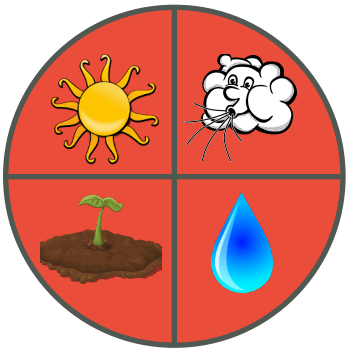
TREES & CLIMATE CHANGE

Before we get to climate change and what it is, let's start with trees.

HOW DOES A TREE GROW?

A tree needs four things to grow: sun, air, soil, and water. Each of these elements provides something for the tree.



SUN: ENERGY
AIR: CARBON DIOXIDE
SOIL: NUTRIENTS
WATER: HYDRATION

What is carbon dioxide?

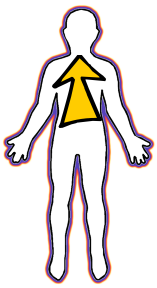
Carbon dioxide is a kind of gas in Earth's atmosphere (the air around the planet). It is made up of one part carbon and two parts oxygen. Trees use carbon dioxide in the process of **photosynthesis.**

WHAT IS PHOTOSYNTHESIS?

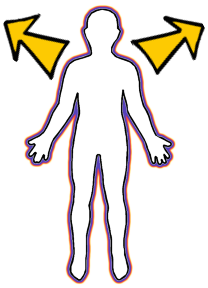
Photosynthesis is the process trees and plants use to make their own food. A tree can't grow unless it has food to nourish it, just like you! You can think of this like cooking: ingredients go in to make the dish (inputs), and at the end you have a meal (output).

What are two *inputs* that you need to live and what *outputs* do they provide you with? Think of outputs in terms of energy, oxygen, nutrients, and hydration.

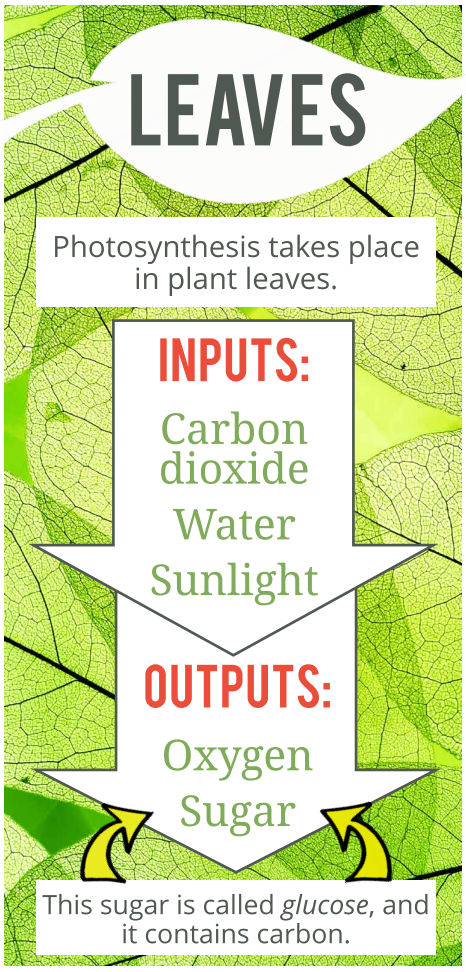
INPUTS:



OUTPUTS:



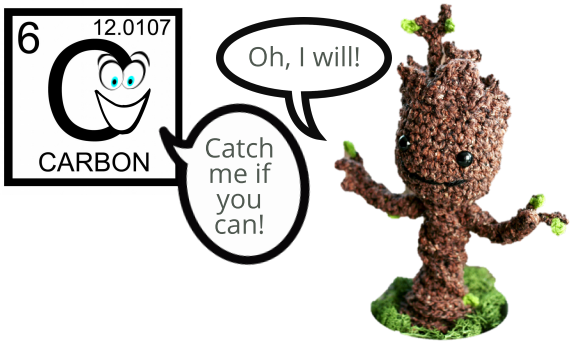
Example: bowl of salad	*Energy to play soccer*



HOW DO TREES HELP WITH CLIMATE CHANGE?

What does this have to do with climate change? Well, the key is in the *carbon*. Trees take in carbon dioxide through their leaves from the atmosphere, which is known as **carbon capture**. They then use the carbon to grow their trunks, branches, and roots. This is called **carbon storage**.

Carbon that is stored in a tree remains there, even after the tree is cut down. That means that if you have a desk, bed, chair, or anything made of wood, it has stored carbon in it.



WANTED: CLIMATE CHANGE CRIMINALS

CO_2 CARBON DIOXIDE
Making up a whopping 84% of all man-made greenhouse gases, CO_2 is the bad boy of the bunch.

CH_4 METHANE
Methane is a dangerous sidekick, making up 9% of man-made greenhouse gases.

N_2O NITROUS OXIDE
Not to be underestimated, nitrous oxide accounts for 5%.

HFC, PFC, SF_6, NF_3 FLUORINATED GASES
Hoping to one day be as cool as their friends above, fluorinated gases currently make up 2%.

