TEACHER'S GUIDE

Climate Restoration For Kids

OVERVIEW

Climate Restoration for Kids is a free digital lesson intended for learners in grades 3-5 (approximately aged 8-12). It was created by the **Foundation for Climate Restoration** (F4CR), a U.S.-based 501(c)3 nonprofit organization. F4CR's mission is to restore a safe and healthy climate by the year 2050.

LESSON URL

https://bit.ly/restoration-lesson

LESSON FOCUS

We can use science, engineering, and biomimicry to reverse climate change.
This lesson introduces students to climate change via the Carbon Cycle. It then introduces the concept of "Climate Restoration", why it matters, who is working on it, and how it can be achieved. Climate Restoration is the global endeavor to return the Earth's climate systems to the safe and healthy state in which humanity and our natural world evolved.

RUN TIME

Approximately 120 minutes total (about 30 minutes per section)

LESSON OUTLINE

PART I: INTRODUCTION TO CLIMATE CHANGE

1. What Is Climate Change?

Key concepts introduced:

- Climate (vs. weather)
- Climate change
- Effects of climate change
- What makes it worse
- Why it matters
    - Video: ***Climate Change (according to a Kid)*** (Runtime: 2:11)

2. What Is Carbon Dioxide?

Key concepts introduced:

- Carbon Dioxide
- History of CO_2 on Earth
- What happens when there's too much CO_2 in our atmosphere

3. The Carbon Cycle

Key concepts introduced:

- The Carbon Cycle
    - Video: ***What Is The Carbon Cycle?*** (Runtime 1:16)
- Opening the Drain on Carbon Dioxide (bathtub analogy)
    - Video: ***Opening the Drain on Carbon Dioxide*** (Runtime: 1:02)
- How CO_2 acts like a blanket to warm the Earth

PART II: CLIMATE RESTORATION

4. What Do You Know About Climate Restoration?

Key concepts introduced:

- Defining Climate Restoration
- Approaches already in use (carbon neutral solutions)
- Silly ideas that won't work

5. Ways to Restore the Climate

Key concepts introduced:

- Copying natural processes
  - o Biomimicry definition and examples
  - o Geomimicry definition and examples
- Biomimicry solution: Carbon Capture in the Deep Ocean
  - o Video: ***2040—Marine Permaculture*** (Runtime: 1:50) (No link. Video is embedded in Lesson 5.)
- Geomimicry solution: Mineralization—Turning CO_2 into Rock
  - o Video: ***Emerging Tech (Mineralization)—Blue Planet*** (Runtime: 1:38)

6. Who Is Working on Climate Restoration?

Key concepts introduced:

- Climate Mitigation activists are working on getting us to "carbon neutral"
- Climate Restoration activists are working on going beyond neutral and restoring the CO_2 levels in our environment
- Kids as Allies
- What we mean by permanent, scalable, and fundable solutions
  - o Video: ***What Is Climate Restoration?*** (Foundation for Climate Restoration Introductory video—Runtime: 2:37)

PART III: ACTIVITY

7. Debunking Myths

Key myths debunked:

Myth 1: Climate restoration is impossible.
Myth 2: Stopping emissions will stop climate change.
Myth 3: We don't know how to get carbon dioxide out of the air.
Myth 4: Climate restoration will take too long.
Myth 5: The Earth would be better off without us.
Myth 6: If we just take our hands off Mother Earth, the climate will go back to normal.
Myth 7: Man-made solutions will have disastrous consequences.

8. What Can I Do to Help?

Key concepts introduced:

- Kids can make a difference
- Reducing your carbon footprint
- Using your voice

CONCLUSION

9. Letter Writing Contest

Key concepts introduced:

- How important issues become laws
- Starting with local laws
- Writing to your mayor
- Letter writing instructions
- Sample letter
- How to enter
- Win the grand prize for your school

10. Drawing Contest

- Create an art project
- What to depict
- How to enter
- Winners' art displayed on the F4CR website (without children's identifying information)

11. Quiz

- 10 true/false questions to test and reinforce learning
- Includes an explanation for why each statement is true or false

12. Final Thoughts

13. Credits/Acknowledgments

ANTICIPATED LEARNING OUTCOMES

Students will:

