The Carbon Cycle – How It Works

Category

Science, Mathematics, Reading

Real World Connection

Research, Climate, Future Planning

Materials

Two Dice, Scissors, Colored Pencils, Plain Paper

Carbon Process Cards and Carbon Reservoir Cards (Included - need to be cut out)

Problem Question

Describe the Carbon Cycle

Prior Knowledge
What I Know

Based on your prior knowledge, answer the problem question to the best of your ability.

Conclusion
What I Learned

Answer the problem question after completing the activity.

Note to Teachers Before Getting Started

In advance, set up twelve stations in the classroom. Allow time for students to prepare the stations according to directions.

Background

Carbon!

Do you know that the element carbon ...

> is **an important building block of life**.
> is a **building block of matter**, including diamonds, coal, CO_2, limestone, pencil lead, medicines, and lots more.
> can chemically **combine with itself**.
> is a source of **energy**.
> is the **twelfth most abundant element** in Earth's crust.
> forms CO_2 .
> **has effects** that we need to be aware of at all times.

Evidence shows that since the beginning of the Industrial Revolution, about the year 1750, **coal, oil, and gas (called fossil fuels)**, which give off CO_2 when burned, are being **used world-wide** by more people, upsetting Earth's natural energy balance. Fossil fuels form from the **decay of plants and animals** that have been buried deep underground for millions of years. When heated, fossil fuels combine with oxygen in the atmosphere to release energy in a chemical reaction. For example, as coal burns:

$$C + O_2 \longrightarrow CO_2 + \text{Energy}$$

$$\text{Carbon + Oxygen} \longrightarrow \text{Carbon Dioxide + Energy}$$

Notice that along with energy, another product forms, **carbon dioxide**. Now, over two centuries later, fossil fuels provide most of our electricity, and almost all of the transportation fuels in the US.

Carbon moves through Earth's atmosphere, oceans, plants, animals, and rocks in a repeating pattern called a **cycle**. For the past half century, researchers have been monitoring and measuring the amount (called the concentration) of CO_2 in Earth's atmosphere. The result of careful measurements shows that the concentration of CO_2 in Earth's atmosphere is not only **increasing**, but the **increase is speeding up**. Why is this important?

Carbon dioxide **traps** and **absorbs** (takes in) invisible energy in the atmosphere. The invisible energy is in the form of **infrared radiation (heat)**. Some of this infrared energy flows from the Earth back into space. However, since the CO_2 concentration has been increasing, more energy is being **absorbed**, and the atmosphere is **warming**. In addition to **absorbing more infrared radiation**, Earth is **also absorbing heat from the sun** in the form of visible rays - just as in the past. The **combined effect is global warming**.

As Earth's atmosphere warms other changes occur. **Weather and climate change**. In turn, the **sea level rises**, **droughts and floods** may become more frequent, **storms** may become more intense. These events will **affect all living organisms**, including ourselves. For example, food crops fail to grow, or grow in unexpected places; diseases like yellow fever and malaria show up in new and different places. These **changes**, and others, can have a **lasting effect on our lives**, including where and how we live.

Background (Continued)

Definition - Climate

The general or average weather conditions of a certain region, usually includes temperature, rainfall, and wind averaged over a given period of time (30 years or more). On Earth, climate is most affected by latitude, the tilt of the Earth's axis, the movements of the Earth's wind belts, the difference in temperatures between land and sea, and topography. Human activity, especially relating to actions involving CO_2, is also an important factor.

Procedure

This is a game where you walk through an imaginary Carbon Cycle, moving to and from one carbon reservoir to another, much as a carbon atom moves through living and non living matter. The goal is to learn ways in which carbon is stored in reservoirs (also called sources and sinks) processes that transport the carbon atom from one location to another, and to draw a map that shows your path through the Carbon Cycle.

There are 12 stations. Each station represent a carbon reservoir. Except for the first station, your roll of the dice determines where your group (your carbon atom) will move.

Remember

**A cycle
is not
a circle...
but a pattern
of repetition.**

Before You Begin...

1. Cut out the process cards that describe how carbon moves from one reservoir to the next. Leave all of the cards from your group at your first station. The next groups will use these cards. Now cut out the reservoir cards and place each card at the station that matches the name and number. Each card goes to a different station. There will be multiple reservoir cards at each station to help each group work together cooperatively.
2. Prepare to draw a map of your path through the Carbon Cycle.

