DIRECTION

ENVIRONMENT AND ECOLOGY

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DIRECTION

INTRODUCTION TO ENVIRONMENT

Our environment provides us with a variety of goods and services necessary for our day to day lives. These **natural resources** include, air, water, soil, minerals, along with the climate and solar energy, which form the non-living or **'abiotic'** part of nature. The **'biotic'** or living parts of nature consists of plants and animals, including microbes. Plants and animals can only survive as communities of different organisms, all closely linked to each in their own **habitat**, and equiring specific abiotic conditions. Thus, forests, grasslands, deserts, mountains, rivers, lakes and the marine environment all form habitats for specialised communities of plants and animals to live in. Interactions between the abiotic aspects of nature and specific living organisms together form **ecosystems** of various types. Many of these living organisms are used as our food resources. Others are linked to our food less directly, such as pollinators and dispersers of plants, soil animals like worms, which recycle nutrients for plant growth, and fungi and termites that break up dead plant material so that micro-organisms can act on the detritus to reform soil nutrients.

Earth's Resources and Man: The resources on which mankind is dependent are provided by various sources or 'spheres'.

1) Atmosphere

• Oxygen for human respiration (metabolic requirements).

• Oxygen for wild fauna in natural ecosystems and domestic animals used by man as food.

• Oxygen as a part of carbon dioxide, used for the growth of plants (in turn are used by man).

The atmosphere forms a protective shell over the earth. The lowest layer, the troposphere, the only part warm enough for us to survive in, is only 12 kilometers thick. The stratosphere is 50 kilometers thick and contains a layer of sulphates which is important for the formation of rain. It also contains a layer of ozone, which absorbs ultra-violet light known to cause cancer and without which, no life could exist on earth. The atmosphere is not uniformly warmed by the sun. This leads to air flows and variations in climate, temperature and rainfall in different parts of the earth. It is a complex dynamic system. If its nature is disrupted it affects all mankind. Most air pollutants have both global and regional effects.

Living creatures cannot survive without air even for a span of a few minutes. To continue to support life, air must be kept clean. Major pollutants of air are created by industrial units that release various gases such as carbon dioxide, carbon monoxide and toxic fumes into the air. Air is also polluted by burning fossil fuels. The buildup of carbon dioxide which is known as 'greenhouse effect' in the atmosphere is leading to current global warming. The growing number of scooters, motorcycles, cars, buses and trucks which run on fossil fuel (petrol and diesel) is a major cause of air pollution in cities and along highways. Air pollution leads to acute and chronic respiratory diseases such as various lung infections, asthma and even cancer.

2) Hydrosphere

• Clean water for drinking (a metabolic requirement
for living processes).
• Water for washing and cooking.
• Water used in agriculture and industry.
• Food resources from the sea, including fish, crustacea, sea weed, etc.
• Food from fresh water sources, including fish, crustacea and aquatic plants.
• Water flowing down from mountain ranges harnessed to generate electricity in hydroelectric projects.

The hydrosphere covers three quarters of the earth's surface. A major part of the hydrosphere is the marine ecosystem in the ocean, while only a small part occurs in fresh water. Fresh water in rivers, lakes and glaciers, is perpetually being renewed by a process of evaporation and rainfall. Some of this fresh water lies in underground aquifers. Human activities such as deforestation create serious changes in the hydrosphere. Once land is denuded of vegetation, the rain erodes the soil which is washed into the sea. Chemicals from industry and sewage find their way into rivers and into the sea. Water pollution thus threatens the health of communities as all our lives depend on the availability of clean water. This once plentiful resource is now becoming rare and expensive due to pollution.

3) Lithosphere

• Soil, the basis for agriculture to provide us with food.
• Stone, sand and gravel, used for construction.
• Micronutrients in soil, essential for plant growth.