1. Know what climate change is and why it matters.
2. Learn what carbon dioxide is, the history of atmospheric carbon dioxide in Earth's atmosphere, and how the carbon cycle works.
3. Understand the bathtub analogy: *If there's too much water in a bathtub, you can't solve the problem just by turning off the tap. The water will stay there until you open the drain to let it out. Likewise, if there's too much CO_2 in the atmosphere, it is important to "turn off the tap" by reducing carbon emissions, but that won't solve the whole problem because the excess CO_2 will stay put and continue to cause climate change. We must, metaphorically speaking, "open the drain" to get that excess CO_2 out of the air.*
4. Learn what climate restoration is.
5. Be able to identify natural processes that store CO_2.
6. Discover how mimicking natural processes helps scientists and engineers to create safe solutions for capturing and storing CO_2 and restoring the climate.
7. Learn that smart people are at work on these solutions now.
8. Be able to describe in simple terms two promising solutions:
   a. **Geomimicry solution:** Mineralization processes for turning CO_2 into synthetic limestone for buildings and roads
   b. **Biomimicry solution:** Carbon capture in the deep ocean through creating kelp farms and fisheries

9. Understand that they can be allies for climate restoration.
10. Learn what to say in response to myths about climate change and climate restoration.
11. Have the opportunity to write a letter to their mayor and/or create art that expresses their concern about climate change and their hope for climate restoration. And they can enter their letters or artwork in twice yearly contests.
12. Feel confident that they can be part of the solution.

EDUCATIONAL TOOLS UTILIZED

- Reading
- Listening
- Visual aids
- Videos (shared without adult content or ads)
- Clickable diagrams
- Clickable photos that reveal hidden information
- Drag and drop games
- Periodic quick knowledge checks
- Final quiz

HOW TO DELIVER THE LESSON

Students can move through the self-propelled lesson individually with minimal supervision.

Alternatively, the teacher can conduct the lesson with a group in front of a larger monitor with the teacher operating the mouse, playing the videos, and engaging students in the built-in learning activities.

The lesson can be completed in one hour-long sitting or be broken into two to four lesson periods. As shown in the Lesson Outline below, Climate Restoration For Kids consists of Parts I, II, III and a Conclusion. Teachers planning lessons can utilize the natural breaks between those four parts.

The Activities in lessons 9 and 10—writing a letter to your mayor and making art that expresses your vision for climate restoration—can be done individually or in groups.

We offer additional Extension Activities below.

EXTENSION ACTIVITIES

Here are some suggestions of activities that could further deepen students' understanding and interaction with the module. These are merely suggestions that expand across different curricular areas. They are starting points for you to develop more in-depth lessons that you can tailor to you and your students' specific needs.

SCIENCE CENTERED ACTIVITIES

1. Greenhouse gas experiment

Try This Greenhouse Effect Experiment | One Stop Science Shop

How to Explain the Greenhouse Effect to Kids (with printables)—KidMinds

2. Carbon Cycle Game

The Carbon Cycle Game

3. Biomimicry related activities

Create Whirly Birds

Create a waterproof shoe

Biomimicry Engineering activity

Beetle Inspired Water Bottle

WRITING-BASED ACTIVITIES

1. Students can write a picture book for younger grades based on what they've learned in the module. They can share it with the younger students in their school. This can create both community and student-led advocacy.

2. Students can design a teaching presentation about different sections of the module. They can focus on a specific science section (like the carbon cycle) or they can focus on the solutions/debunking myths section. They can then give these presentations to their community (parents) or even to local leaders. This will not only build community but also empower students to speak about their learning and invite others to join the climate restoration movement.

3. Students can write persuasive essays to decision makers (local leaders, community organization leaders, non-profit leaders, business owners, etc.) to ask them to sign the F4CR pledge and join the movement. Part of the learning can also extend into research. Older students can research who would be a good audience for these letters in order to maximize the impact. They can also design metrics or systems to track their results. Were the letters received? Did anyone take action upon receiving the persuasive essay?

MULTIMEDIA ACTIVITIES

1. Students can create a video, podcast, or PSA about what they learned about in the module and encourage others to become allies for climate restoration, **sign the F4CR pledge**, and join the movement.