DEFINING CLIMATE CHANGE

Climate change is defined as a significant and long-lasting change in the Earth's climate and weather patterns. Some climate change is normal, but some change is driven by our behaviors. Too much change can threaten animal habitats, cause sea levels to rise, and increase catastrophic storms and natural disasters.

Some of the biggest culprits of climate change are greenhouse gases (GHGs). **Greenhouse gases** are gases in Earth's atmosphere that absorb heat energy from the sun and radiate it back to Earth's surface, thus warming the planet. One such gas is carbon dioxide.

Though natural processes also release GHGs, most are released by human activities (see the list to the left).

How does a tree's ability to store carbon affect climate change?

HUMAN ACTIVITIES

What are the human activities that release the greenhouse gases above? We can trace an overwhelming amount of our emissions back to fossil fuels. **Fossil fuels** are carbon-rich reserves of plant and animal remains that have decomposed over millions of years. Fossil fuels include the coal that we burn in power plants to create electricity for our homes, the natural gas that we burn to heat them, and the oil that we use to power our cars and planes. Fortunately, trees help absorb the carbon dioxide emissions from these activities, which is why we need to keep planting and protecting them!

HOW DO YOU MEASURE CARBON IN A TREE?

That is what you are going to learn now!

The amount of carbon that a tree can store depends on the size of the tree. Think of it like a suitcase: the larger the suitcase, the more you can put in it. To figure out how much carbon is in a tree, you have to measure the size of the tree. Two measurements are important: circumference and height.

Because tree trunks are different shapes and sizes, **arborists** (tree specialists) had to come up with a consistent way to measure the circumference. They decided to measure the circumference of all trees at 4.5 feet from the ground, called "**standard height.**"

First, describe the tree:

Materials:

Long string	**Meter stick**
Activity page or notebook	**Pencil and marker**
Another person	**Tape**

Instructions:

Gather the materials listed above, and go find a tree outside that you can measure. Look for a tree in your own yard, a park, or another public space.

HOW TO MEASURE CIRCUMFERENCE:

- Use the meter stick to find where standard height is on the tree.
- Mark that height with a piece of tape.
- Take your string and wrap it around the trunk of the tree at the marked spot.
- Use your marker to draw on the string at the point where it has encircled the tree.
- Measure the length of string up to the marked point using the meter stick.
- Record below.

Tree circumference: _____ meters

HOW TO ESTIMATE HEIGHT:

- Have the person who is with you stand next to the tree and hold the meter stick on the ground.
- Step far enough away from the tree that you can see the bottom of the trunk and the top of the branches.
- Use your thumb and index finger to approximate the size of the meter stick.
- Keep your fingers in that same position and count up the tree to estimate how many meters the tree is in height.
- Record below.

Tree height: _____ meters

HOW MUCH CARBON IS THAT?

Use the chart on the next page to find out approximately how much carbon is stored in the tree that you measured, and record it below.

This tree stores: _____ kilograms **of carbon.**

HOW MUCH CARBON CAN ONE TREE STORE?

Use this table to find a rough estimate of the amount of carbon stored in a tree on the basis of the tree's circumference at standard height and your estimation of the tree's height. The estimated amount of carbon is in kilograms (kg).

Circumference at Standard Height (in meters)

Tree Height (in meters)	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75	3.0	3.25	3.5	3.75	4.0
2	10	14	19	26	36	48	61	77	95	115	138	162	189	217	248	281
3	10.5	16	23.5	49	42	67	87	111	138	168	202	238.5	278.5	321	367	416.5
4	11	18	28	43	62	86	113	145	181	221	266	315	368	425	486	552
5	12	20	33	51.5	75.5	105	139	179	224	274	330	397	457.5	529	605.5	687.5
6	13	22	38	60	89	124	165	213	267	327	394	467	547	633	725	823
8	14	26	48	77	115	162	217	281	353	433	522	620	726	840	963	1,095
10	15	31	57	94	142	200	269	349	439	539	651	773	905	1,048	1,202	1,366
12	16	35	67	111	168	238	321	416	525	645	779	925	1,084	1,256	1,440	1,638
14	17	39	76	128	195	276	373	484	610	751	907	1,078	1,263	1,464	1,679	1,909
16	18	43	86	145	221	315	425	552	696	857	1,035	1,231	1,443	1,672	1,917	2,180
18	19	48	95	162	248	353	477	620	782	963	1,164	1,383	1,622	1,879	2,156	2,452
20	20	52	105	179	274	391	529	688	868	1,069	1,292	1,536	1,801	2,087	2,394	2,723
22	21	56	114	196	301	429	581	756	954	1,175	1,420	1,688	1,980	2,295	2,633	2,994
24	22	60	124	213	327	467	633	823	1,040	1,281	1,549	1,841	2,159	2,503	2,872	3,266
26	23	64	133	230	354	505	685	891	1,126	1,387	1,677	1,994	2,338	2,710	3,110	3,537
28	24	69	143	247	380	544	737	959	1,211	1,493	1,805	2,146	2,517	2,918	3,349	3,809
30	25	73	152	264	407	582	789	1,027	1,297	1,599	1,933	2,299	2,697	3,126	3,587	4,080

This chart was adapted by Canopy from a Project Learning Tree resource: https://www.plt.org/activity-resources/focus-on-forests-activity-8-climate-change-and-forests/

These estimates are based on the formula: MC (mass of carbon in the tree) = 0.5 x Mw (mass of the wood). where Mw = 0.55 x V (volume of tree) x Dw (density of wood); V = 0.0567 + 0.5074 x (CBH/π)2 x H. It assumes that Dw = 0.6 g/cm^3, and that water makes up 45 percent of the tree's mass.