Steps...

1. Near the center of your paper, draw an oval shape and inside the oval write the name of the carbon reservoir for your station and the word “start”. Then, as you move from station to station, draw ovals to represent reservoirs, rectangles for the transport process, and arrows to show the direction of movement. **At the first station only**, write the name of the station - **but no process for getting there.** Refer to the sample map at the end of this activity.
2. There are cards at each station to explain the processes for transporting carbon from one location to another. Use the process cards and discussion with your group, to identify the process or processes that transported your carbon atom to the reservoir where you are. On your paper, draw a rectangle and write the name of the transport process and a description of the journey. Refer to the sample map at the end of this activity.

Dice Roll Table

Dice Roll Number	Go To Station Number
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
*****	13

Procedure (Continued)

Steps (Continued)...

3. Insert arrows to show the direction of movement for your carbon atom. Refer to the sample playboard at the end of this activity.

4. Each station is numbered and represents a different reservoir. When you have gathered all of the information from your station, roll the dice to find out where your carbon atom will go next. Move to the station that has the number that you rolled.

5. Repeat the procedure until time runs out. Try to pass through as many reservoirs (sources and sinks) as possible.

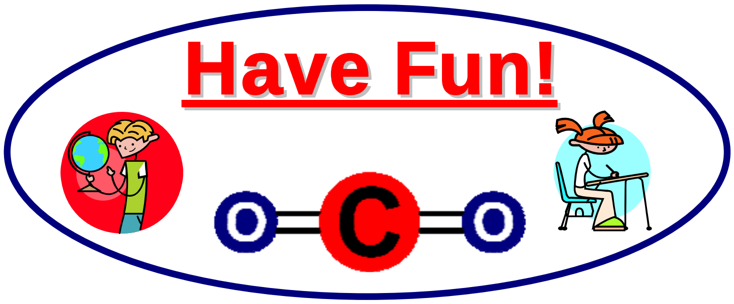
6. Color your carbon cycle as time allows.

Notes:

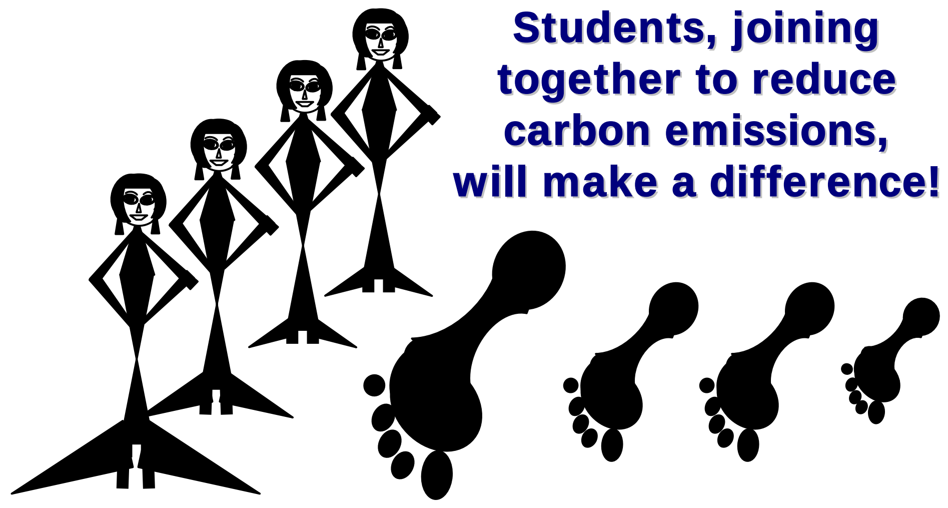
- *Take turns rolling the dice.*
- *Roll only once; no repetitions.*
- *If your roll of the dice is the same number as the station you are on, go to Station No. 13.*
- *Use ovals to represent reservoirs, rectangles for the transport process, and arrows to show the direction of movement. Refer to the sample playboard at the end of this activity.*

All of the information you need to create the carbon cycle is on the Process and Reservoir Cards. You decide in what order to write the information on your blank worksheet for the carbon cycle.

Work cooperatively in your group.



Have Fun!



Students, joining together to reduce carbon emissions, will make a difference!