2. Students can draft powerful social media posts that their grown-ups can share in powerful communities to encourage others to become allies for climate restoration.

3. Older students can study the art of digital persuasion and make short social media-inspired video clips that encourage others **to take the F4CR pledge** and educate others. Invite them to be creative and think about other powerful messages they may want to share about climate restoration.

4. Students can create an original song or rewrite a popular song to convey the key takeaways of the F4CR learning module. They can record or perform this song to teach others about climate restoration.

STUDENT-LED SERVICE LEARNING PROJECT

If students are inspired by the module and want to take action, they can! Invite them to think of ways where they can positively impact F4CR (which is a U.S.-based 501(c)3 nonprofit organization. Donations to F4CR are tax deductible to the full extent provided by law).

This could be done in a multitude of ways. Students can figure out different and creative ways (art projects, school-wide initiatives, community involved campaigns) to fundraise for F4CR. They can create campaigns to get local leaders **to take the F4CR pledge**. This type of activity can be as big or small as you have time to invest. It can be a great way to build advocacy and give the students a taste of environmental allyship because they know they made a difference in the world.

ALIGNMENT TO CURRICULUM FRAMEWORKS

3RD GRADE NGSS STANDARDS

EARTH SCIENCE

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

ESS2.A: Earth Materials and Systems. Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)

ESS3.C: Human Impacts on Earth Systems. Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)

LIFE SCIENCE

LS2.C: Ecosystem Dynamics, Functioning, and Resilience. When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die

4TH GRADE NGSS STANDARDS

EARTH SCIENCE

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

ETS1.B: Designing Solutions to Engineering Problems. Testing a solution involves investigating how well it performs under a range of likely conditions.

5TH GRADE NGSS STANDARDS

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

ESS3.C: Human Impacts on Earth Systems. Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

BACKGROUND INFORMATION FOR TEACHERS

MORE ON THE BATHTUB ANALOGY:

Think of our climate like a bathtub: When we started burning fossil fuels we turned on a CO_2 "faucet," increasing the amount of CO_2 being added to a tub that had been calibrated just right for humanity and our natural world to bathe in. As our world has industrialized, we've been turning the flow rate of the faucet higher and higher. While we clearly do need to slow down and ultimately stop the faucet, the tub is already overflowing. Legacy emissions—the water that has already been added to the tub—accounts for 95% of the excess CO_2 warming our planet. It's never too early to open the drain as we work to simultaneously turn off the faucet.

The bathtub analogy is explained in this video: **Opening the Drain on Carbon Dioxide** (Runtime: 1:02)

WHY DOES CLIMATE RESTORATION FOCUS ON CO_2 PPM RATHER THAN TEMPERATURE LEVELS?

Climate Restorationists use CO_2 ppm as a yardstick since it is simpler to measure and control than temperature levels. Global winds keep CO_2 levels uniform around the planet, so readings from Mauna Loa, Hawaii accurately chart progress. In contrast, checking global average temperature requires calibrating and collating thousands of measurements.

We know how the composition of air has changed over the last 800,000 years. Scientists analyze air bubbles trapped in "ice cores"—samples of ice drilled miles down in the ice caps of Greenland and Antarctica. In those 800,000 years—longer than modern humans have existed—CO_2 levels have never strayed above 300 ppm for any significant length of time, until 1925. In 2019, atmospheric carbon reached 415 ppm; it continues to rise 2.5 ppm per year.

The commonly discussed climate plans, such as the IPCC 1.5 report and Project Drawdown, call for attaining net zero CO_2 emissions by roughly 2050. If that happens, CO2 will stabilize at 455 ppm, 50% higher than has been proven to be safe.

We can infer from historic climatic records that leaving CO_2 above 300 ppm long-term poses a significant risk that humanity may not survive. We are already getting a taste of the "natural" disasters, resource conflicts, droughts and ecosystem disruption that will only accelerate without active efforts to reduce atmospheric CO_2. Therefore the objective of Climate Restoration is to reduce CO2 levels to below 300 ppm.

HANG ON...IS THIS GEOENGINEERING?

"Geoengineering" refers to deliberate, large-scale intervention in natural systems to counteract climate change (Oxford University, 2018).

