Ecology: 2.1 Cycling of Matter in Ecosystems

Lesson 11

Text Book Reference: Page 50 - 51

The_____ is the source of energy for all ecosystems.

_____, (or autotrophs) include plant life, aquatic or terrestrial _____are either herbivores, carnivores or omnivores; whilst_____ in an ecosystem include bacteria, fungi, vultures: these return nutrients to the ecosystem.

Chemical elements are recycled in an ecosystem as the biotic components die and decompose.

If a balance between the biotic components and abiotic components is established then the ecosystem can attain a state of balance, i.e., a **dynamic equilibrium**.

Living matter is continuously recycled and all life is dependent on the recycling of nutrients.

[Definition: A **nutrient** is the basic raw material from which organisms manufacture everything needed to grow and carry out their life functions]

Organisms obtain necessary nutrients from compounds they absorb from their environment. If nutrients were not recycled, they would become entirely used up and life on Earth would cease to exist.

Several cycles contribute to the nutrient cycle in nature – *the carbon and nitrogen cycles, the water and the phosphorus cycles* – to provide nutrients for plant and animal growth.
Each of these nutrients circulate through living things into the abiotic environment and then back through a living system again.
The nutrient has therefore made a complete cycle through the environment.

Organic compounds contain C, H, and often O, N, S, P.

Organic chemistry is the study of carbon compounds.
Organic compounds result from the sharing of electrons to form _____bonds.

The cycling of organic compounds involves breaking down these covalent bonds (single, double, triple) to release energy and smaller compounds; and the building up new bonds during synthesis reactions.
The amount of energy that can be stored in organic molecules depends on the strength and types of bonds in the organic molecules.

Through a series if chemical reactions, the carbon is exchanged between autotrophs, heterotrophs, and the abiotic environment.

Homework:
Read page 50 - 51
Answer Understanding Concepts, Page 51 # 2,4,5

Photosynthesis and Cellular Respiration

These two processes are important in the carbon cycle.

The carbon atom is central to the existence of life, found mostly in organic compounds.

But inorganic carbon in the form of CO_2 is needed for photosynthesis, converting the CO_2 into carbohydrates:

$$6\ CO_2 + 6\ H_2O + \text{sun light energy} \xrightarrow{\text{Chlorophyll}} C_6H_{12}O_6 + 6\ O_2$$

Living things, including plants break down these complex carbon compounds, e.g. carbohydrates — using oxygen, releasing carbon dioxide and energy back into the environment — this process is known as **Cellular Respiration:**

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

The waste products of cellular respiration, carbon dioxide is used as a reactant in photosynthesis.

THE CARBON CYCLE

Text Reference, Section 2.5, page 62-65

All living things need carbon. It is needed for proteins, fats and other substances that make up living things. The carbon comes from carbon dioxide.

The availability of carbon to form CO_2 depends on the complex inter-relationships known as the **carbon cycle.**

Inorganic carbon can be found in 3 main storage areas:

(1) the atmosphere
(2) the oceans and
(3) Earth's crust

The atmosphere contains the smallest reservoir of carbon – only ~ 0.03 % CO_2, although this is most easily accessed by land plants, it is a limiting factor in the rate of photosynthesis.

Most of the atmospheric CO_2 results from the respiration of plants, animals, and decomposers or from the burning of fossil fuels.

Fossil fuel carbon has been stored for many years in deposits of peat, coal, natural gas, or petroleum; these were formed by the death and compression of organic materials from prehistoric plants and animals.

Aquatic plants, e.g., algae, can obtain CO_2 more easily then land plants, even though the concentration of CO_2 in water is the same as in the atmosphere.

However, the CO_2 also reacts with water to form carbonic acid, $H_2CO_{3\,(aq)}$, thus allowing more CO_2 to dissolve (concentration of CO_2 and H_2CO_3 in water is ~ 100 - 200 times greater than the concentration in air).

Aquatic plants are, therefore more efficient in carrying on photosynthesis than terrestrial plants.

The carbonate ion in water combines with calcium to form calcium carbonate, $CaCO_3$, used to make shells, and other hard structures in living things.

Limestone, $CaCO_3$ is shells and bones of living things – however it takes millions of years to break these rocks down to release CO_2.

Whether in an aquatic or terrestrial environment, plants need carbon to make organic compounds, and these compounds maintain life as we know it — through the carbon cycle.

Deforestation and burning of fossil fuels interfere with the carbon cycle – resulting in the release of greater amounts of CO_2 into the atmosphere than can be absorbed by plant matter for photosynthesis, hence creating an imbalance of carbon in the atmosphere.

Excessive CO_2 in the atmosphere traps heat energy from the sun in Earth's atmosphere and gradually heats Earths resulting in the effect known as: Global Warming.

Assignment
(1) Video: Carbon Cycle Worksheet
(2) Read page 62-65
(3) Answer page 65, Understanding Concepts # 1, 4, 5, 6
(4) Worksheet: Carbon Cycle