Carbon Process Cards (Need to be cut out and placed at your first station)

Absorption

Uptake of substances into cells or across tissues such as skin, intestines, and kidneys.

Weathering

Breaking down rocks and minerals by the action of the atmosphere (weather) and living things.

Photosynthesis

Green plants use carbon dioxide, water, and light to create carbohydrates for food and to give off oxygen.

Burial and Decomposition

Fossil fuels form from the fossilized remains of dead plants and animals, under tremendous heat and pressure, over millions of years.

Burial and Rock Formation

Sediments compact (squeezed together) under pressure, become cemented and slowly form solid rock.

Combustion (Burning)

A chemical process called oxidation that releases energy. It is used to describe a fuel in a state of combustion.

Dissolving in Rain or Seawater

Adding a solid substance into a solvent (usually a liquid) to form a solution. For example, dissolving salt in water yields a saltwater solution.

Volcanoes

Lava, ash, and gases, that include carbon dioxide (CO_2), erupt through an opening in the Earth's Crust.

Respiration (Breathing)

Taking up oxygen (O_2) and giving off carbon dioxide (CO_2) in order to provide energy.

Erosion

Transporting (moving) weathered rock and minerals to a different location.

Death, Decomposition, and Excretion of Organisms

Breaking down organic material, such as dead plant or animal tissue, into small parts.

Consuming (Eating)

Taking in food to convert into energy.

Carbon Reservoir Cards (Need to be cut out and placed at the station that matches the title and the number. Each card goes to a separate station.)

Carbon dioxide (CO_2) in the atmosphere

2

Carbon in limestone (carbonate rock on land)

3

Carbon in the ocean where small plankton flourish

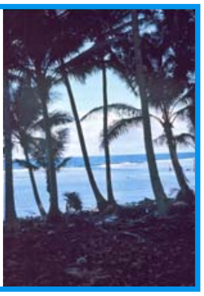
4

Carbon on land – consumers (including human beings)

5

Carbon in green plants on land

6



Carbon in marine carbonate sediment – small broken sea shell particles, sometimes combined with minerals and debris

7

Carbon , or CO_2 from the atmosphere, dissolved in seawater – volcano spewing CO_2 bubbles that dissolve in seawater

8

Carbon in coal – a fossil fuel (coal, oil, and natural gas)

9

Carbon in marine mammals

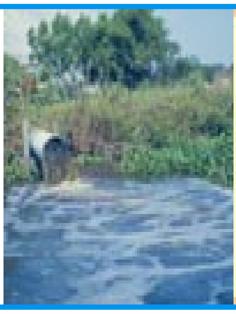
10

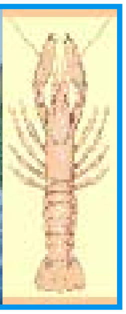
Carbon in sea plants growing on the sea floor

11

Carbon in rivers and lakes (fresh water)