• Microscopic flora, small soil fauna and fungi in soil, important living organisms of the lithosphere, which break down plant litter as well as animal wastes to provide nutrients for plants.
• A large number of minerals on which our industries are based.
• Oil, coal and gas, extracted from underground sources. It provides power for vehicles, agricultural machinery, industry, and for our homes.

The lithosphere began as a hot ball of matter which formed the earth about 4.6 billion years ago. About 3.2 billion years ago, the earth cooled down considerably and a very special event took place - life began on our planet. The crust of the earth is 6 or 7 kilometers thick and lies under the continents. Of the 92 elements in the lithosphere only eight are common constituents of crustal rocks. Of these constituents, 47% is oxygen, 28% is silicon, 8% is aluminium, 5% is iron, while sodium, magnesium, potassium and calcium constitute 4% each. Together, these elements form about 200 common mineral compounds. Rocks, when broken down, form soil on which man is dependent for his agriculture. Their minerals are also the raw material used in various industries

4) Biosphere In simpler terms, biosphere refers to the narrow zone of the earth in which all life forms exist. Do you know why life becomes possible in this zone? It is because this is the zone in which all the three essentials things which are required for sustenance of life are found in a right mixture. They are land (lithosphere), air (atmosphere) and water (hydrosphere). In other words, this narrow zone is a place where lithosphere, atmosphere and hydrosphere meet .We must appreciate that how narrow this zone is? It extends vertically into the atmosphere to about 10km, downward into the ocean to depths of about 10.4 km and into about 27,000 ft of the earth's surface where maximum living organism have been found. There are some life forms which are found in extreme conditions. Two examples of this type are algae and thermophillic. Algae which is supposed to be one of the earliest forms of life can exist even in the most hostile environment such as frozen Antarctica. On the other extreme side, thermophillic (heat loving) bacteria usually inhabit deep sea volcanic vents having a temperature of more than 3000C. In fact, these bacteria can not survive in a temperature below boiling point. The situation was not like this when the life form began. About 700 million years ago, it is believed to have been only a narrow discontinuous land encompassing only shallow parts of the oceans. As per the trend of expansion of area in terms of the availability of life form, it can be predicated that may be after a few million years, the

expanse of the biosphere gets extended beyond the upper troposphere. This shows that biosphere has been evolving over the time. Till now we have discussed about the vertical expansion, but horizontally the biosphere covers the entire globe, though the life may not be possible in some of the hottest and the coldest parts. However, most living things are confined to a narrow band which permits the capture of solar energy through the process of photosynthesis, which is essential for any organic life. This narrow region extends from about 180-200 feet below sea level to the highest value of snowline in Tropical and sub-tropical mountain ranges (say 6,550M above sea levels). When it extends beyond this line, life forms become very limited

Within this framework, those characterized by broadly similar geography and climate, as well as communities of plant and animal life can be divided for convenience into different bio geographical realms.

These occur on different continents. Within these, smaller bio geographical units can be identified on the basis of structural differences and functional aspects into distinctive recognizable ecosystems, which give a distinctive character to a landscape or waterscape. Their easily visible and identifiable characteristics can be described at different scales such as those of a country, a state, a district or even an individual valley, hill range, river or lake.

The simplest of these ecosystems to understand is a pond. It can be used as a model to understand the nature of any other ecosystem and to appreciate the changes over time that are seen in any ecosystem. The structural features of a pond include its size, depth and the quality of its water. The periphery, the shallow part and the deep part of the pond, each provide specific conditions for different plant and animal communities. Functionally, a variety of cycles such as the amount of water within the pond at different times of the year, the quantity of nutrients flowing into the pond from the surrounding terrestrial ecosystem, all affect the 'nature' of the pond.

The ecosystem functions through several biogeochemical cycles and energy transfer mechanisms. Both these aspects of the ecosystem interact with each other through several functional aspects to form Nature's ecosystems. Plants, herbivores and carnivores can be seen to form food chains. All these chains are joined together to form a 'web of life' on which man depends. Each of these use energy that comes from the sun and powers the ecosystem.