The thought of intentional, large-scale involvement in the atmosphere and ocean raises alarm bells, especially for those passionate about the environment. Many ask, "Isn't mucking around with the Earth's systems the way we got into this mess in the first place?" (Yes, in fact, our climate crisis is the result of over a hundred of years of negative geoengineering.)

"Geoengineering," though, also encompasses proposals for massive tree-planting, adopting regenerative agriculture, rebuilding ecosystems, and turning large amounts of biomass into charcoal to make the soil more CO_2-rich.

The IPCC now prefers the term "carbon-dioxide removal" (CDR) to refer to large-scale efforts to remove carbon dioxide from the air or industrial emissions (IPCC, 2014), and "solar radiation management" (SRM) for reflecting sunlight back to space (Solar Radiation Management Governance Initiative, 2019). Because of their specificity, we prefer these terms as well. The American Geophysical Union proposes the neutral phrase, "climate intervention" (Landau, 2018).

IT'S NOT JUST WHAT YOU DO, IT'S HOW YOU DO IT

Tree-planting sounds natural and benign. But plant the wrong type in the wrong place—especially on a large scale—and you can seriously harm ecosystems, wildlife, crops, and even water cycles (Jackson,2005) (Maathai, 2011) (Parr & Lehmann, 2012). BECCS and other proposals to grow "biomass" to absorb carbon can also take up precious cropland—problematic in a world trying to grow food for nearly eight billion people (Bailey, 2018).

High-tech as some may sound, most Climate Restoration methods are actually based on "biomimicry" or "geomimicry" of natural processes (Zari, 2010). For instance, creating synthetic limestone (calcium carbonate) mimics how shellfish build seashells from calcium and CO2 and how corals build reefs.

WHO IS BEHIND CLIMATE RESTORATION FOR KIDS?

This free lesson was designed by a team of experts in science, instruction, and curriculum design, who volunteer with the Foundation for Climate Restoration (F4CR), a US-based 501(c)3 charitable organization. The team was led by Erica Dodds, PhD, Chief Operating Officer of F4CR.

F4CR's mission is to catalyze the commitment and action needed for Climate Restoration because we hold ourselves accountable for ensuring that humans survive and flourish. F4CR encourages and spotlights achievable solutions to draw down excess CO_2 from the air and rebuild Arctic ice, engaging in dialogue and

global initiatives to unite the public, policy-makers, and technical and business experts behind the common goal of reversing global warming and restoring a healthy climate for future generations.

LEARN MORE: WHITE PAPERS AND ARTICLES

Interested in learning more, including the hard science, economic models, and peer reviewed research underpinning this lesson? Access F4CR white papers, progress reports, and videos here: **https://foundationforclimaterestoration.org/resources/#key-resources**

Read this September 17, 2020, ***Washington Post* Op ED on Climate Restoration** co-authored by Sir David King, former chief scientific adviser to the British government, emeritus professor and the founding chair of the Center for Climate Repair at the University of Cambridge, and Rick Parnell, president and CEO of the Foundation for Climate Restoration, former chief operating officer of the United Nations Foundation.

GLOSSARY OF TERMS USED

Ally: A person who supports a cause or speaks out about it.

Atmosphere: The layer of gas that surrounds the Earth. Also called air, it consists of several different gases including carbon dioxide. It protects life on Earth by shielding us from harmful solar rays and by holding an optimal amount of heat close to Earth's surface. Right now Earth's atmosphere contains too much CO_2, which is causing it to hold in too much heat.

Biomimicry: Learning from and copying the way things are done in nature to solve human challenges.

Carbon Capture: A chemical process for taking carbon dioxide out of the air.

Carbon Cycle: A process by which carbon dioxide travels from the atmosphere into living organisms and the Earth, then back into the atmosphere. CO_2 is released back into the atmosphere when plants and animals die, volcanoes erupt, fires blaze, and fossil fuels are burned.

Carbon Dioxide (CO2): An invisible gas—made of carbon and oxygen—that we can't see, taste, or smell. Carbon is part of every living thing, as well as many non-living things like rocks. When we breathe out, we exhale CO_2.

Carbon Footprint: How much carbon dioxide an individual, family, community, or company emits into the air.

Carbon Neutral: Reducing carbon emissions to the point where we aren't putting more CO_2 into the atmosphere than we are taking out.

