EDUCATOR GUIDE

LESSONS 6-8

DINOSAURS OF ANTARCTICA

EDUCATOR GUIDE

DISCOVERY PLACE

Educator Guide written by Candice Wilson-McCain, Ed.S.

Dinosaurs of Antarctica is a production of Giant Screen Films.
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GIANT SCREEN FILMS

dinosaursofantarctica.com

Dinosaurs of Antarctica Educator Guide

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INTRODUCTION TO GUIDE

The ***Dinosaurs of Antarctica*** Educator Guide, created by Discovery Place Education Studio in Charlotte, North Carolina, in partnership with Giant Screen Films, is appropriate for students in grades kindergarten through eighth. The guide is most beneficial when used as a companion to the film but also useful as an independent resource. Educators are encouraged to modify the learning activities included in this guide to meet the needs of their students' functional level and to support specific state standards. Activities developed for this guide support the Next Generation Science Standards (NGSS) and national Common Core ELA and math standards. However, educators will find that the ***Dinosaurs of Antarctica*** film and guide align with other content areas such as geography. This guide focuses on the scientific understanding of Antarctica's geological and ecological history while exploring the career understandings of scientists who studied Antarctica. Students will examine the roles of a climatologist, paleontologist, and geologist by completing hands-on activities related to work in the field. This guide consists of sixteen engaging lessons that have been approved by teachers.

Dinosaurs of Antarctica is a story about Antarctica's geological and ecological history, specifically focusing on the Permian and Triassic extinction and Antarctica's climate transition from Icehouse to Greenhouse, creating a connection to present-day climate science. The film highlights the expedition to Shackleton Glacier featuring scientists from the Natural History Museum of Los Angeles and Field Museum, Chicago, along with other academic institutions. During the exploration, scientists uncover Antarctica's past through the discovery of ancient animal and plant fossils. Utilizing computer-generated imagery, ***Dinosaurs of Antarctica*** brings to life the eras of Antarctica's history and utilizes attributes of the giant screen to convey challenging scientific concepts such as plate tectonics, geological time, climate processes, etc. During the film viewers will shadow a team of scientists as they encounter extreme weather conditions to excavate fossils that will deepen our understanding of life on Earth.

Dinosaurs of Antarctica is a production of Giant Screen Films, directed by Dave Clark. The film has a run time of 40 minutes.

BACKGROUND

ABOUT ANTARCTICA

Antarctica is the coldest, windiest, and driest southernmost continent near the South Pole and contains 90% of all of the ice on Earth. Antarctica is a desert because it only receives two inches of rain per year. The small amount of rainfall received each year does not soak into the ground, causing it to accumulate as ice and snow. The Antarctic ice sheet is the largest single piece of ice in the world, covering more than 5 million square miles. Although Antarctica's temperature makes it difficult for many animals to survive, it is still home to some animals such as seals, whales, penguins, fish, and krill. Also, organisms such as algae and moss can survive the icy conditions. No permanent residents are living in Antarctica. However, Antarctica attracts thousands of scientists each year during the summer months to conduct research. Scientists and early explorers have been researching Antarctica since the late 1800's and each century uncovers new findings.

Although 98% of Antarctica is covered in snow and ice making it an icehouse, 200 million years ago, it was a greenhouse with wooded, lush habitat where dinosaurs and other living things thrived. Scientists have discovered fossils and other data that confirm the theory of plate tectonics, the movement of continents over time, and the impact on Antarctica's climate. Fossil records provide paleontologists a global perspective to dinosaur origin, enhancing their understanding of the End-Permian and End-Jurassic extinction events.

ANTARCTIC GEOLOGICAL TIMELINE

Geologists have divided Earth's history into a series of time intervals known as a geological time scale. The geological time scale consists of three eras: Cenozoic, Mesozoic, and Paleozoic. Each era splits into periods. Fossils found in Antarctica provide clues to the changing climate and position of the continent during each phase of the geological time scale.

ERA	PERIOD	ABOUT ANTARCTICA	TIMEFRAME
Paleozoic	Permian	The continents were connected as Pangaea. Scientists found fossils of the same species on all continents, including Antarctica.	299-252 million years ago
Mesozoic	Triassic	Antarctica plants and animals experienced climate patterns similar to today, consisting of sunlight in the summer and darkness in the winter.	252-201 million years ago
	Jurassic	Over time, Pangaea split into two supercontinents, Gondwana and Laurasia. Antarctica became part of Gondwana.	201-145 million years ago
	Cretaceous	Antarctica split away from Africa but was still connected to South America and Australia which created a gap filled by the ocean over time.	145-66 million years ago
Cenozoic	Paleogene	Antarctica began transitioning from a greenhouse to an icehouse.	62-23 million years ago

BACKGROUND

ANTARCTIC EXPEDITIONS

Antarctica has been an area of interest for explorers for hundreds of years. Antarctica was the last of the seven continents discovered, and early explorers were interested in learning more about the continents' natural resources. Some early explorers hoped to find new locations to hunt for whales and seals, while others wanted the glory of being the first to visit the continent. Regardless of the reason for expeditions to Antarctica, explorers faced incredible hardships, and many lost their lives in the process. Modern scientists utilize early explorers' findings to conduct further research to understand the history of Earth.

THE EARLY 1900S EXPEDITIONS

to Antarctica focused on competition to reach the South Pole.

1900

1901

British Discovery Expedition: Captain Scott and his team led their first Antarctic expedition with the goal of reaching the South Pole. The scientists turned around due to the extreme weather they encountered.

1907-1909

Ernest Shackleton led an expedition to the South Pole but was forced to turnaround after he runs out of supplies.

1910

1910-1912

Norwegian Antarctic Expedition: Roald Amundsen and his team became the first group of people to reach the South Pole.

1910-1913

Terra Nova Expedition: Captain Robert Falcon Scott, along with his team, set out to reach the South Pole again, hoping to be the first people to accomplish the task, but they found out they were a couple of months too late. Scott and his team reached the South Pole but perished during the return trip home.

1915-1917

Endurance Expedition: Ernest Shackleton and his team set out on a journey to reach Antarctica again with the goal of crossing the continent. However, his ship was crushed by ice and destroyed. The team was rescued five months later.

1920

THE MID 1900'S EXPEDITIONS

to Antarctica focused on research and scientific exploration.

1950

1957-1958

McMurdo Station, the first permanent research station in Antarctica, was built by the U.S. military to support the scientific study of over sixty nations.

1959

The Antarctic Treaty was established to make Antarctica a scientific preserve that banned military activity but supported freedom of research.

1960

THE LATE 1900'S & EARLY 2000'S EXPEDITIONS

to Antarctica focused on understanding Antarctica's past and present environment and excavating fossils.

1990

1990

Geologist, David Elliot, and his team discovered a set of large bones on Mount Kirkpatrick in Antarctica.

1994

Dr. William Hammer, along with other scientists, began excavating Mount Kirkpatrick and retrieved a skull and thigh bone of a dinosaur described as *Cryolophosaurus ellioti*.

2000

2003

Scientists continued to excavate *Cryolophosaurus* bones but ended the expedition early due to harsh weather.

2010

2011

Dr. Nate Smith and Dr. Pete Makovicky, along with other scientists, retrieved the remaining fossils of the dinosaur, *Cryolophosaurus*, and discovered new dinosaur fossils.

