CYCLES

Biochemists are scientists who study the type of chemical compounds that are found in living things. They study the interaction of these compounds in an attempt to understand how life works at the chemical level. The work of biochemists has lead to the realization that living organisms are composed of some of the same elements that are found in the air, water and soil. Following many years of analysis on many different organisms, biochemists have been able to describe the types of elements found in plant and animal tissues.

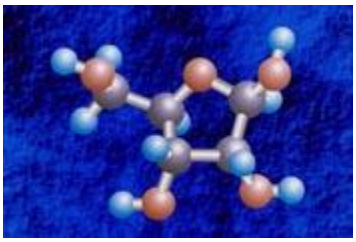
Although each organism is different in terms of the relative amounts of each type of element, the types of elements present are the same. Although there are 92 elements know to occur naturally on Earth, fewer than 20 elements are presently known to occur in the tissues of living things. Only 6 elements make up 99.2% (rounded to 3 significant digits) of human or pumpkin tissues. The table below compares the relative abundance (percentage by weight) of a few selected elements found in the Earth's crust, human, and pumpkin.

Element Name (Symbol)	Earth % weight	Human % weight	Pumpkin % weight
Oxygen (O)	46.6	65	85
Carbon (C)	0.19	18	3.3
Hydrogen (H)	trace	10	10.7
Nitrogen (N)	trace	3	0.16
Calcium (Ca)	3.6	2.0	0.02
Phosphorus (P)	trace	1.2	0.05
Potassium (K)	2.6	0.20	0.34
Sulfur (S)	trace	0.25	<0.05
Sodium (Na)	2.8	0.1	0.001
Magnesium (Mg)	2.1	0.05	0.01
Chlorine (Cl)	trace	0.15	<0.05
Iron (Fe)	5.0	trace	0.008
Copper (Cu)	trace	trace	0.0001
Iodine (I)	trace	trace	<0.05
Silicon (Si)	27.7	trace	trace
Zinc (Zn)	trace	trace	0.0002
Aluminum (Al)	8.1	trace	trace

others	trace	trace	trace

As you can see from the table, oxygen, carbon, hydrogen and nitrogen make up the vast majority of living tissue. These four elements are recycled between living organisms and the soil, water and atmosphere of the Earth.

These elements are first taken up by plants, some oxygen is released to the atmosphere as a product of photosynthesis, but the rest is converted into food, passed through the food web as they pass through plants, consumers, and finally decomposers such as fungi and bacteria, and then returned to the environment in a continuous recycling of materials. If recycling of these materials did not occur, life could not exist.



The continuation of life depends on the continued recycling of the materials that make up the food that passed through the ecosystem. Some of these elements (carbon, oxygen, sulfur, nitrogen) are found in gaseous forms and their cycles involve the atmosphere. As a result they have a global nature. One should also be aware that some of the elements may have a short term cycle such as when carbon is transferred from animals to plants in the form of carbon dioxide and a long term cycle such as the transfer of carbon from a fossil fuel to a plant following combustion.

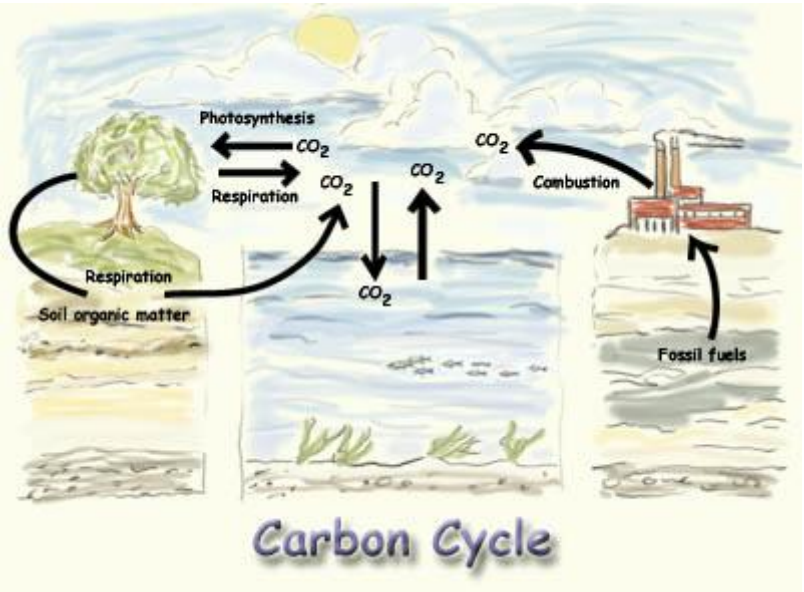
The elements are cycled between the living organisms and the environment (both long and short term). It is a combination of biological and geological processes that drives chemical recycling.

Biological processes include:

- respiration,
- decomposition,
- excretion,
- photosynthesis,
- and assimilation.

Geological processes involve fossilization, erosion, combustion of fossil fuels (peat, oil, coal), weathering, and formation of sedimentary rock.

Carbon Cycle



Plants extract carbon dioxide and water from their environment. They use the energy they capture from the sun to carry on a process known as **photosynthesis** which converts the atoms in the carbon dioxide and water into sugar and oxygen.

$$6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_6$$

The oxygen, released as a byproduct of photosynthesis, generally passes into the atmosphere. The sugar (known as glucose) serves a food for all consumers in the ecosystem. The consumers carry on a metabolic process known as **cellular respiration**. During cellular respiration, oxygen is taken in from the atmosphere and used to break down the sugar resulting in a release of energy and the molecular products, carbon dioxide and water.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$$

What do you notice about these two reactions?

As you can see from the equations, **photosynthesis** and **cellular respiration** are complementary processes. Provided these processes occur in balance, the amount of carbon dioxide (about 0.023% of the air) and oxygen (about 21% of the air) are maintained in equilibrium. This balance is called the **carbon-hydrogen-oxygen cycle** (or simply **carbon cycle** for short).

In modern times (past 200 years) people have discovered these fossil fuel deposits and have used them to supply our energy needs. Humans have also affected the carbon cycle by cutting down forests. As a result of human activity, the amount of carbon dioxide is being produced at a faster rate than nature can recycle it. As a result of this imbalance, the amount of carbon dioxide in the atmosphere is increasing. As a result the earth is presently undergoing an **enhanced greenhouse effect** in which the atmosphere is gradually heating up. The gradual rise in temperature is predicted to have a disastrous effect on world biomes. If the rise in temperature occurs too fast for organisms to adapt, widespread extinction of plants and animals may be the result. Extinction events have occurred in past history, but never the result of human influence. We are the only species that can do something about the problems we have created.