where are all of these cows?

To accommodate a growing demand for beef, milk, and other dairy products, most of those 1.4 billion cows are raised on factory farms. These farms maximize the number of cows per pen and per area to allow for automated feeding and waste removal. Cows are fed diets of grain because there isn't enough space for grazing on grass. This diet contributes to an increased demand for land because not only do factory farms take up a large amount of space, but a lot of land is also needed to grow food for the cows who are raised on these farms.

Findings by FAO (Food and Agricultural Organization of the United Nations)

- According to a report published by the FAO, animal agriculture is responsible for more greenhouse gas emissions than every car, bus, train, boat, airplane, and any other mode of transportation on the planet combined.[2]
- According to this report, animal agriculture is responsible for 37% of all human-caused methane emissions, and most of these emissions are coming from the digestive systems of ruminants - cows, goats, and sheep. Methane is a greenhouse gas that is 23 times as warming as CO_2.[2]
- According to this report, farm animals occupy 30% of the Earth's entire land surface.[2]

Fighting Climate Change

Reducing the amount of beef and dairy we consume is one step individuals can take to help this problem. If people begin to limit the amount of beef and dairy they eat, fewer cows will be raised for food. That would mean less methane gas in the atmosphere—and fewer animals enduring factory farm conditions.

Reading Level 970L Lexile

References:

[1] **Counting chickens. (2011, July 27).**
Retrieved from:
https://www.economist.com/graphic-detail/2011/07/27/counting-chickens

[2] **Matthews, C. (2006, November 29). Livestock a major threat to environment.**
Retrieved from FAO Newsroom website:
http://www.fao.org/newsroom/en/news/2006/1000448/index.html

[3] **Overview of greenhouse gases. (n.d.).**
Retrieved from United States Environmental Protection Agency website:
https://www.epa.gov/ghgemissions/overview-greenhouse-gases

[4] **Sources of greenhouse gas emissions. (n.d).**
Retrieved from United States Environmental Protection Agency website:
https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#agriculture

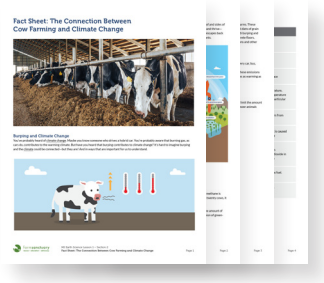
Terms and Definitions

Term	Definition
Atmosphere	The mixture of gases that surrounds the Earth
Carbon Dioxide	A gas breathed out by people and animals from the lungs or produced by burning carbon
Climate	The regular pattern of weather conditions of a particular place
Climate Change	Changes in the Earth's weather, including changes in temperature, wind patterns and rainfall, especially the increase in the temperature of the Earth's atmosphere that is caused by the increase of particular gases, especially carbon dioxide
Fossil Fuels	Fuel such as coal or oil, that was formed over millions of years from the remains of animals or plants
Global Warming	The increase in temperature of the Earth's atmosphere, that is caused by the increase of particular gases, especially carbon dioxide
Greenhouse Effect	A phenomenon where gases allow sunlight to enter Earth's atmosphere but make it difficult for heat to escape.
Methane	A gas without colour or smell, that burns easily and is used as fuel; natural gas consists mainly of methane
Ruminant	Animals, such as cows and sheep, who bring back food from their stomachs and chew it again

Sources:
Greenhouse effect. (n.d.). Retrieved from: https://www.nationalgeographic.org/encyclopedia/greenhouse-effect/
Oxford learner's dictionaries. (n.d.). Retrieved from: https://www.oxfordlearnersdictionaries.com/us/

Reading a Fact Sheet

For this activity, you will be reading and interacting with a fact sheet.



Step 1

- Read through the fact sheet on your own silently. Circle or highlight the following:
  - ✓ Words or phrases that are unfamiliar to you
  - ✓ Facts that surprise you
  - ✓ Anything that stands out to you as especially interesting
- After this first reading, discuss with your neighbor/reading partner what you circled or highlighted. Did you circle or highlight similar things?