ABOUT THE SCIENTISTS IN THE FILM

DR. NATHAN SMITH

Paleontologist, Associate Curator, Dinosaur Institute
Natural History Museum of Los Angeles County

Originally from Crystal Lake, Illinois, Nate grew up fascinated with dinosaurs, science, and baseball. He received his B.A. in Biology from Augustana College, a M.S. in Geoscience from the University of Iowa, and a Ph.D. in Evolutionary Biology from the University of Chicago. Nate also served as a Postdoctoral Research Scientist at the Field Museum of Natural History and an Assistant Professor of Biology at Howard University before joining the Natural History Museum of Los Angeles County in 2015.

Nate conducts paleontological research for the museum's Dinosaur Institute, focusing on the evolution and biogeography of Triassic–Jurassic dinosaurs, among other topics. He has made many significant finds in Antarctica and is responsible for naming *Glacialisaurus* (featured in ***Dinosaurs of Antarctica***). Nate's work has taken him to Antarctica, Argentina, China, and the southwestern and western United States, and he appeared in the giant screen film Dinosaurs Alive, featuring his collaborative dinosaur dig at Ghost Ranch in New Mexico.

Dr. Nathan Smith.
Photo courtesy of Akiko Shinya.

LIBBY IVES

PhD Student, Geosciences—Physical Sedimentology
University of Wisconsin—Milwaukee

Libby grew up in Wisconsin and always had a strong love of the outdoors. She spent many summers camping and exploring wilderness areas as a counselor at YMCA camps. She completed a B.S. in Earth Science at Northern Michigan University, and holds an M.S. in Geology from Iowa State University. She has studied geological formations across the world, from volcanoes in Russia to Ice Age deposits in Argentina. Libby is trained as a Wilderness First Responder, a special type of medical certification that's useful for remote field work expeditions.

As a PhD student, Libby is studying the sedimentology and stratigraphy of Late Paleozoic (320 – 250 million year old) Ice Age deposits at sites in Antarctica (Transantarctic Mountains), Tasmania (Wynyard Formation), and Argentina (Tepuel Basin). Her aim is to better understand the type, timing, and extent of glaciation during the Late Paleozoic.

Libby Ives.
Photo courtesy of Dr. John Isbell.

DR. PATRICIA RYBERG

Paleobotanist, Associate Professor of Biology; Honors Academy Director
Park University

Although she was on a pre-med career track as an undergraduate student, Dr. Ryberg found her passion for paleobotany on a biology class field trip in Nebraska, where on an excursion to find fossil shark teeth, she also discovered fossil plants. She realized that field research would allow her to travel and spend time outside, discovering plants that are totally unlike anything that exists today. Dr. Ryberg's bachelor's degrees are in biological sciences and history from the University of Nebraska, and she completed her doctoral degree in botany at the University of Kansas.

Dr. Ryberg specializes in studying *Glossopteris*, an extinct plant species from about 260 million years ago. She's especially interested in ecology and the evolution of plant life at high latitudes, and what the ancient past might signal about the future. Her work has taken her on research adventures around the world, from South Africa to Australia to Antarctica.

Dr. Patricia Ryberg

DR. PETER MAKOVICKY

Paleontologist, Professor, Department of Earth and Environmental Sciences, University of Minnesota

Dr. Makovicky is a paleontologist whose research focuses on dinosaur evolutionary history. He received his PhD in Earth and Environmental Sciences from Columbia University, and spent 18 years as a Curator of Paleontology at the Field Museum in Chicago, where he was the lead curator of the Antarctic Dinosaurs exhibition. Prior to that he received his BSc and MSc degrees from Copenhagen University in Denmark, where he grew up.

He has conducted fieldwork on four continents and described more than 15 new dinosaur species from the US, China, Mongolia, Argentina, and Antarctica. Dr. Makovicky uses dinosaurs as model systems to study broader topics in evolutionary biology. His current research focuses on understanding how carnivorous dinosaurs evolved herbivory, and how dinosaur evolution and biogeography were shaped by major geological events. He has also studied biomechanics, scaling, dinosaur trackways, and behavior.

Dr. Peter Makovicky

LESSON 6.1

STUDYING ANTARCTICA'S WEATHER

GRADE LEVEL 6-8

DINOSAURS OF ANTARCTICA EDUCATOR GUIDE

Dinosaurs of Antarctica Educator Guide

LESSON 6.1
STUDYING ANTARCTICA'S WEATHER

GRADE LEVEL 6-8
(1) 40 MINUTE LESSON

STANDARDS:

• CCSS.MATH.CONTENT.6.NS.C.5. Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.

FROM THE FILM:

In the film ***Dinosaurs of Antarctica,*** researchers and tourists typically visit the continent during the summer months, which occur from October to February. Due to the Earth's tilt and its orbit around the sun, Antarctica receives less heat and energy from the sun. As a result, during the summer months, it's almost always sunny, and during the winter months, it's mostly dark.

LESSON OVERVIEW:

In this lesson, students will analyze Antarctica's monthly weather pattern to determine the best time for researchers to visit the continent. Students will use data gathered from weather reports to identify weather tends by creating a line graph.

MATERIALS:

- Analyzing Antarctica's Weather Student Resource Sheet 6.1
- Technology to access the website and video:

  bit.ly/McMurdoStationWeather

- Antarctica: Destination World by National Geographic Kids

  http://bit.ly/DestinationAntarctica [2:57]

LESSON 6.1
STUDYING ANTARCTICA'S WEATHER

EDUCATOR PREP:

Print a copy of "Analyzing Antarctica's Weather Student Resource Sheet 6.1" for each student. Ensure that each student has access to technology for research purposes.

EDUCATOR GUIDE:

1. In the film ***Dinosaurs of Antarctica***, students will learn that scientists commonly visit the continent during particular seasons. However, the film does not explain in detail about Antarctica's seasons. Explain to students that due to the high elevation and large landmass of the South Pole, Antarctica is significantly colder than the north. Share with students that although Antarctica's climate is typically harsh, there are points in the year that are more suitable for humans to visit.

2. To help students make the connection between weather and its impact on people's choice of activities, solicit relevant examples based on your students' experience. For example, you could ask students:

When does someone typically go swimming in an outdoor pool? Why?

When does someone typically go ice skating? Why?

When has the weather impacted your weekend plans?

3. Tell students that they are going to explore the best time for people to visit Antarctica. Share with students the following scenario: A group of students would like to visit Antarctica. Using weather data, their task is to determine when conditions are best for students to visit the continent. Ask students:

Which months do you think would be the best time to visit Antarctica? Why?

Which months do you think would be the worst time to visit Antarctica? Why?

Why do you think it matters when people visit Antarctica?

How might Antarctica's environment affect humans?

Record students' responses. Students will revisit their ideas later in the lesson.

Adelie Penguins jump off an iceberg at Paulet Island, Antarctica.

LESSON 6.1
STUDYING ANTARCTICA'S WEATHER

4. Provide each student with a copy of "Analyzing Antarctica's Weather Student Resource Sheet 6.1." First, ask students to record their predictions about when would be the best time to visit Antarctica. Prompt students to make an educated guess about the continent's weather conditions throughout the year. Afterward, ask students to create a data table utilizing the online resource *www.timeanddate.com* to analyze the climate & weather averages in McMurdo Station, Antarctica. Allow students five minutes to record the mean temperature averages for each month. Circulate to provide support if necessary.