Carbon Sink: A natural or artificial reservoir where CO_2 is stored for a long period of time. Examples include the deep ocean floor and rock formations belowground.

Climate: The pattern of weather over a long period of time, usually around 30 years.

Climate Change: A change in the average conditions—such as temperature and rainfall— in a region over a long period of time.

Climate Mitigation: Reducing emissions of and stabilizing the levels of heat-trapping greenhouse gases such as CO_2 in the atmosphere.

Climate Restoration: Returning the climate to the condition it was in before humans caused it to change. The mission of Climate Restoration is to remove the excess carbon dioxide from our atmosphere and restore the amount of CO_2 in the air to a healthy level.

Drought: A continuous period of dry weather, lasting many months or years, when an area gets less rain than normal. Droughts are dangerous to plants and animals that need water to live and grow.

Extinction: When an animal species no longer exists. Loss of food sources or habitat due to climate change can cause species to die out and go extinct.

Fossil Fuels: Fuels that come from old life forms, like dinosaurs, that have decomposed below the earth's surface over a long period of time. Coal, petroleum, and natural gas are fossil fuels that humans burn to run our vehicles and to create heat and electricity. When we burn fossil fuels, they emit carbon dioxide into the air.

Fundable Climate Restoration Solution: A solution that is not too expensive and may even make money, so people will want to invest in it. For example, ocean fisheries can make money for people in the fishing industry.

Geomimicry: Learning from and copying geologic processes, like rock formations and volcanic eruptions. Ice Age: A time when glaciers cover huge areas of land causing big changes to the Earth's surface. Ice ages have happened on Earth several times. Scientists estimate that the latest began more than 1.8 million years ago and ended about 10,000 years ago.

Ice Sheet Melt: An ice sheet is a mass of glacial ice more than 50,000 square kilometers (19,000 square miles). Ice sheets contain about 99% of the freshwater on Earth, and are sometimes called continental glaciers. They act like a protective cover over the Earth and our oceans. The bright white ice reflects excess heat back into space and helps cool the Earth. Ice sheets at both poles are rapidly melting due to climate change.

Kelp: A type of giant seaweed that makes good food for fish. Kelp takes in CO_2 during photosynthesis and grows up to two feet (half a meter) per day. Kelp can be harvested, compressed, and sunk to the deep ocean where its carbon is stored for thousands of years.

Law: Rules that everyone must follow.

Myth: A story that many people believe but is actually not true.

Permanent Climate Restoration Solution: A solution that stores the CO_2 so it doesn't return to the atmosphere for at least 100 years.

Photosynthesis: The process by which plants convert energy from sunlight into energy for food. This process requires water and carbon dioxide. Plants absorb rain water through their roots and receive carbon dioxide from the air through their leaves. Without photosynthesis plants would not produce oxygen. Without oxygen to breathe animals, including humans, could not live. Without animals plants would not receive carbon dioxide.

Rising Seas: As water gets warmer, it takes up more space and causes sea levels to rise. In addition, melting glaciers and ice sheets are adding more water to the oceans. Rising sea levels are a threat to people who live near the ocean. Climate scientists predict that due to climate change some low-lying areas will experience more and more flooding and very low-lying lands are likely to be submerged completely.

Scalable Climate Restoration Solution: Even though the solution has been tested on a small scale, we can make it way, way bigger—big enough to capture a lot of the one trillion tons of carbon dioxide we need to remove.

Synthetic Limestone: Scientists can use chemistry to convert CO_2 into limestone in a lab. The chemical process is the same one that clams use to build their shells. This limestone can be used in concrete or other building materials. Synthetic limestone will soon be produced all over the world and can be used in all kinds of buildings and roads. Right now it's being made in California. You can see it in the Terminal 1 pavement at the San Francisco International Airport.

The Paris Agreement: In 2015, 196 nations signed a document called The Paris Agreement that set limits on the amount of greenhouse gases countries can emit. The goal of setting these limits is Climate Mitigation not Climate Restoration.

The Water Cycle: The path that all water follows as it moves around our planet–in our oceans, on land, and in the air.

Weather: The *daily* state of the atmosphere, or air, in any given place with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness.