The Carbon and Oxygen Cycles

Carbon is an essential part of life on Earth. About half the dry weight of most living organisms is carbon. It plays an important role in the structure, biochemistry, and nutrition of all living cells.

The process by which carbon moves through an ecosystem is called the **carbon cycle**. On Earth, carbon is stored in a variety of places:

- the atmosphere
  - 750 billion tons of carbon, mostly as carbon dioxide gas
- the landmass of Earth (including the interior)
  - the largest amount of carbon
  - remains trapped for millions of years
  - 80 quadrillion tons in the rocks of Earth's crust
  - 1.5 trillion tons in soil
- all of Earth's water
  - 36 trillion tons, mostly as dissolved ions
- all living organisms
  - 575 billion tons as organic compounds (e.g. carbohydrates)

Carbon is moved through the biosphere primarily by two processes: photosynthesis and respiration.

Photosynthesis is a process by which plants use the Sun's energy to convert carbon dioxide into glucose, releasing oxygen in the process.

$$CO_2(g) + H_2O(l) + energy \rightarrow C_6H_{12}O_6(s) + O_2(g)$$

$$carbon\ dioxide + water + energy \rightarrow glucose + oxygen\ gas$$

This process removes carbon from the atmosphere and stores it in living things (plants) in the form of glucose. The carbon in glucose then moves through the biosphere by way of the food chain.

Respiration is essentially the reverse of photosynthesis: it combines glucose and oxygen and converts it into carbon dioxide, water, and energy.

$$C_6H_{12}O_6(s) + O_2(g) \rightarrow CO_2(g) + H_2O(l) + energy$$

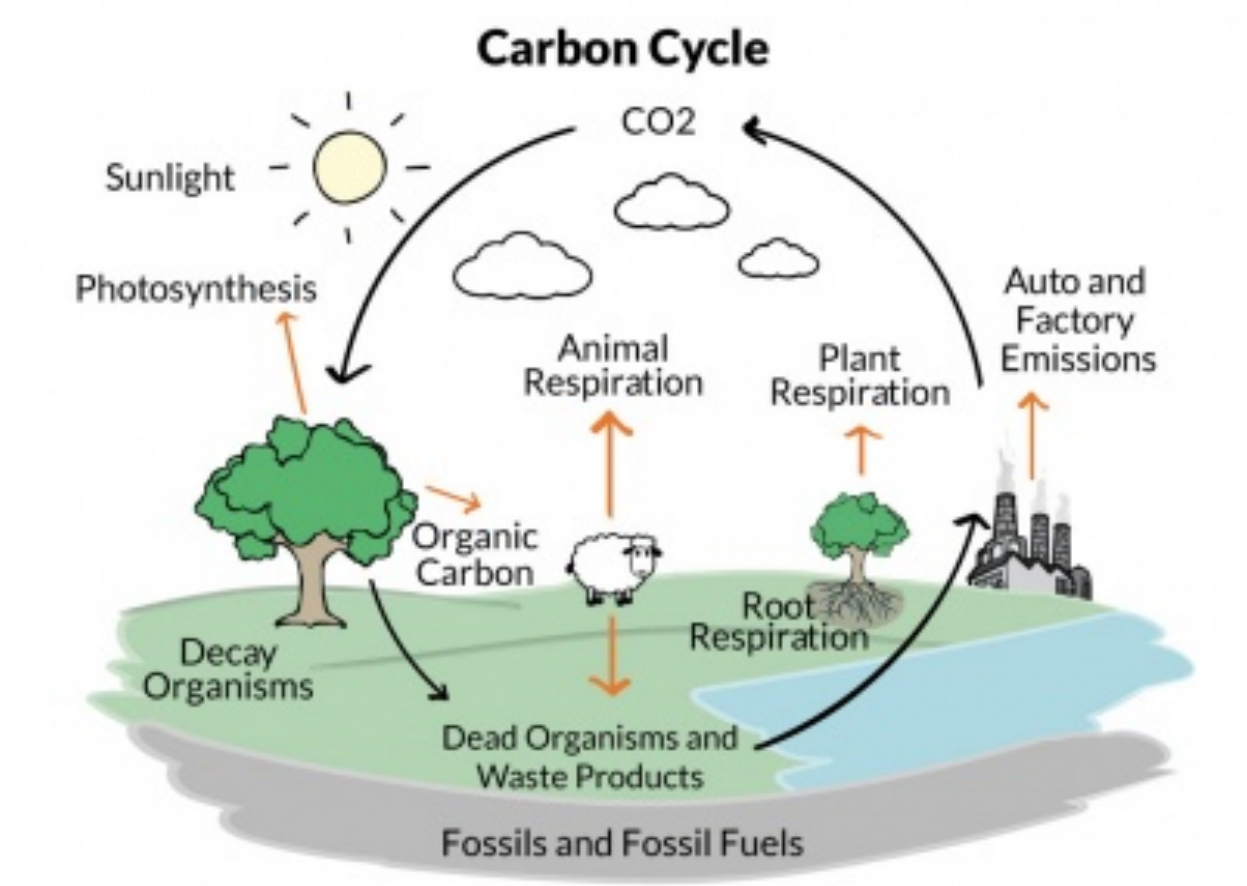
$$glucose + oxygen\ gas \rightarrow carbon\ dioxide + water + energy$$