5. Tell students that their next task is to create a line graph using the data. Review the purpose of a line graph and how to create a line graph with students. Ask students:

Who has created a line graph before?
How do you create a line graph?
A line graph shows how something changes over time. Line graphs have an x-axis (horizontal) and a y-axis (vertical). Typically, the x-axis represents the time period, and the y-axis has numbers that represent what is being measured.

In the graph you create, what will the x-axis and y-axis represent?
The x-axis will represent the month of the year. The y-axis will represent the average temperature each month.

6. Using "Analyzing Antarctica's Weather Student Resource Sheet 6.1," review how to interpret the graph (ex: descriptive title, what each axis represents, how to record data, etc.). Tell students that due to the large size of Antarctica, the climate varies based on the location. Remind students that other large continents such as North America's climate also varies. Ask students to provide examples detailing how the weather may vary based on which part of North America they reside in. Share with students that they will analyze the weather near McMurdo Station, where most researchers visit.

7. At this grade level, students should be familiar with the concept of negative numbers. Draw a number line to display negative and positive numbers. Remind students that standard numbers, anything greater than zero, are characterized as 'positive' numbers. Numbers that are less than zero are described as 'negative' numbers. Tell students that on a number line, negative numbers are placed to the left of zero and positive numbers are placed to the right of zero.

Educator Notes:

LESSON 6.1
STUDYING ANTARCTICA'S WEATHER

8. Explain to students that when analyzing temperatures in Antarctica, negative numbers represent colder temperatures than positive numbers. For example, -8 degrees is colder than 27 degrees. Remind students that freezing occurs at 32 degrees. Model how to create a line graph for students by reviewing the data for January. Using the "Analyzing Antarctica's Weather Student Resource Sheet 6.1" allow students ten minutes to make a line graph of the data. Circulate to provide assistance if needed.

9. After the allotted time has expired, allow students to share their line graph with a peer. Revisit student predictions regarding the best and worst time to visit Antarctica and compare their earlier thoughts to their current findings. Ask students:

Based on the data, which months do you think would be the best time to visit Antarctica? Why?
Example: The warmest temperature occurs between November and February. The best time to visit is in January since it's usually the hottest month.

Based on the data, which months do you think would be the worst time to visit Antarctica? Why?
Example: The coldest temperature occurs between March and October. The worst time to visit is in July since it's usually the coldest month.

How is Antarctica's temperature different from where you live?
Example: It appears that our seasons are different. Our warm months occur between June to August but Antarctica's warm months occur from October to February.

Wooden Thermometer in the snow with freezing temperatures.

LESSON 6.1
STUDYING ANTARCTICA'S WEATHER

10. To help students learn more about Antarctica, show the video "Antarctica: Destination World" by National Geographic Kids. After showing the video, ask students:

Why do we describe Antarctica as a desert?
A desert is an area of landscape where little precipitation occurs and Antarctica only receives about two inches of rain per year.

Who has the largest ice sheet in the world?
What would happen if it melted?
The Antarctic Ice Sheet is the largest ice sheet in the world and if it melted, sea levels would rise by 200 feet.

What type of animals can survive the cold weather of Antarctica?
Antarctica is home to penguins, seals, whales, and octopuses to name a few.

Why do scientists and explorers visit Antarctica?
Since the early 1900's, explorers have been interested in Antarctica to research the landscape, climate change, space meteors, etc.

11. To conclude the lesson, explain to students that Antarctica has two seasons: summer and winter. Since it's located in the southern hemisphere, Antarctica's summer is from October to February and during this time, it's almost always sunny. Tell students that most research occurs during Antarctica's summer months.

Educator Notes:

Analyzing Antarctica's Weather

Record and study Antarctica's monthly weather pattern to determine the best time for researchers to visit.

My Predictions

I predict that the best month to visit Antarctica is _____ .

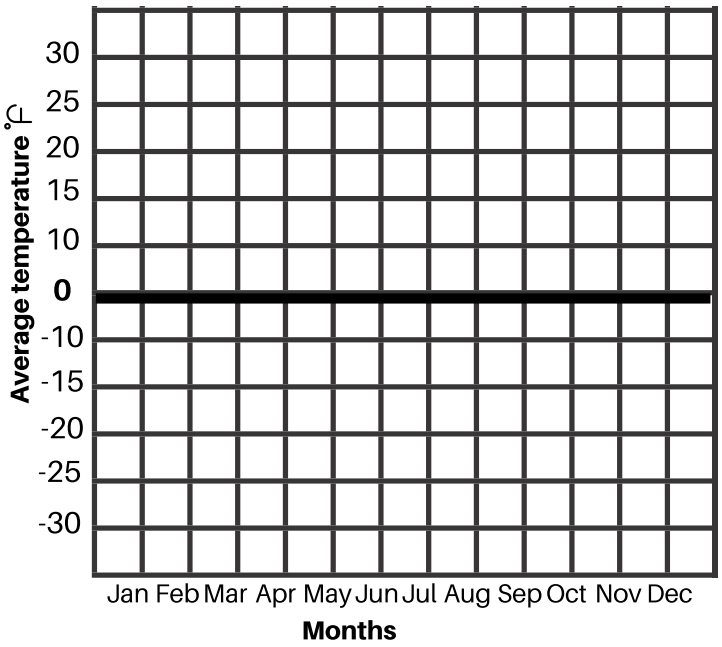
I predict that the worst month to visit Antarctica is _____ .

Actual Weather Averages in McMurdo Station in Antarctica

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Based on weather reports gathered from years 2005-2015.

Antarctica Weather Graph



Discussion Questions

Based on the graph, when is the best month to visit Antarctica? Why?

_____

Based on the graph, when is the worst month to visit Antarctica? Why?

_____

Why does it matter which month researchers visit Antarctica?

_____

_____

Analyzing Antarctica's Weather

Record and study Antarctica's monthly weather pattern to determine the best time for researchers to visit.

My Predictions

I predict that the best month to visit Antarctica is answers may vary .

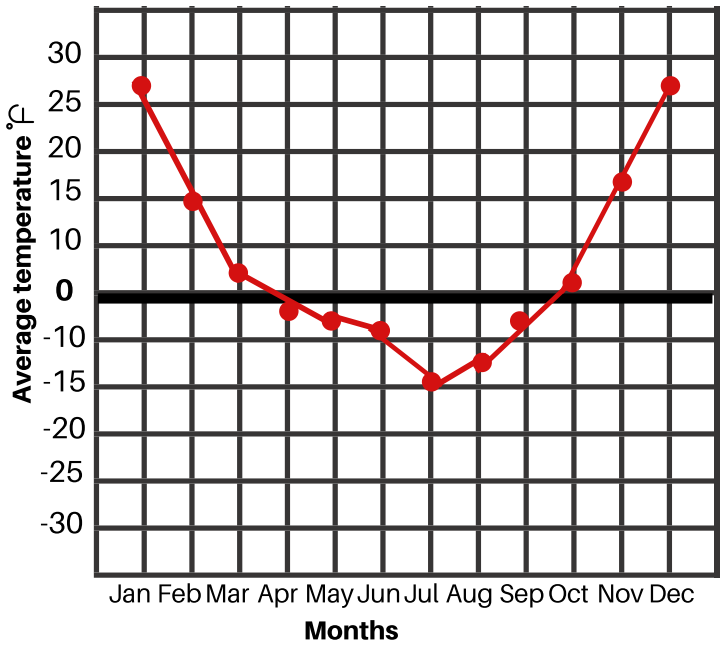
I predict that the worst month to visit Antarctica is answers may vary .