HOW MUCH CARBON DO PEOPLE USE?

Use the chart on the right to compare the amount of carbon in the tree that you measured to the amount of carbon needed for human activities. Jot down below the number of miles a car could travel, the gallons of gasoline consumed, and the number of times a phone could be charged with the amount of carbon stored in your tree.

MY TREE EQUALS

_____ miles driven by a car

_____ gallons of gasoline

_____ smartphones charged

Kilograms (kg) of carbon	Miles driven by an average passenger	Gallons of gasoline consumed	Number of smartphones charged
5	12	0.5	638
10	24.5	1	1,275
25	61	2.5	3,188
50	122	5	6,376
75	183	7.5	9,563
100	244	10	12,751
200	488	20	25,502
300	732	30	38,253

Source: http://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

WHERE DOES CARBON GO WHEN A TREE DIES?

In the lesson activity below, you will be given two situations that affect the carbon in trees: fire and decomposition. Three friends have given different explanations for each. Choose the description that you think is correct, and explain why you think so in the space provided.

FIRE

Humans burn large amounts of forests every year, usually to clear land for agriculture.

DECOMPOSITION

Fallen branches and the wood of dead trees are broken down by an array of insects, bacteria, and fungi in the process of **decomposition**. This is important because decomposition helps recycle nutrients into the soil, and make them available for plants. When forests are unhealthy, dead plant material can pile up because there are not enough decomposers to break it down.

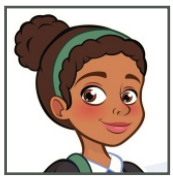
DONTE

I think that burning wood will release carbon back into the atmosphere as carbon dioxide, and that the decomposition of tree wood by insects, bacteria, and fungi will do the same.

JOLENE

I do not think that burning wood will release the wood's carbon back into the atmosphere as carbon dioxide. I think that the decomposition of wood will only release some carbon, and that the rest will be incorporated into the soil.

MIA



I think that burning wood will release carbon back into the atmosphere as carbon dioxide, and that the decomposition of wood will release some carbon as carbon dioxide, but that most will be incorporated into the soil.

Who do you think is correct? Explain why you agree with him/her.

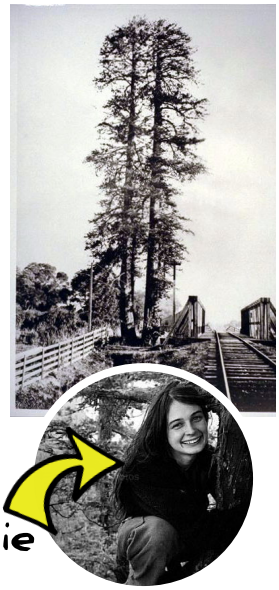
CARBON & CALIFORNIA'S REDWOODS

BEST IN SHOW

In terms of ability to store carbon, not all trees are made equal. California is fortunate to be home to many coast redwoods, which can grow to over 100 meters tall and can live for over 1,000 years. Coast redwoods are **native** to California, meaning that they have developed here and occur naturally.

Scientists have found that CA's ancient redwood forests store more carbon per acre than any other forest in the world!

EL PALO ALTO & LUNA: BELOVED REDWOODS



You might have visited a famous coast redwood in Palo Alto that gave the city its name. The tree, El Palo Alto, means "the tall stick" in Spanish. As of 2020, it is 33.5 meters high and 1,080 years old! The photo to the right shows El Palo Alto in 1875 with twin trunks, before one fell during a storm. Great efforts have been taken to preserve this tree, including installing a water misting system to reach its tall canopy.

Though events like storms and internal decay can fell trees, a bigger threat is **deforestation**: the removal of entire forests of trees by fire or logging. In 1997, a woman named Julie Butterfly Hill was so distraught by the deforestation of the California redwood forests that she climbed into the canopy of a tree called Luna in Humboldt County, north of San Francisco, and refused to leave for *two years* until the lumber company agreed to preserve Luna and some surrounding acreage!

What are two ways in which deforestation contributes to climate change?

Congratulations! You have successfully:

- *Measured the circumference and estimated the height of a tree*
- *Discovered approximately how much carbon it stores*
- *Compared that amount of carbon to what we use in our daily activities*
- *Explained what you think happens to a tree's carbon during fire and decomposition*
- *Identified two reasons why deforestation contributes to climate change*

Challenge: Use your newfound knowledge of the important role that trees play in reducing climate change to seek out opportunities to plant, protect, and advocate for trees. Remember that actions of any size count! You definitely don't need to live in a tree for two years in order to make a positive impact.