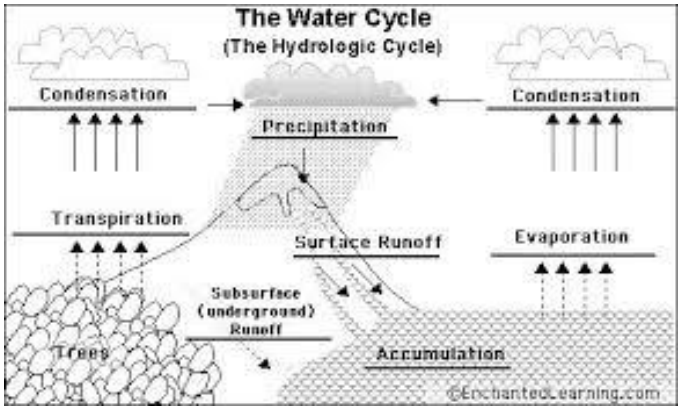
ENERGY FLOW IN THE ECOSYSTEM

Every ecosystem has several interrelated mechanisms that affect human life. These are the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle. While every ecosystem is controlled by these cycles, in each ecosystem its abiotic and biotic features are distinct from each other.

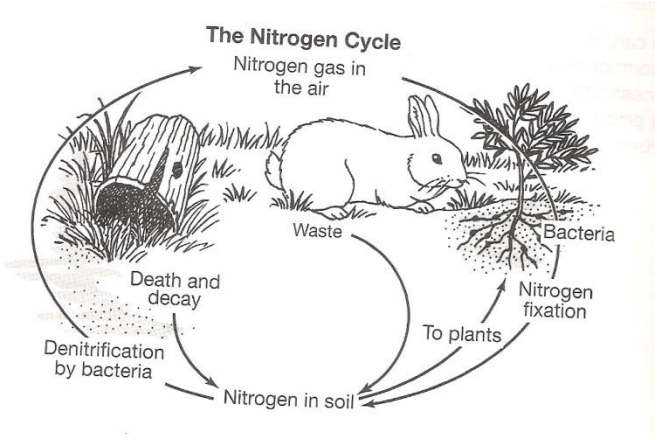
All the functions of the ecosystem are in some way related to the growth and regeneration of its plant and animal species. These linked processes can be depicted as the various cycles. These processes depend on energy from sunlight. During photosynthesis carbon dioxide is taken up by plants and oxygen is released. Animals depend on this oxygen for their respiration.

The water cycle depends on the rainfall, which is necessary for plants and animals to live. The energy cycle recycles nutrients into the soil on which plant life grows. Our own lives are closely linked to the proper functioning of these cycles of life. If human activities go on altering them, humanity cannot survive on our earth.

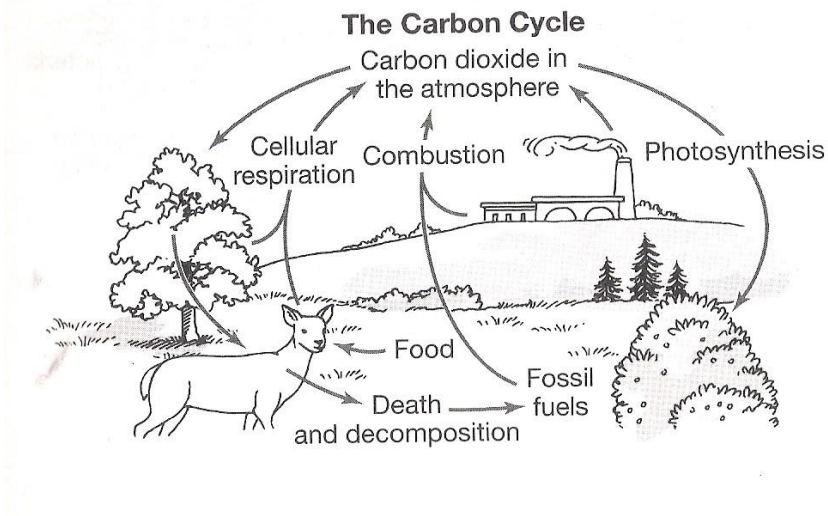
1. **The Hydrological Cycle** This cycle helps in exchange of water between air, land, sea, living plants and animals. Solar energy is used to drive the hydrological cycle. Massive evaporation of water from the oceans, cloud formation and rainfall gives us our supply and reserves of fresh water. At sub-zero temperature, rainwater freezes into snow and in presence of strong wind forms hail. Water as rain, snow and hail is precipitated on land and water surfaces. On land surface water seeps into the soil and is stored as ground water. The natural water level or water table exists below the ground. The water table is supported by the underlying clay and rock strata. Ground water does not remain static but moves in various directions. It moves up through capillary action and reaches soil surfaces where it is drawn by plant roots.