Actual Weather Averages in McMurdo Station in Antarctica

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28°F	15°F	1°F	-7°F	-8°F	-9°F	-15°F	-12°F	-8°F	°1F	16°F	27°F

Based on weather reports gathered from years 2005-2015.

Antarctica Weather Graph



Discussion Questions

Based on the graph, when is the best month to visit Antarctica? Why?
Example: The best time to visit is in January since it's usually the hottest month.

Based on the graph, when is the worst month to visit Antarctica? Why?
Example: The worst time to visit is in July since it's usually the coldest month.

Why does it matter which month researchers visit Antarctica?
answers may vary

LESSON 6.2

ANALYZING GLOBAL WARMING

GRADE LEVEL 6-8

DINOSAURS OF ANTARCTICA EDUCATOR GUIDE

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LESSON 6.2
ANALYZING GLOBAL WARMING

GRADE LEVEL 6-8
(1) 50 MINUTE LESSON
(1) 10 MINUTE CLEAN UP

STANDARDS:

- MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
- SP2: Develop and use a model to describe phenomena.

FROM THE FILM:

In the film ***Dinosaurs of Antarctica,*** students learned that scientists discovered more clues that proved the climate of the continent changed over millions of years. Despite its harsh weather, some animals, such as penguins, have been able to adapt to Antarctica's environment. Changes in temperature can influence the environment and thus make it difficult for some living things to survive. Scientists are using clues from Antarctica's past to predict how climate change can impact the future.

LESSON OVERVIEW:

In this lesson, students will explore global warming by modeling the greenhouse effect.

MATERIALS:

- Clean sand
- 4 clear, plastic cups (10 oz)
- 2 cups of water
- 2 empty soda bottles (1 liter)
- Scissors
- Tray of ice cubes
- Plastic wrap
- Rubber band
- Ruler
- Clip-on spotlight or light source with at least 100-watt bulb
- Analyzing Global Warming Lab Student Resource Sheet 6.2
- Analyzing Global Warming Student Resource Sheet 6.2a (each student)

LESSON 6.2
ANALYZING GLOBAL WARMING

EDUCATOR PREP:

Assign each student a lab partner. Based on your group size, gather enough materials to accommodate each set of partners. Print a copy of the "Analyzing Global Warming Lab Student Resource Sheet 6.2" for each set of partners. Print a copy of "Analyzing Global Warming Student Resource Sheet 6.2a" for each student. This lesson can also be taught as a whole class demonstration.

EDUCATOR GUIDE:

1. In the film ***Dinosaurs of Antarctica,*** scientists discovered more clues that proved the climate shifted over the years transitioning the continent into an icehouse. While Antarctica's weather is bleak, it is still home to seals, whales, penguins and other animals that have the ability to adapt to the conditions. Changes in temperature can influence the environment and thus make it difficult for some living things to survive.

2. To activate prior knowledge, facilitate a discussion using the following question prompts:

> *What happened when you got into a car that had been left in the sun on a hot day with the windows rolled down?*
> Example response: When you leave the car windows rolled up, the car becomes very hot causing someone to immediately roll down the window to cool it off. Sometimes the seat belt buckle is so hot it almost burns your hand. However, when you leave the windows down, the car feel cooler.

Ask students:

> *Why do you think the temperature in a car with the windows rolled up is higher than the temperature in a car with the windows rolled down?*
> Example response: The air in the car is trapped inside and is unable to circulate.

Crabeater seals resting on icebergs in Antarctica.

LESSON 6.2
ANALYZING GLOBAL WARMING

3. Share with students that the experience they described getting into a car placed in the sun with the windows rolled up is how the greenhouse effect works. Ask students:

Have you ever heard of the greenhouse effect?
The greenhouse effect is a process that occurs when gases such as carbon dioxide in Earth's atmosphere trap the Sun's heat.

Have you ever seen a greenhouse?
What is the purpose of a greenhouse?
A greenhouse is a building with glass walls and a glass roof often used to grow plants. A greenhouse stays warm inside because sunlight shines into the greenhouse and warms the plants and air inside because the glass walls of the greenhouse trap the Sun's heat.

Have you ever heard of greenhouse gases? What is it?
Gases in the atmosphere trap heat just like the glass roof of a greenhouse. These gases are called greenhouse gases and they allow sunlight to pass through the atmosphere, but they also prevent the heat that the sunlight brings from leaving the atmosphere making the Earth warmer.

Can you explain global warming?
Global warming is the long-term warming of the Earth's overall temperature.

4. Tell students that today they will explore global warming by modeling the greenhouse effect. Provide each group with a set of lab materials, the "Analyzing Global Warming Lab Student Resource Sheet 6.2" and "Analyzing Global Warming Student Resource Sheet 6.2a" Review lab safety rules if necessary. Circulate to provide assistance when needed but encourage students to utilize their partners for support.

Educator Notes:

LESSON 6.2
ANALYZING GLOBAL WARMING

5. PART 1 STUDENT DIRECTIONS:

- Carefully cut both one-liter soda bottles approximately 4 inches from the bottom.
- Place 1 inch of sand at the bottom of each bottle.
- Carefully, using scissors, cut four wide vertical slits in the bottom half of two clear, plastic cups. The purpose of the slits is to allow melted ice water to flow out of these cups. Make sure the slits are wide and reach the bottom of the cups.
- Place one of the plastic cups without slits upside down on a flat surface and place one of the plastic cups with slits facing up on top so that the bottoms of each cup touch. Without covering the slits on the top cup, tape both cups together to prevent movement. Repeat the process using the remaining two unused plastic cups.

6. PART 2 STUDENT DIRECTIONS:

- To create your "island" place one set of cup structures in each soda bottle on top of the sand. Make sure the plastic cup with slits is still on top.
- Pour water in each soda bottle until the water level is approximately 1 inch above the sand. If you accidentally over pour water in one bottle simply adjust the other bottle by adding more water until both bottles' water level is the same.
- Add "glaciers" to the "island" by placing ice cubes in both bottles. Choose the same number of ice cubes to place in each of the plastic cups with slits.
- Using plastic wrap, cover the opening of one of the soda bottles and secure it tightly with a rubber band. Label the bottle, "greenhouse."
- Leave the other soda bottle top uncovered. Label the bottle, "control."

Educator note: Circulate to check for accuracy.

7. PART 3 STUDENT DIRECTIONS:

- Record the water level in each bottle.
- Place the heat source in a position to shine on the two bottles.
- Wait 6 minutes and then measure the water level in each bottle.
- Check back every 6 minutes and record data for the next 24 minutes.

Educator note: The ice in the bottle covered with plastic should melt faster indicating warmer temperatures than the uncovered bottle.

Humpback whale in Antarctica.

LESSON 6.2
ANALYZING GLOBAL WARMING

8. After students record the initial set of data, reiterate how global warming impacts our environment by showing the video, "Cause and effects of climate change' by National Geographic [3:00 minutes]. As students view the video, using the "Analyzing Global Warming Student Resource Sheet 6.2a" instruct them to complete the guided notes sections of the document. After the video, allow students to collaborate with their partners to fill in missing notes. Ask for volunteers to share their responses and encourage students to make corrections if necessary.

9. Instruct students to measure the water level of their bottles again and record the data. At this stage of the lab, students should have recorded water levels twice.