12



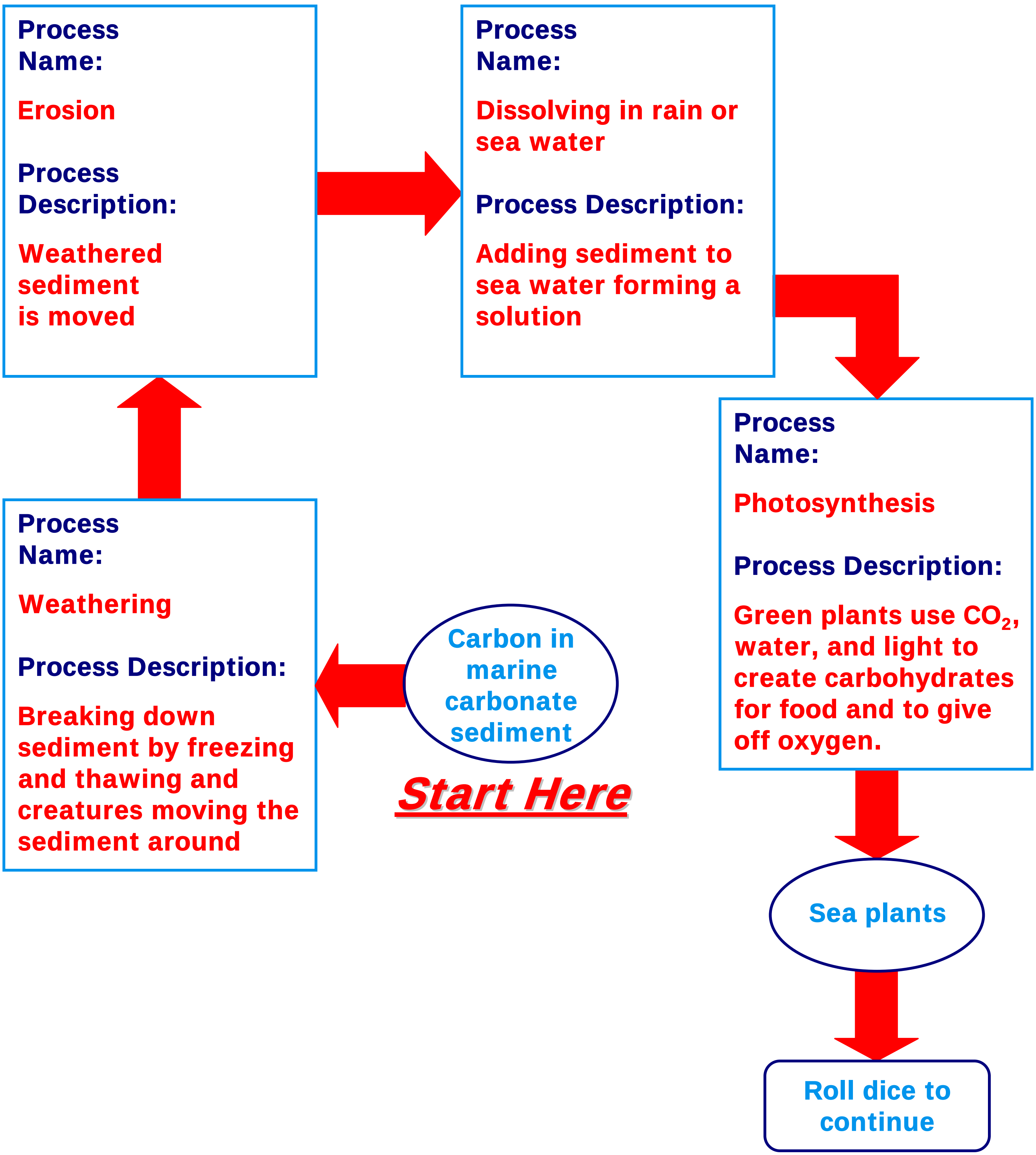


Carbon in soil

13

Sample Map for the Carbon Cycle

1. Do NOT copy this pattern.
2. Draw your own carbon cycle on your blank worksheet based on the path of your carbon atom.
3. Notice that there may be more than one process (in the rectangle) to move a carbon atom from one reservoir to another, and that there are many different possibilities for a diagram like this one.



Carbon in marine carbonate sediment

Start Here

Process Name:

Weathering

Process Description:

Breaking down sediment by freezing and thawing and creatures moving the sediment around

Process Name:

Erosion

Process Description:

Weathered sediment is moved

Process Name:

Dissolving in rain or sea water

Process Description:

Adding sediment to sea water forming a solution

Process Name:

Photosynthesis

Process Description:

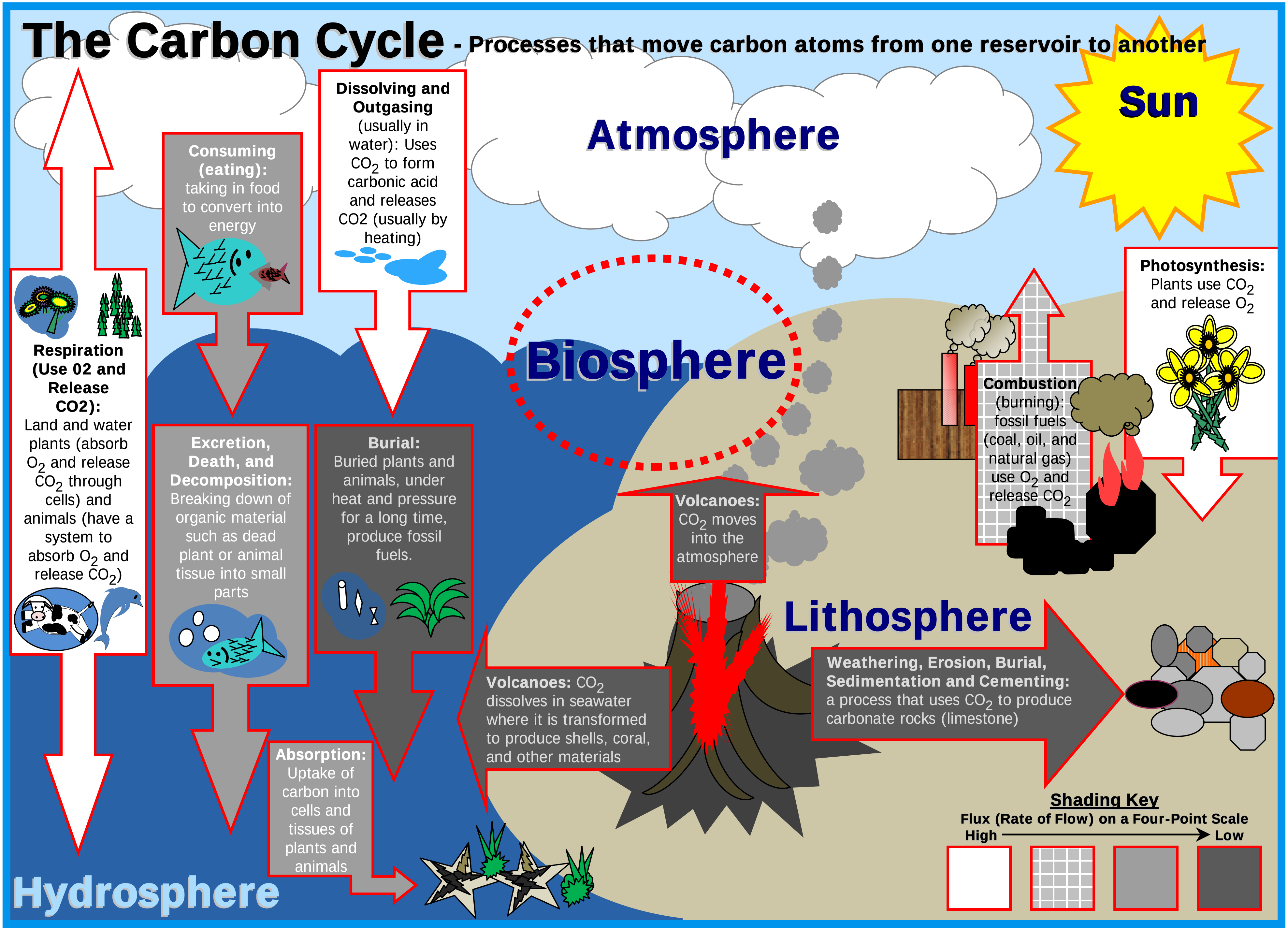
Green plants use CO_2, water, and light to create carbohydrates for food and to give off oxygen.

Sea plants

Roll dice to continue

For Your Carbon Cycle Map

Optional Background Information for Students to use in Preparation for this Activity



The Carbon Cycle - Processes that move carbon atoms from one reservoir to another

Respiration (Use 02 and Release CO2): Land and water plants (absorb O_2 and release CO_2 through cells) and animals (have a system to absorb O_2 and release CO_2)

Consuming (eating): taking in food to convert into energy

Dissolving and Outgasing (usually in water): Uses CO_2 to form carbonic acid and releases CO2 (usually by heating)

Excretion, Death, and Decomposition: Breaking down of organic material such as dead plant or animal tissue into small parts

Burial: Buried plants and animals, under heat and pressure for a long time, produce fossil fuels.

Absorption: Uptake of carbon into cells and tissues of plants and animals

Volcanoes: CO_2 moves into the atmosphere

Volcanoes: CO_2 dissolves in seawater where it is transformed to produce shells, coral, and other materials

Combustion (burning): fossil fuels (coal, oil, and natural gas) use O_2 and release CO_2

Photosynthesis: Plants use CO_2 and release O_2

Weathering, Erosion, Burial, Sedimentation and Cementing: a process that uses CO_2 to produce carbonate rocks (limestone)

Shading Key

Flux (Rate of Flow) on a Four-Point Scale

High → **Low**

□ ▦ ▩ ■