The energy is used by organisms for growth, movement, reproduction, etc. The carbon dioxide is returned to the atmosphere, and the cycle continues.

Carbon is also returned to the atmosphere in several other ways:

- the decay of animal and plant matter releases methane gas (CH_4)
- burning fossil fuels (gasoline, coal, etc.) releases carbon dioxide gas
- as sea water warms, it releases dissolved carbon dioxide gas
- volcanic eruptions release carbon dioxide gas

The diagram below illustrates the carbon cycle.



Under normal conditions, the amount of carbon being removed from the atmosphere and the amount of carbon being returned to the atmosphere are the same. This means the amount of carbon in the atmosphere usually remains constant.

There are, however, a number of things that can artificially increase the amount of carbon being returned to the atmosphere. This can result in the amount of atmospheric carbon increasing over time, which can have a number of negative effects.

Disturbing the Carbon Cycle

Human Impact

The most well known example of the disruption of the carbon cycle is the burning of fossil fuels by humans.

What are fossil fuels?

Fossil fuels are carbon-based compounds like oil, coal, and natural gas. They are formed over millions of years as dead organisms decay and are buried beneath Earth's surface.

What do they have to do with the carbon cycle?

Normally, fossil fuels remain deep underground for millions of years. When humans remove them from the ground and burn them (e.g. as gasoline in our cars), the carbon in the fuel returns to the atmosphere.

Why is this bad?

When we burn a liter of gasoline in our cars, the carbon goes into the atmosphere. In order for that carbon to return to the Earth as a fossil fuel, it must:

- be absorbed by a living organism
- then the organism has to die
- finally, the dead organism has to decay and be buried underground for millions of years

So, carbon that took us a few years to move from underground to the atmosphere will take millions of years to put back underground. This will result in the amount of atmospheric carbon slowly increasing over time.

Increased atmospheric carbon is believed to be a major cause of **global warming**.

Another human activity that disturbs the carbon cycle is **deforestation**, or the cutting down of trees. The removal of a large number of trees decreases the amount of plants available for photosynthesis. This in turn decreases the amount of carbon being removed from the atmosphere, resulting in an overall increase in the amount of carbon in the atmosphere.

Natural Events

The carbon cycle can also be disturbed by some natural events, such as forest fires or volcanoes.

The **combustion** or burning of plant material (wood) releases large amounts of carbon dioxide into the atmosphere. This creates an increase in the amount of carbon being returned to the atmosphere, resulting in an overall increase in the amount of carbon in the atmosphere.

Volcanoes can also disrupt the carbon cycle. Volcanic activity breaks down rocks containing carbon and releases carbon dioxide into the atmosphere. The ash generated from a volcano can

also block sunlight from reaching Earth's surface, resulting in a decrease in the amount of photosynthesis taking place. These two effects combined will both decrease the amount of carbon being removed from the atmosphere and increase the amount being returned, resulting in a net increase in the amount of carbon in the atmosphere.

Worksheet

1. Write down the chemical formula for photosynthesis (in either words or formulas). _____

2. Write down the chemical formula for respiration (in either words or formulas). _____

3. Explain the importance of decomposers in the carbon cycle. _____

4. What three elements are carbohydrates made from? _____

5. Explain how deforestation, fire, and combustion of fossil fuels disrupt the balance between photosynthesis and respiration. _____

6. What are some of the obstacles that stand in the way of reducing human disruption of the carbon cycle? _____

7. Some Canadians are not concerned about global warming. How would you respond to someone who thinks global warming would be great because it would make our winters shorter and not as cold? _____