Notes:

Step 2

- Now, read through the fact sheet a second time. During this second read-through, write a one-sentence summary next to each section. Each section can be identified by a heading or a title.
- Once you are done, share your sentences with your partner. Did you come up with similar or different summaries?

Notes:

Step 3

- Now it's time to "Be the Teacher"! If YOU were assigning this fact sheet to students, what questions would YOU ask?
- Come up with three questions and their answers. Write down your three questions.
- When you're done writing down your questions, turn to your partner. Take turns asking each other the questions. Can you both answer each other's questions?

Notes:

Terms and Definitions Activity

Print two copies of this worksheet. One copy is your reference. With the second copy, cut out each term and definition and place them in an envelope or bag. Have each pair of students draw either a term or a definition from the envelope or bag. Have students find their match by talking with other student pairs. One copy of this sheet contains enough terms and definitions for 18 student pairs/36 students. If you have less than 18 pairs, have a few student pairs draw a second term or definition so all vocabulary is included in the activity.

Refer to **Section 2** of the lesson plan for detailed instructions.

Term	Definition
Atmosphere	The mixture of gases that surrounds the Earth
Carbon Dioxide	A gas breathed out by people and animals from the lungs or produced by burning carbon
Climate	The regular pattern of weather conditions of a particular place
Climate Change	Changes in the Earth's weather, including changes in temperature, wind patterns and rainfall, especially the increase in the temperature of the Earth's atmosphere that is caused by the increase of particular gases, especially carbon dioxide
Fossil Fuels	Fuel such as coal or oil, that was formed over millions of years from the remains of animals or plants
Global Warming	The increase in temperature of the Earth's atmosphere, that is caused by the increase of particular gases, especially carbon dioxide
Greenhouse Effect	A phenomenon where gases allow sunlight to enter Earth's atmosphere but make it difficult for heat to escape
Methane	A gas without colour or smell, that burns easily and is used as fuel; natural gas consists mainly of methane
Ruminant	Animals, such as cows and sheep, bring back food from their stomachs and chew it again

Sources:
Greenhouse effect. (n.d.). Retrieved from: https://www.nationalgeographic.org/encyclopedia/greenhouse-effect/
Oxford learner's dictionaries. (n.d.). Retrieved from: https://www.oxfordlearnersdictionaries.com/us/

Final Activity: Sticky Note Exercise

Purpose: Identify key student learning to assess lesson effectiveness

1. Requirements

Time

5-10 minutes
at end of session

Materials

- One sticky note for each student
- Thin-line markers (such as sharpies) or pens

Board or Wall Space

A place where students can post the sticky notes and the class can gather around to view them

2. Introduction

Inform the class that the final activity will have them reflect upon what they have learned throughout the lesson. **Ask each student to write 1-2 sentences on a sticky note about what they think is the most important thing they learned. Students should not write their names on the sticky notes.**

3. Individual Work Time (2 minutes)

4. Posting Sticky Notes (2 minutes)

Students should now post their sticky notes on the board/wall so that they can see what their fellow classmates learned as a whole. Inform the students that they do not have to post their sticky note if they prefer not to do so. Students should remain standing by the board/wall once they have posted their sticky notes.

5. Themes (up to 5 minutes)

Now, ask the class if they see similar concepts, facts, or comments referred to on the sticky notes. Encourage a brief discussion.

Time Permitting: Have the students group together sticky notes with similar ideas. Then ask students to come up with a title to describe each group of sticky notes. Finally, add titles to each group of sticky notes using an additional sticky note.

Conclude by taking a photo of the anonymous sticky notes for your records, checking that each sticky note is legible in the photo. You may choose to keep the sticky notes or recycle them. Please e-mail this photo to Farm Sanctuary's Humane Educator Maddie Krasno at mkrasno@farmsanctuary.org.