Lessons to Grow By – Plant Needs

In this series of Lessons to Grow By, we are exploring plant needs. For healthy growth and development, plants must obtain just the right amounts of light, water, air, and nutrients and they also need space to grow. These five requirements are the basic needs for all plant life.

Fortunately for our world full of diverse environments, different plants need different amounts of each of these essentials so there are plants well adapted to grow in almost all environmental conditions.

Through these activities, kids will investigate plant needs to better understand how to take care of their green friends while also gaining a deeper appreciation for how the living and nonliving elements in an ecosystem work together.

Week 3: Air

Learning Objectives:

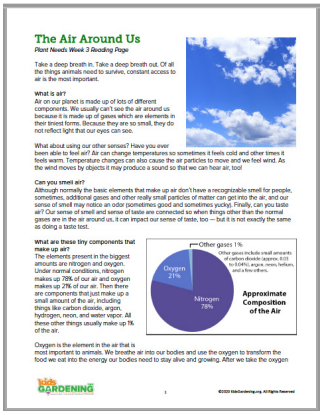
This week focuses on the plant need of air. Kids will:

- Learn that people and plants work together to keep the amounts of oxygen and carbon dioxide in our air relatively consistent.
- Explore how plants need air for their leaves and stems above ground and for their roots below ground.
- Discover that plants are an important part of the Earth's carbon cycle.

Materials Needed for the Week

Activity 1: What is Air?

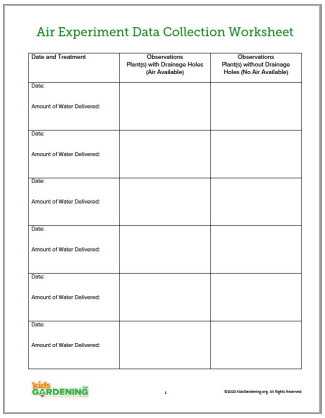
- The Air Around Us Reading Page
- Plastic bags in different colors or flagging tape
- A metal clothes hanger or a plastic loop
- String



The Air Around Us Reading Page

Activity 2: Air Above and Below Ground

- Microscope (optional)
- Bucket or bowl of soil (no drainage holes)
- Tape
- Watering can
- 2 potted plants of the same variety and approximately the same size (herbs in 4" pots work well). One pot needs to have no (or blocked) drainage holes. The other pot needs drainage holes.
- Seed viewers (bean seeds, paper towels, clear plastic cups)
- Air Experiment Data Collection Worksheet



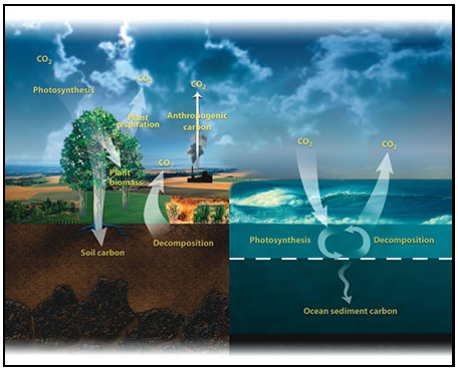
Air Experiment Data Collection Worksheet

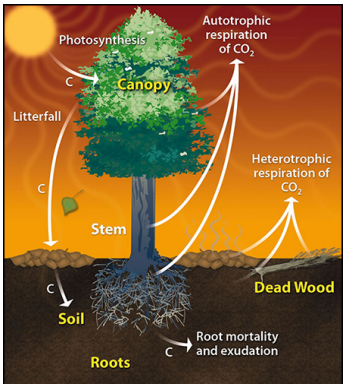
Activity 3: The Carbon Cycle

- Components of the Global Carbon Cycle Diagram from the US Department of Energy: https://public.ornl.gov/site/gallery/originals/CCycle_cover_image.jpg

- Terrestrial Photosynthetic Carbon Cycle Diagram from the US Department of Energy: https://public.ornl.gov/site/gallery/originals/Pg028_CCycle08.jpg

- Internet connection to watch the Kiss the Ground's *The Soil Story*



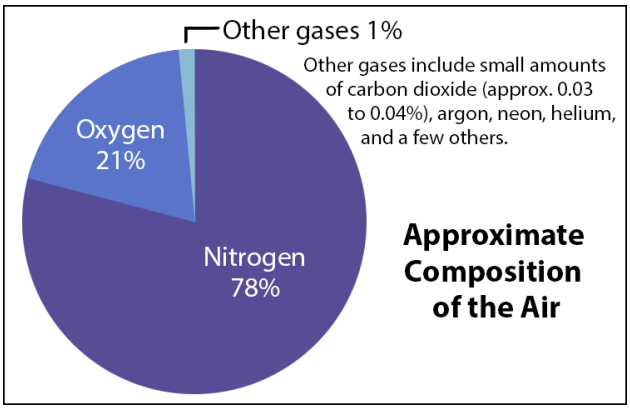


Left: Components of the Global Carbon Cycle
(link above)
Source: Office of Biological and Environmental Research of the U.S. Department of Energy Office of Science. science.energy.gov/ber/