2. **The Nitrogen Cycle** Nitrogen and its compounds are essential for life processes in the biosphere. There is continuous exchange of nitrogen within the ecosystem operating the nitrogen cycle. Proteins produced by plants and animals in their metabolic processes are organic compounds of nitrogen. The major load of nitrogenous organic residue in soil originates from death and decay of plants and excreta of animals. These organic residues in soil are taken up by various soil micro-organisms who break down soil nitrate into nitrogen by denitrification process while others transform nitrogen into soluble nitrogen compounds.



3. **The Carbon Cycle** The carbon cycle is a very important chemical cycle. The atmosphere is the minor reservoir of carbon. Hydrosphere is the major reservoir which contains approximately 50 times more as that of atmosphere. It is stored as bicarbonate mineral deposit on the ocean floor. The later regulates the carbon dioxide level in the atmosphere. The cycle operates in the form of carbon dioxide exchanging among the atmosphere, biosphere and the oceans.

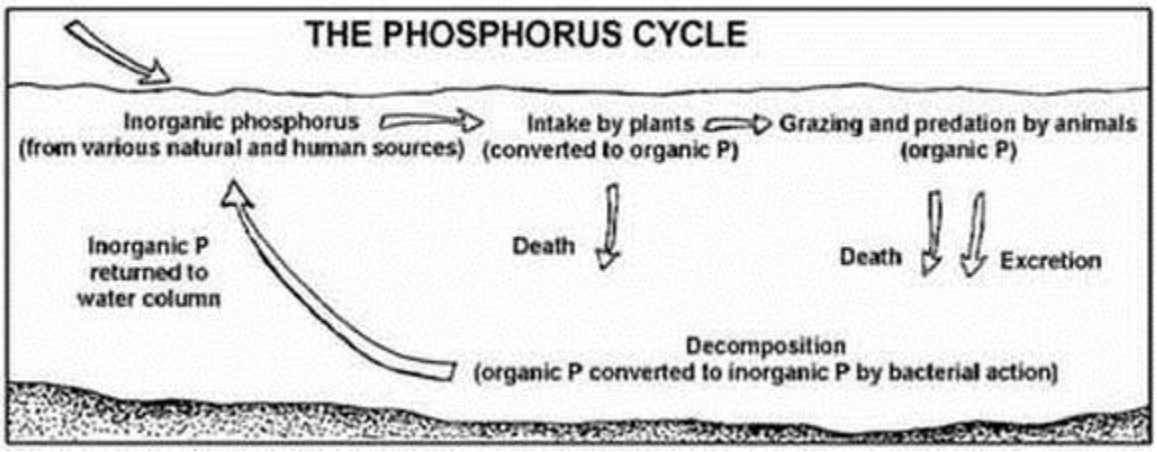


The Phosphorus Cycle – The phosphorus cycle is representative of the cycles for all the mineral nutrients – those required elements that have their origin in rock and soil minerals. We focus on phosphorus for both simplicity and because its shortage tends to be a limiting factor in a number of ecosystems.