10. Share with students that the cause of global warming is controversial in the scientific community. Explain that some scientists believe that humans are the main contributors to the shift in climate while others believe that it's a natural process that occurs and humans have little effect on global warming. Antarctica was once a warm continent but shifted to a cold continent making it difficult for many animals to survive in such extreme conditions. Facilitate a discussion using the following question prompts:

> *Should humans continue to release more carbon dioxide or other greenhouse gases in the atmosphere and hope scientists are wrong? Or should we reduce the production of greenhouse gases and hope it's not too late?*

11. After the discussion, remind students to measure the water level of their bottles again and record the data. At this stage of the lab, students should have recorded water levels three times.

Educator Notes:

LESSON 6.2
ANALYZING GLOBAL WARMING

12. While students wait to observe their bottles for the last time, instruct them to record their observations and complete the reflection questions using the "Analyzing Global Warming Student Resource Sheet 6.2a" with their partner.

Why do scientists use models to understand phenomena?
Scientists use models to try to understand ideas that may be too hard to test in nature or a laboratory because they are too far away, take too long to measure, too small, etc. A model is used to help scientists visualize things they may not actually see.

Was there a difference in the warming rate of the greenhouse bottle and the control bottle? If so, described what you noticed.
In the greenhouse (covered) bottle, the warm air couldn't escape so it became warmer quicker than the control bottle.

What might be the effect of placing the bottles different distances from the light source?
Example response: We may document unreliable data because one bottle may receive more heat than the other causing it to warm quicker and skew our results.

How did the change in Antarctica's climate impact the environment?
Antarctica's climate was much warmer and wetter millions of years ago but it's now covered in ice and receives very little rain. Excavations in Antarctica revealed dinosaur fossils that proved the climate changed over time. A shift in climate millions of years ago is believed to be caused by natural occurrences impacting Earth.

13. To conclude the lesson, ask students: How might understanding Antarctica's past help humans on Earth today?

Neko Harbor Glacier calving at Andvord Bay on the Antarctic Peninsula in Antarctica.

Analyzing Global Warming Lab

Use the directions below to explore global warming by modeling the greenhouse effect.

☐ Part 1: Student directions

- Carefully cut both one-liter soda bottles approximately 4 inches from the bottom.
- Place 1 inch of sand at the bottom of each bottle.
- Carefully, using scissors, cut four wide vertical slits in the bottom half of two clear, plastic cups. The purpose of the slits is to allow melted ice water to flow out of these cups. Make sure the slits are wide and reach the bottom of the cups.
- Place one of the plastic cups without slits upside down on a flat surface and place one of the plastic cups with slits facing up on top so that the bottoms of each cup touch. Without covering the slits on the top cup, tape both cups together to prevent movement. Repeat the process using the remaining two unused plastic cups.

☐ Part 2: Student directions

- To create your "island" place one set of cup structures in each soda bottle on top of the sand. Make sure the plastic cup with slits is still on top.
- Pour water in each soda bottle until the water level is approximately 1 inch above the sand. If you accidentally over pour water in one bottle simply adjust the other bottle by adding more water until both bottles' water level is the same.
- Add "glaciers" to the "island" by placing ice cubes in both bottles. Choose the same number of ice cubes to place in each of the plastic cups with slits.
- Using plastic wrap, cover the opening of one of the soda bottles and secure it tightly with a rubber band. Label the bottle, "greenhouse."
- Leave the other soda bottle top uncovered. Label the bottle, "control."

☐ Part 3: Student directions

- Record the water level in each bottle.
- Place the heat source in a position to shine on the two bottles.
- Wait 6 minutes and then measure the water level in each bottle.
- Check back every 6 minutes and record data for the next 24 minutes.

Analyzing Global Warming

I. Lab notes: Use the table to record your observations.

Label	Starting height of water level	Height of water after 6 minutes	Height of water after 12 minutes	Height of water after 18 minutes	Height of water after ice melts
Greenhouse Effect					
Control					

Why do scientists use models to understand phenomena?

_____

_____

Was there a difference in the warming rate of the greenhouse bottle and the control bottle?
If so, described what you noticed.

_____

_____

What might be the effect of placing the bottles different distances from the light source?

_____

_____

How did the change in Antarctica's climate impact the environment?

_____

_____

II. Video reflection: As you view the "Cause and effects of climate change" video, fill in the blanks.

Human activities such as _____ and _____ are contributing to the increase in the Earth's temperature. The _____ occurs when gases in the atmosphere allow the sunlight in and prevent some of the heat from _____ like glass walls of a greenhouse. Human activities such as _____ have increased the amount of carbon dioxide in the atmosphere causing the planet to warm at a faster rate. Climate change has consequences for our _____, _____, _____, and _____ . Water from melting glaciers causes _____ . Climate change can cause _____ impacting our _____ and _____ . In areas with high amounts of smog, health problems can occur such as _____, _____, and _____ . Humans can reduce the rate of climate change by replacing _____ with _____ energy sources that don't produce greenhouse gases.

Analyzing Global Warming

I. Lab notes: Use the table to record your observations.

Label	Starting height of water level	Height of water after 6 minutes	Height of water after 12 minutes	Height of water after 18 minutes	Height of water after ice melts
Greenhouse Effect					
Control					

Why do scientists use models to understand phenomena?

Scientists use models to try to understand ideas that may be too hard to test in nature or a laboratory because they are too far away, take too long to measure, too small, etc. A model is used to help scientists visualize things they may not actually see.

Was there a difference in the warming rate of the greenhouse bottle and the control bottle?
If so, described what you noticed.

In the greenhouse (covered) bottle, the warm air couldn't escape so it became warmer quicker than the control bottle.

What might be the effect of placing the bottles different distances from the light source?

Example response: We may document unreliable data because one bottle may receive more heat than the other causing it to warm quicker and skew our results.

How did the change in Antarctica's climate impact the environment?

Antarctica's climate was much warmer and wetter millions of years ago but it's now covered in ice and receives very little rain. Excavations in Antarctica revealed dinosaur fossils that proved the climate changed over time. A shift in climate millions of years ago is believed to be caused by natural occurrences impacting Earth.

II. Video reflection: As you view the "Cause and effects of climate change" video, fill in the blanks.

Human activities such as population and overpopulation are contributing to the increase in the Earth's temperature. The greenhouse effect occurs when gases in the atmosphere allow the sunlight in and prevent some of the heat from escaping like glass walls of a greenhouse. Human activities such as burning of fossil fuels have increased the amount of carbon dioxide in the atmosphere causing the planet to warm at a faster rate. Climate change has consequences for our weather, oceans, food, and health. Water from melting glaciers causes rising sea levels. Climate change can cause extreme weather impacting our food and health. In areas with high amounts of smog, health problems can occur such as asthma, heart disease, and lung cancer. Humans can reduce the rate of climate change by replacing fossil fuels with renewable energy sources that don't produce greenhouse gases.

LESSON 6.3

INVESTIGATING SEA LEVELS

GRADE LEVEL 6-8

DINOSAURS OF ANTARCTICA EDUCATOR GUIDE

Dinosaurs of Antarctica Educator Guide

LESSON 6.3
INVESTIGATING SEA LEVELS

GRADE LEVEL 6-8
(1) 60 MINUTE LESSON
(1) 10 MINUTE CLEAN UP

STANDARDS:

- MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
- SP2: Develop and use a model to describe phenomena.