Right: Terrestrial Photosynthetic Carbon Cycle
(link above)
Source: Image adapted from and used courtesy of N. Scott and M. Ernst, Woods Hole Research Center. whrc.org

Introduction

Both animals and plants need air to live and grow. Our air is made up of many different kinds of gases including nitrogen (78%), oxygen (21%) and an assortment of others, including carbon dioxide, argon, neon, helium, and a few others (collectively 1%).



Animals need oxygen from the air for a process called respiration. Respiration is how we turn our food into energy that our body can use. Through this process oxygen is used and carbon dioxide is released. So, we breathe in air, use the oxygen, and breathe out air that has a higher concentration of carbon dioxide.

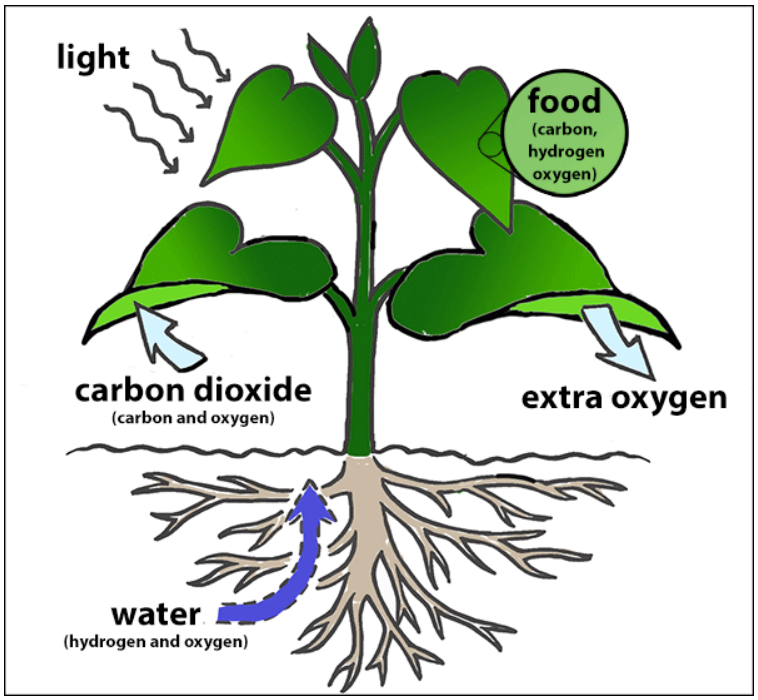
Plants also use oxygen for respiration to turn food into energy. However, unlike us, plants also need carbon dioxide from the air for photosynthesis. In the process of photosynthesis, they take the carbon dioxide out of the air and use it to make food in the form of carbohydrates. Not only do plants rely on this food — all living things rely on the food plants make! (For more details check out KidsGardening's Photosynthesis 101 at: https://kidsgardening.org/garden-how-to-photosynthesis-101/.)

Plants take in air, use some of the oxygen for respiration and carbon dioxide for photosynthesis, and then release the extra oxygen back into the air.

Photosynthesis:

carbon dioxide (carbon and oxygen) + water (hydrogen and oxygen) —with light energy→ food (carbon, hydrogen, oxygen) + extra oxygen

In a very simplified way of looking at our air composition, the net impact is that people/animals are removing oxygen and adding carbon dioxide into the air, and plants are removing carbon dioxide and adding oxygen into the air. Together we work to keep a balance so that the relative amounts of oxygen and carbon dioxide stay consistent.



That being said, there are a number of other factors that come into play and impact the elements found in our air. From gases and small particles that are released through human activity and considered pollutants, to actions and activities that release these naturally occurring elements in unnatural quantities, the balance of carbon dioxide and oxygen is a present-day concern. The vast removal of

plants for human use or to make way for development has decreased the amount of oxygen being released into the air in a significant way. In addition, some of our inventions and agricultural practices have increased carbon in the air. This imbalance is causing a change in our climate.

Carbon is an essential element on our planet, and the Carbon Cycle is an important part of all life. In terms of the air, atmospheric carbon combines with oxygen to become carbon dioxide, which is a greenhouse gas. Greenhouse gases absorb and then re-emit energy back to the Earth. Therefore, the more carbon dioxide in the air, the warmer the temperatures both on land and in the oceans. The warmer temperatures also increase the amount of water vapor present in the atmosphere, increasing temperatures even more.

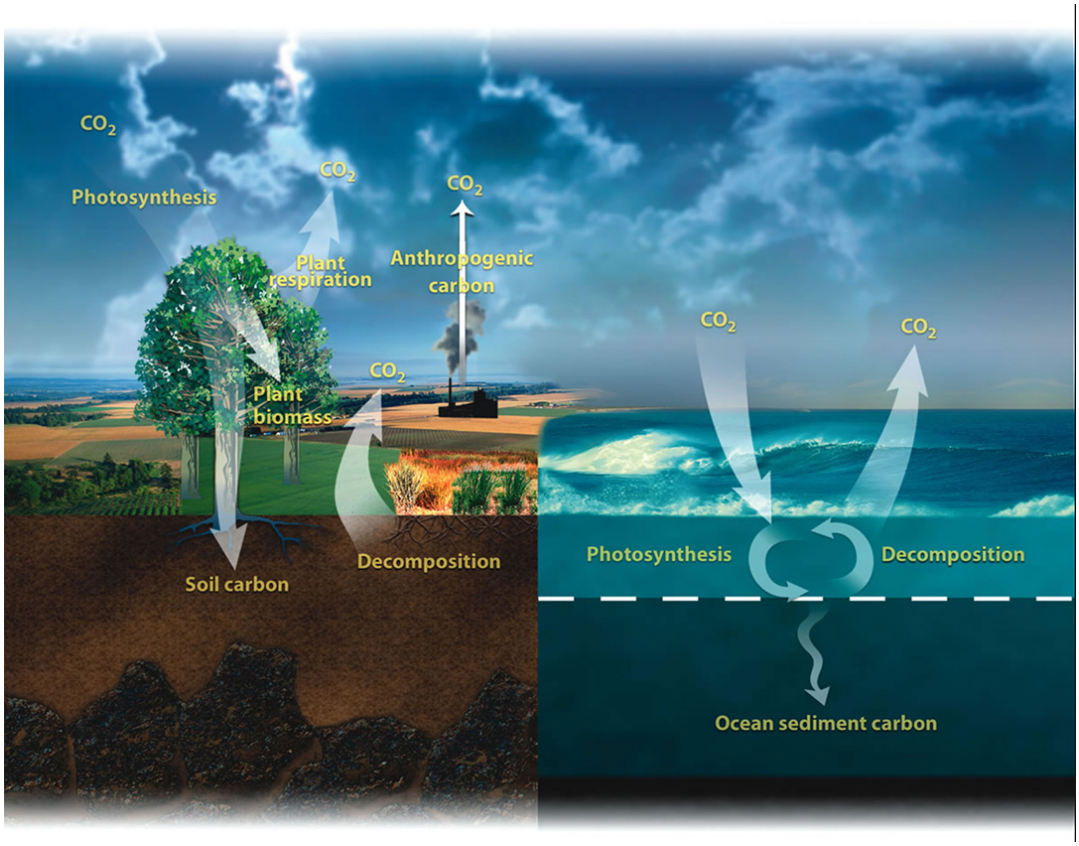
Plants' Role in the Carbon/Oxygen Balance in our Air

Plants are an important part of the solution for bringing balance back to our air:

- They take in carbon dioxide and use it to create food in the form of carbohydrates.
- They release oxygen back into the air.

And through this process, they not only capture carbon in their leaves, stems, and other structures, they also return carbon back to the soil and store it there in the form of living roots and decaying plant matter. Carbon that is "sequestered" in this way helps reduce the amount of carbon dioxide in the air.

Just another important job that plants do in our world! For more in-depth background information about the Carbon Cycle, check out The Carbon Cycle (shown below) from NASA's archives at: https://earthobservatory.nasa.gov/features/CarbonCycle.



Components of the Global Carbon Cycle *(link above)*
Source: Office of Biological and Environmental Research of the U.S. Department of Energy Office of Science. science.energy.gov/ber/

Activity 1: What is Air?

1. Read **The Air Around Us Reading Page**. This reading page may be best to read as a group with younger students (3rd through 4th grade) so you can pause for additional clarification if needed. For older students it can be an independent reading page. Together or independently, complete the reading comprehension questions and then discuss your answers as a group.