FROM THE FILM:

In the film ***Dinosaurs of Antarctica,*** geoscientists such as Libby Ives study the Earth's composition, structure, and other physical aspects such as physical sedimentology and glacial geology. Analyzing Earth's landscape helps scientists understand how our planet changes over time. For example, if scientists can understand the process of how melting glaciers and ice sheets contribute to sea-level rising, they can create solutions to minimize human and animal impact.

LESSON OVERVIEW:

In this lesson, students will investigate the relationship between climate change and sea-level rise.

MATERIALS:

- 2 plastic rectangle containers of the same size (per group)
- 8 sticks of modeling clay (per group)
- 1 tray full of ice cubes (per group)
- 1 liter of water (per group)
- Ruler (per group)
- Technology to show the following videos:

  "How Glaciers Changed The World" by SciShow Kids [5 minutes]

  http://bit.ly/aboutglaciers

  "NASA's Earth Minute: Sea Level Rise" [1:30]

  http://bit.ly/aboutsealevels

- Investigating Sea Levels Lab Student Resource Sheet 6.3
- Investigating Sea Levels Student Resource Sheet 6.3a

LESSON 6.3
INVESTIGATING SEA LEVELS

EDUCATOR PREP:

Split your class into groups of four. Gather enough materials to accommodate each group. Print copies of "Investigating Sea Levels Lab Student Resource Sheet 6.3" and "Investigating Sea Levels Student Resource Sheet 6.3a." The day before the class, place one ice tray for each group in the freezer. Remove the ice tray from the freezer five minutes before starting the lab.

EDUCATOR GUIDE:

1. In the film ***Dinosaurs of Antarctica,*** students learned how scientists worked to understand the story of Antarctica by researching how climate changed over time impacting the landscape, plants, and animals. Antarctica was once a warm continent with lush plants and various animals such as dinosaurs. However, as the climate began to shift, the environment changed as well. Currently, Antarctica is a desert with large sheets of ice, glaciers, and icebergs. Scientists are studying the causes of the previous climate shift in Antarctica to predict what might happen in the future.

2. Share with students that they will investigate the relationship between climate change and rising sea levels by simulating what happens to floating ice and ice on land when it melts. Explain to students that the thermal expansion of seawater is one of the main causes of rising sea levels that result from a warming climate. Tell students that they should be able to answer the following question after completing the lab activity:

   Which type of melting will cause a greater increase in sea level?

3. Provide each group with a set of lab materials, the "Investigating Sea Levels Lab Student Resource Sheet 6.3" and "Investigating Sea Levels Student Resource Sheet 6.3a." Allow a few minutes for students to decide on group roles. Review lab safety rules if necessary. Circulate to provide assistance when needed but encourage students to utilize their group for support.

Scientists Explore Antarctic Icebergs by boat.

LESSON 6.3
INVESTIGATING SEA LEVELS

4. PART 1 STUDENT DIRECTIONS:

- Make a prediction using the following question prompt:
  Which type of melting will cause a greater increase in sea level?
- Use your hands to combine four sticks of clay together.
- Place the clay on one side of the plastic container. Make sure the top of the clay is flat so that your ice cubes (glaciers) can balance. Label this container "Glacier."
- Use your hands to combine the remaining four sticks of clay together.
- Place the clay on one side of the second plastic container. Label this container "Iceberg."
- Add one cup of water to each container. Make sure the top of your clay (island) is above the water level. You may have to adjust the amount of water utilized based on the size of the container.
- Make a prediction based on your model.

  What might happen if you place an ice cube directly in the water?

  What might happen if you place an ice cube on top of the clay (island)?

  What does an ice cube represent in this experiment?

5. PART 2 STUDENT DIRECTIONS:

- Using the container labeled "Glacier," place six ice cubes (glaciers) on top of the clay (island).
- Use the ruler to measure and record the water level before the ice cubes (glaciers) melt on your data chart.
- Using the container labeled "Iceberg," place six ice cubes (icebergs) near the clay (island).
- Use the ruler to measure and record the water level before the ice cubes (icebergs) melt on your data chart.
- Place both containers in a sunny area if possible.

6. Remind students that Antarctica is surrounded by water. Tell students that today they will explore the relationship between climate change and rising sea levels. Show students the video, "How Glaciers Changed The World" by SciShow Kids [5 minutes]. Instruct students to complete the "Investigating Sea Levels Student Resource Sheet 6.3a" as they watch the clip.

Educator Notes:

LESSON 6.3
INVESTIGATING SEA LEVELS

7. After showing the video, permit two minutes for students to work with their partner to fill in any missing sections on their video reflection guide. After the time allowed expires, ask volunteers to share their responses to check for accuracy. Encourage students to correct their guides if necessary.

8. Facilitate a discussion using the following question prompts:

What are glaciers?
A glacier is a large mass of ice that moves slowly over land.

Where is the largest glacier in the world?
The largest glacier is found in Antarctica.

How do glaciers form?
Glaciers form when snow remains in the same area over time and accumulates to transform into ice.

What does it mean to have a glacier retreat?
When a glacier melts more ice in the summer than it builds up in the winter, it will retreat or move back.

Why do scientists study glaciers?
When glaciers move, it indicates something in the environment changed like temperature. Scientists can use this information to guess what the Earth was like a long time ago. Scientists and engineers have used the energy from melting glaciers to in useful ways, such as turning the energy into electricity. Scientists also study glaciers because if too many glaciers melt it can cause sea levels to rise which may impact how humans live.

How might a melting glacier impact sea levels?
Melting glaciers on land add more water to the oceans causing the sea level to rise. When the ocean becomes warmer, it takes up more space also causing the sea level to rise.

9. Tell students that over the next hour, they will monitor the water levels in both containers.

Scientists researching a frozen lake in Antarctica.

PART 3 STUDENT DIRECTIONS:

- After 15 minutes, measure the water in both containers again and record the data on your chart.
- After 30 minutes, measure the water in both containers again and record the data on your chart.
- After 45 minutes, measure the water in both containers again and record the data on your chart.

LESSON 6.3
INVESTIGATING SEA LEVELS

10. Check for understanding by reading the following statements aloud and ask students to complete the following sentences.

The plastic containers represent an ocean basin.

The ice cubes represent glaciers or icebergs.

The water represents ocean water.

The clay represents an island.

The ruler represents a sea-level gauge.

11. Lead a class discussion using the following question prompts:

How does this experiment describe sea-level rising in the real world?
The experiment simulated what happens when icebergs and glaciers melt. Glaciers contribute to the rising of sea level because water is being removed from the land and placed in the water to the ocean basin. Icebergs don't cause the sea level to rise because they are already in the water. Therefore, the volume of an iceberg has already impacted the sea level.

Describe how the iceberg and glacier impact sea level during this simulation.
After reviewing my data chart, I noticed that when the glaciers melted, there was a rise in the water level. When the iceberg melted, the water level stayed the same.

12. To ensure that students understand why scientists monitor the sea level, show the following video clip NASA's Earth Minute: Sea Level Rise [1:30]. Instruct students to complete the "Investigating Sea Levels Student Resource Sheet 6.3a."

13. To conclude the lesson, lead a whole-class discussion using the following question prompts: How do you think rising sea level will affect people where you live? What if all of the ice in Antarctica melted, what do you think would happen? Why might scientists want to understand the relationship between glaciers and climate in Antarctica?

Educator Notes:

Investigating Sea Levels Lab

Use the directions below to investigate the relationship between climate change and rising sea levels by simulating what happens to floating ice and ice on land when it melts.