2. Understanding why people and plants need air can be especially complex for students to understand because it is not something we can see with our eyes. Take a nature walk in your schoolyard or local greenspace to "look" for air. Use all of your senses to explore air as mentioned in the reading page. What are some of the sensory signs that let us know air exists; e.g. touch (temperature and wind) and smell.

3. When air moves, we call it wind. We can feel the wind on our face and also see wind when it makes objects move.

4. Make a windsock for your garden so you can "see" air and watch as it moves through your garden:

    - Cut plastic bags into strips or get a few rolls of flagging tape from a hardware store.

    - Use an old metal hanger or a plastic ring to make the base for your windsock. There are many items you could repurpose to make a ring such as cutting a cross-section of a 2-liter water bottle, using an old pool toy, or if you want to go big, looking for an old hula hoop. You could also make your own hoop with a flexible piece of pipe or tubing that can be bent into a ring shape and taped.

    - Securely tie the strips of plastic on your ring so that they hang down and flow easily in the wind. Make sure your ties are secure to avoid unnecessarily littering the environment with plastic.

Windsock

5. Find a location to hang your new windsock that you can observe its movement regularly. You may want to experiment by tracking movement in different kinds of weather and hanging it in different places to see how plants and other objects impact wind movement.

Activity 2: Air Above and Below Ground

Plants take in air through stomata in their leaves, and they also need air for their roots.

1. Use the background information to explain how plants take in air through the stomata on their leaves. If you have a microscope available to you, try to look for stomata on leaf samples.

   The stomata are typically found in greater numbers on the undersides of the leaves and on the outside layer of the leaf. To be able to see them under a microscope, you can fold the leaf in half and then tear it so that you can try to separate the bottom layer to get a thinner sample to look through.

   The California Academy of Sciences also offers suggestions for using clear nail polish and tape to try and separate the stomata off of your leaf for viewing. Instructions for this method can be found at: https://www.calacademy.org/educators/lesson-plans/stomata-printing-microscope-investigation.

   If you do not have a microscope, you can check out *Travel Deep Inside a Leaf,* also from the California Academy of Sciences: https://www.youtube.com/watch?v=Bf-RFPaZeAM.

2. Explain that plant roots need air to survive. Healthy soil is full of pore space — tiny open spaces between soil particles. These spaces contain water or air and make them available to plant roots. To demonstrate soil pore space, take a bucket or bowl with no holes in the bottom and fill it with soil. Spread the soil so it's level and place a piece of tape on the wall of the container to mark the soil line.

3. Slowly add water to the soil with a watering can. Look at the tape. Does the soil get higher? If the soil level does not rise, ask kids where the water is going? Keep adding water until your soil becomes completely saturated. Explain that the water is filling the air pockets or pores of air in your soil, displacing the air.

4. Plan an experiment to show that plant roots need these pockets of air for healthy growth. Gather two plants of the same kind that are approximately the same size. Plant them in pots that are also the same size, but one should have drainage holes and the other should either not have drainage holes or have the holes completely blocked. Add the same amount of water to each of them and place them in the same location.

5. Continue to water both plants at the same intervals and the same amount. Track the growth of each and compare. As you water, you will want to apply enough water so that your sample without holes is consistently waterlogged.

6. If you do not have any potted plants readily available (or none that you would like to sacrifice for the sake of experiment), you can also start some seed viewers of bean seeds to experiment with.

To make a seed viewer:

- Cut a piece of construction paper into a rectangular strip to fit inside the plastic cups. This is optional, but it helps with viewing.
- Ball up a few pieces of paper towels and place them inside the construction paper liner until the cup is full.
- Place 3 to 4 beans in the cup between the side of the cup and the paper towels or construction paper liner so the seeds are visible from the outside of the cup.
- Gently water the paper towels in the center until saturated.
- Place the cup (or cups if you would like to try multiples) on a shelf or windowsill and watch them grow. First you will notice the seed coat expanding (wrinkling) as the seed absorbs water. The root will start to grow in 2 to 3 days. Water as necessary to keep the paper towel and seeds continually moist.

Seed Viewer

Once your seedlings have two true leaves, start your experiment. For half of your seed viewers, continue to only provide enough water to keep the paper towels moist. These samples will have air available to their roots. On the other half of the seed viewers, fill the cup completely with water so that the plants are kept in standing water which means they do not have any air available to them. Compare their growth.

*Please note: If using seed viewers, you can start testing the effects of no air and varying water availability right from the start and also look at the impact on seed germination, or you can wait to begin your experiment after the first set of true leaves appears.

7. Track your observations using the Air Experiment Data Collection Worksheet or your garden journal. If you are not seeing much variation in the appearance and growth of your plants, you may need to adjust the amount of water you are using, which in this experiment is representing the amount of air availability.

8. Discuss your results. Did some of your plants grow better than others? What happened to the plants that did not have any air available to their roots? Does this show us that plant roots need air?

Extend the Activity: Testing the impact of air availability to leaves is very challenging. Because plants conduct both respiration (which gives off carbon dioxide) and photosynthesis (which gives off oxygen), plants grown in an enclosed space such as a terrarium can actually continue to provide for their own air-related needs for a very, very long time. You can try growing a plant in vacuum-sealed food container that comes with a pump to remove the air; however, you may or may not notice significant differences in growth.

Activity 3: The Carbon Cycle

1. Share with your kids the **Components of the Global Carbon Cycle Diagram** from the US Department of Energy available at: https://public.ornl.gov/site/gallery/originals/CCycle_cover_image.jpg

   Use the background information above to help you explain how carbon moves through the atmosphere and why that it is important. There is a fixed amount of carbon on our planet. It moves between being stored in the soil, the air, the water, and in living things. Keeping a set balance of carbon is important for keeping everything in our world working right. Share that if there is too much or too little carbon in our air, it can change our climate and environment.

2. Next, share the **Terrestrial Photosynthetic Carbon Cycle Diagram** from the US Department of Energy available at: https://public.ornl.gov/site/gallery/originals/Pg028_CCycle08.jpg.

   Explain that plants are a really important part of the carbon cycle and how they can take extra carbon from the air and then turn it plant food that can get stored in the plant and also returned to the soil.

3. The nonprofit organization Kiss the Ground has a short video called *The Soil Story* that helps explain this phenomenon in simple terms. There are 3 different versions of this video available to watch (and even more translated into different languages) at: https://kisstheground.com/thesoilstory/

The core message of this video is that the amount of carbon on our planet does not change, but it can be stored in different locations, including the atmosphere, oceans, biosphere, soil, and fossils. As we have released more carbon into the atmosphere, we have changed the balance in the storage location of carbon, negatively impacting our environment. Kiss the Ground presents different solutions for moving carbon back into the soil as a way to solve the problem of climate change.

Ask kids to consider the role of plants in bringing and keeping carbon in balance in our atmosphere. Are plants important for people?

Digging Deeper

You can use the following resources to dig deeper into this week's lessons:

Books and Additional Resources:

Seed School by Joan Holub

Jack's Garden by Henry Cole

Up in the Garden and Down in the Dirt by Kate Messner

A Place to Grow by Stephanie Bloom

10 Interesting Things About Air from NASA Climate Kids:
https://climatekids.nasa.gov/10-things-air/

Why Does Wind Blow? From NOAA SciJinks:
https://scijinks.gov/wind/

Why is Air Invisible? From Highlight Kids:
https://www.highlightskids.com/explore/science-questions/why-is-air-invisible

For Older Kids and Parents:
Understanding Food and Climate Change from The Center for Ecoliteracy:
https://www.ecoliteracy.org/download/understanding-food-and-climate-change-interactive-guide

Understanding Food and Climate Change uses video, photography, text, and interactive experiences to show how food and climate systems interact and how personal choices can make a difference. Ideal for grades 6–12 (and adults too), the guide provides connections to Next Generation Science Standards and the National Curriculum Standards for Social Studies themes. It also offers activities for student research and resources for further investigation.

Videos:
Travel Deep Inside a Leaf from the California Academy of Sciences:
https://www.youtube.com/watch?v=Bf-RFPaZeAM

Kiss the Ground's The Soil Story:
https://kisstheground.com/thesoilstory/

Photosynthesis — The Dr. Binocs Show By Peekaboo Kids
https://www.youtube.com/watch?v=D1Ymc311XS8

Additional Related KidsGardening Lessons and Activities to Try:

Photosynthesis Runs the World:
https://kidsgardening.org/lesson-plan-photosynthesis/

Photosynthesis 101:
https://kidsgardening.org/garden-how-to-photosynthesis-101/

Tropical Rainforests:
https://kidsgardening.org/lesson-plan-tropical-rainforests/

The Soil-Air Connection:
https://kidsgardening.org/lesson-plan-soil-air-connection/

Garden Basic: Carbon Cycle and Carbon Sequestration:
https://kidsgardening.org/garden-how-to-carbon-cycle-and-carbon-sequestration/

Building a Terrarium:
https://kidsgardening.org/garden-activities-building-a-terrarium/

Weather-Tracking Tools:
https://kidsgardening.org/lesson-plans-weather-tracking-tools/

Digging into Soil:
https://www.diggingintosoil.org/