☐ Part 1: Student directions

- Make a prediction using the following question prompt: Which type of melting will cause a greater increase in sea level?
- Use your hands to combine four sticks of clay together.
- Place the clay on one side of the plastic container. Make sure the top of the clay is flat so that your ice cubes (glaciers) can balance easily. Label this container "Glacier."
- Use your hands to combine the remaining four sticks of clay together.
- Place the clay on one side of the second plastic container. Label this container "Iceberg."
- Add one cup of water to each container. Make sure the top of your clay (island) is above the water level. You may have to adjust the amount of water utilized based on the size of the container.
- Make a prediction based on your model.

  What might happen if you place an ice cube directly in the water?

  What might happen if you place an ice cube on top of the clay (island)?

☐ Part 2: Student directions

- Using the container labeled "Glacier," place six ice cubes (glaciers) on top of the clay (island).
- Use the ruler to measure and record the water level before the ice cubes (glaciers) melt on your data chart.
- Using the container labeled "Iceberg," place six ice cubes (icebergs) near the clay (island).
- Use the ruler to measure and record the water level before the ice cubes (icebergs) melt on your data chart.
- Place both containers in a sunny area if possible.

☐ Part 3: Student directions

- After 15 minutes, measure the water in both containers again and record the data on your chart.
- After 30 minutes, measure the water in both containers again and record the data on your chart.
- After 45 minutes, measure the water in both containers again and record the data on your chart.

Investigating Sea Levels

I. Lab notes: Use the table to record your observations.

"Iceberg"

Time	Water Level	Observations
immediately		
15 minutes		
30 minutes		
45 minutes		

"Glacier"

Time	Water Level	Observations
immediately		
15 minutes		
30 minutes		
45 minutes		

II. Video reflection: As you view the "How Glaciers Changed The World" video, fill in the blanks.

When snow accumulates over days, it can turn into layers of _____ like a _____ . Glaciers hold a frozen supply of the Earth's _____ water. They grow and _____ . Sometimes they _____ around. The process of layers of snow can take a long time, such as _____ years. The world's biggest glacier is _____ in Antarctica. Glaciers cover _____ of the Earth. When a glacier becomes large, the ice on the bottom can no longer hold up the ice _____ it. The ice at the bottom will float out and _____ . When a glacier melts more ice in the summer than it builds up in the winter, it will _____ or move back. When glaciers move, it tells scientists that something in the Earth is _____ . Over the past 100 years, the Earth has become warmer, causing some glaciers to _____ or _____ . Sometimes melting glaciers can be helpful. Water from melting glaciers often flows into rivers. _____ , _____ , and _____ use water from rivers. However, if glaciers melt too fast, it causes the sea level to _____ .

III. Video reflection: After viewing the "NASA's Earth Minute: Sea Level Rise" video, answer the following questions.

How do you think rising sea level will affect people where you live?

_____

_____

What if all of the ice in Antarctica melted, what do you think would happen?

_____

_____

Why might scientists want to understand the relationship between glaciers and climate in Antarctica?

_____

_____

Investigating Sea Levels

I. Lab notes: Use the table to record your observations.

"Iceberg"

Time	Water Level	Observations
immediately		
15 minutes		
30 minutes		
45 minutes		

"Glacier"

Time	Water Level	Observations
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15 minutes		
30 minutes		
45 minutes		

II. Video reflection: As you view the "How Glaciers Changed The World" video, fill in the blanks.

When snow accumulates over days, it can turn into layers of ice like a glacier. Glaciers hold a frozen supply of the Earth's fresh water. They grow and shrink. Sometimes they move around. The process of layers of snow can take a long time, such as 100 years. The world's biggest glacier is Lambert Fisher in Antarctica. Glaciers cover one-tenth of the Earth. When a glacier becomes large, the ice on the bottom can no longer hold up the ice above it. The ice at the bottom will float out and advance. When a glacier melts more ice in the summer than it builds up in the winter, it will retreat or move back. When glaciers move, it tells scientists that something in the Earth is changing. Over the past 100 years, the Earth has become warmer, causing some glaciers to shrink or disappear. Sometimes melting glaciers can be helpful. Water from melting glaciers often flows into rivers. Plants, people, and animals use water from rivers. However, if glaciers melt too fast, it causes the sea level to rise.

III. Video reflection: After viewing the "NASA's Earth Minute: Sea Level Rise" video, answer the following questions.

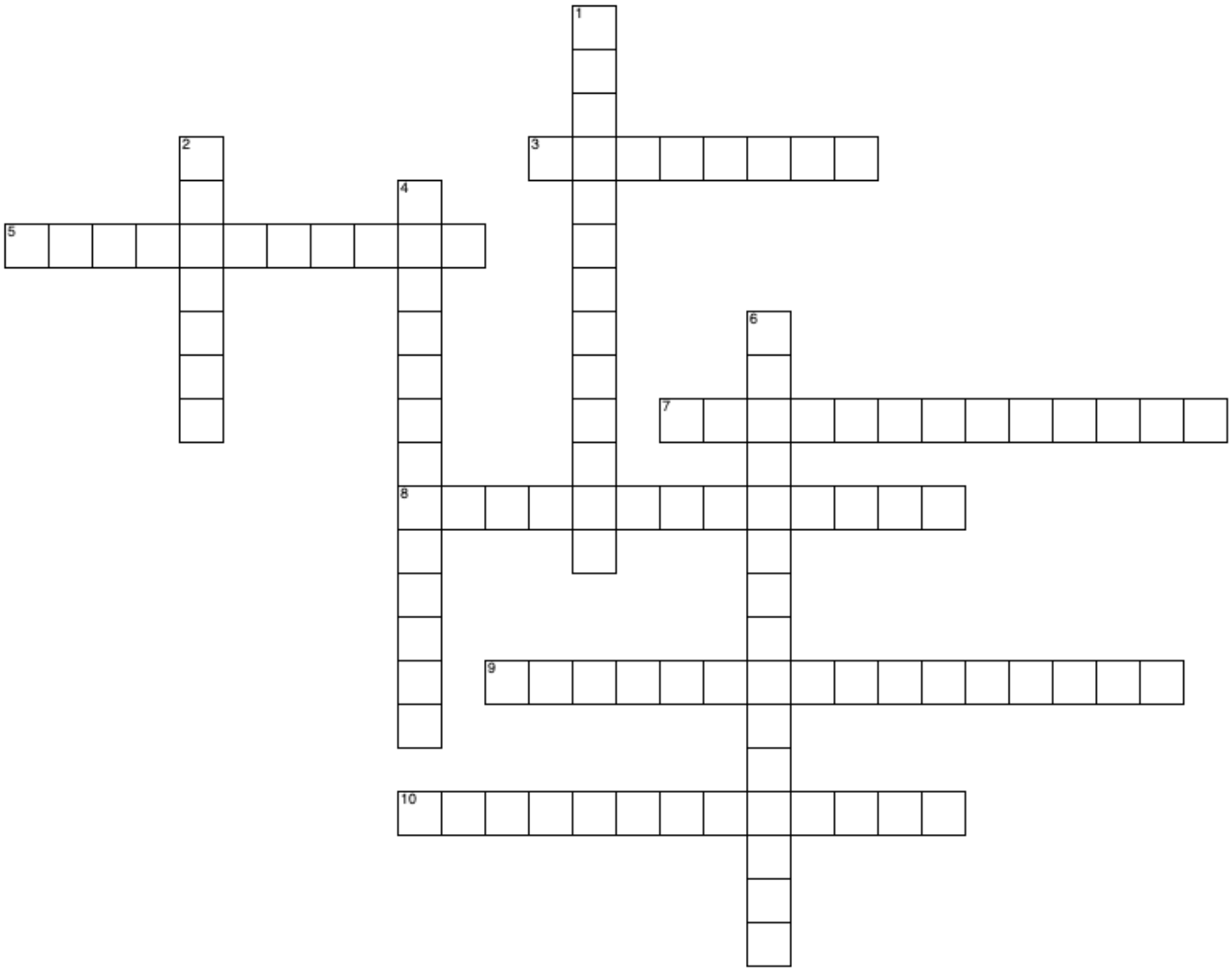
How do you think rising sea level will affect people where you live?
answers will vary

What if all of the ice in Antarctica melted, what do you think would happen?
answers will vary

Why might scientists want to understand the relationship between glaciers and climate in Antarctica?
answers will vary

Word Search

Select a word that match the definition below. Match the number beside the definition to the boxes placed across or down the grid. If correct, the word will fit perfectly in the puzzle.



Across

3. the average height of the sea's surface

5. a fuel (such as coal or oil) that is formed in the Earth from dead plants or animals

7. a colorless, odorless gas that is released from the burning of fossil fuels

8. a person who studies climate patterns to provide an understanding of the conditions of an area

9. the warming of the Earth's atmosphere often caused by air pollution

10. an increase in the Earth's average temperature that causes changes in the climate

Down

1. a natural or human-made gas that traps heat in the atmosphere

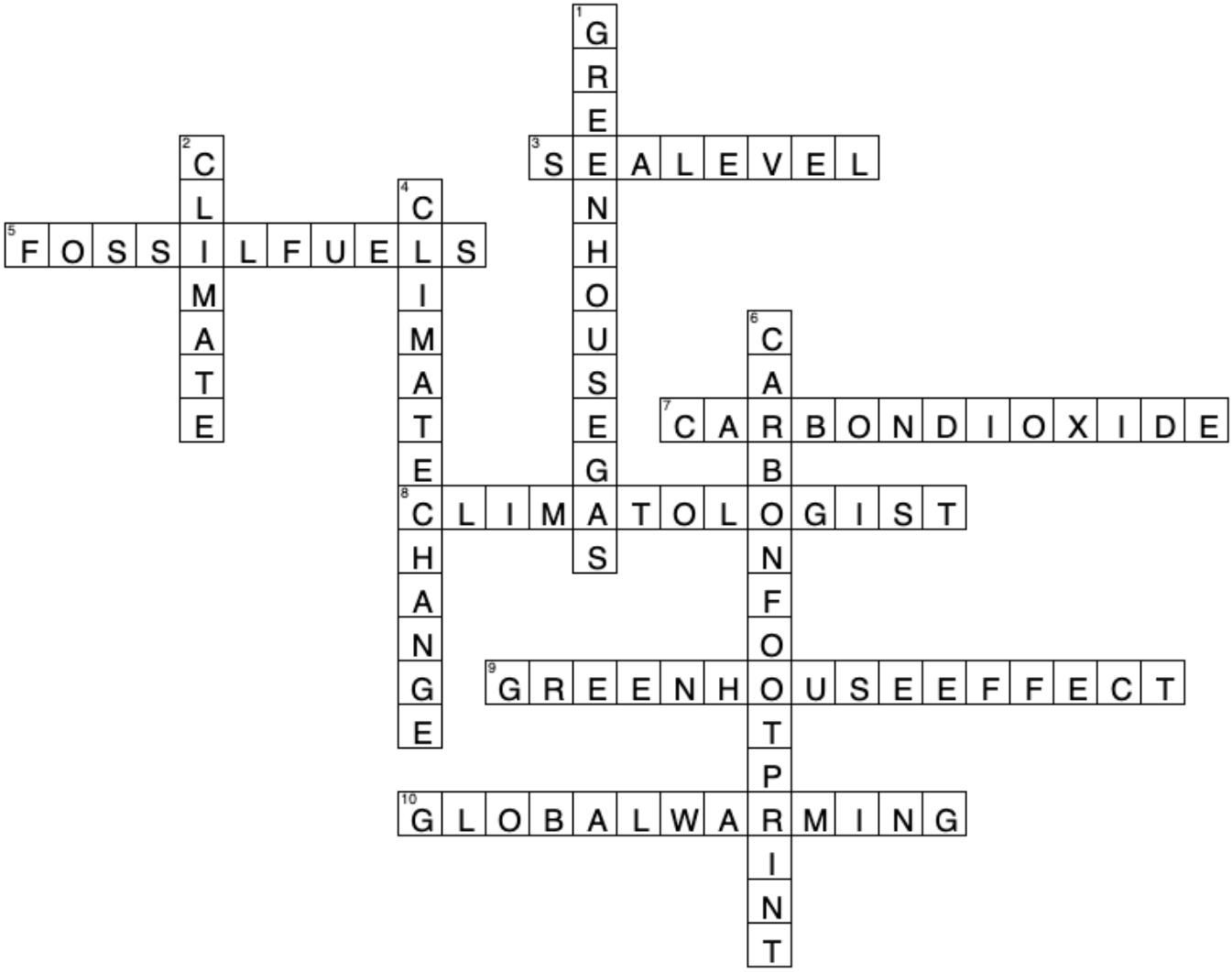
2. the pattern of weather over a long period of time

4. a significant shift in the climate over time

6. the amount of greenhouse gases released by a person, family, or company each year

Word Search

Select a word that match the definition below. Match the number beside the definition to the boxes placed across or down the grid. If correct, the word will fit perfectly in the puzzle.



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WRITERS AND CONTRIBUTORS:

LESSON PLAN DEVELOPER:

Candice Wilson-McCain, *Ed.S in Curriculum & Instruction*
Discovery Place, Inc.

EDUCATION EVALUATOR:

Karen Elinich, *Ed.D in Educational Technology*

PROJECT MANAGEMENT:

Joanie Philipp
Discovery Place, Inc.

Heather Norton
Discovery Place, Inc.

Deborah Raksany
Giant Screen Films, Inc.

GRAPHIC DESIGN:

Althea Holenko
Discovery Place, Inc.

Andrew Crews
Discovery Place, Inc.

WRITERS AND CONTRIBUTORS

LESSON PLAN REVIEWERS:

DISCOVERY PLACE TEACHER ADVISORY COUNCIL

Stacie Bunn, *M.Ed in Elementary Education*
Kannapolis City Schools District

Anita Cathey, *MS in Information Systems*
Charlotte Mecklenburg School District

Toni Hall, *MA in Leadership*
Charlotte Mecklenburg School District

Robert Leichner, *M.Ed in Curriculum & Supervision*
Charlotte Mecklenburg School District

Meredith Katz, *B.S. in Elementary Education*
Kannapolis City Schools District

Kim Mayes, *BA in Anthropology*
Charlotte Mecklenburg School District

Aeronia Poole, *M.Ed in Curriculum & Instruction*
Charlotte Mecklenburg School District

Danielle Redmond, *MS in Education*
Charlotte Mecklenburg School District

Jill Staton, *M.Ed in Elementary Education*
Cabarrus County School District

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DISCOVERY PLACE

GIANT SCREEN FILMS

DINOSAURS OF ANTARCTICA