Phosphorus exists in various rock and soil minerals as the inorganic ion phosphate (PO3-4). As rock gradually breaks down, phosphate and other ions are released. Phosphate dissolves in water, but does not enter the air. Plants absorb phosphate from the soil or from a water solution, and when it is bonded into organic compounds by the plant, it is referred to as **organic phosphate**. Moving through food chains, organic phosphate is transferred from producers to the rest of the ecosystem. As with carbon, at each step there is a high likelihood that the organic compounds containing phosphate will be broken down in cell respiration, releasing inorganic phosphate in urine or other waste. The phosphate may then be reabsorbed by plants to start another cycle.

There is an important difference between the carbon cycle and the phosphorus cycle. No matter where carbon dioxide is released, it will mix into and maintain the concentration of carbon dioxide in the air. Phosphate, however, which does not have a gas phase, is recycled only if the wastes containing it are deposited on the soil from which it came. The same holds true for other mineral nutrients. Of course, in natural ecosystems wastes (urine, detritus) are deposited in the same area so that recycling occurs efficiently. Humans have been extremely prone to interrupt this cycle, however.

A very serious case of humans disrupting the phosphorus cycle is the cutting of tropical rain forests. This type of ecosystem is supported by a virtually 100 percent-efficient recycling of nutrients. There are little or no reserves of nutrients in the soil. When the forest is cut and burned, the nutrients that were stored in the organisms and detritus are readily washed away by the heavy rains, and the land is thus rendered unproductive. Another human effect on the cycle is that much phosphate from agricultural crop lands makes its way into waterways – either directly, in runoff from the crop lands, or indirectly, in sewage effluents. Because there is essentially no return of phosphate from water to soil, this addition results in over-fertilization of bodies of water, which in turn leads to a severe pollution problem known as eutrophication. Meanwhile, the lost phosphorus must be replaced on the crop lands by mining phosphate rock – a process that will ultimately result in depletion of the phosphate.



Energy Cycle

The energy cycle is based on the flow of energy through the ecosystem. Energy from sunlight is converted by plants themselves into growing new plant material which includes leaves, flowers, fruit, branches, trunks and roots of plants.

Since plants can grow by converting the sun's energy directly into their tissues, they are known as producers in the ecosystem. The plants are used by herbivorous animals as food, which gives them energy. A large part of this energy is used up for day to day functions of these animals such as breathing, digesting food, supporting growth of tissues, maintaining blood flow and body temperature. Energy is also used for activities such as looking for food, finding shelter, breeding and bringing up young ones. The

carnivores in turn depend on herbivorous animals on which they feed. Thus the different plant and animal species are linked to one another through food chains. Each food chain has three or four links. However as each plant or animal can be linked to several other plants or animals through many different linkages, these inter-linked chains can be depicted as a complex food web. This is thus called the 'web of life' that shows that there are thousands of interrelationships in nature.

The energy in the ecosystem can be depicted in the form of a food pyramid or energy pyramid. The food pyramid has a large base of plants called 'producers'. The pyramid has a narrower middle section that depicts the number and biomass of herbivorous animals, which are called 'first order consumers'. The apex depicts the small biomass of carnivorous animals called 'second order consumers'. Man is one of the animals at the apex of the pyramid. Thus to support mankind, there must be a large base of herbivorous animals and an even greater quantity of plant material.

When plants and animals die, this material is returned to the soil after being broken down into simpler substances by decomposers such as insects, worms, bacteria and fungi so that plants can absorb the nutrients through their roots. Animals excrete waste products after digesting food, which goes back to the soil. This links the energy cycle to the Nitrogen cycle.

Integration of cycles in Nature

These cycles are a part of global life processes. These bio-geo-chemical cycles have specific features in each of the ecosystems. These cycles are however linked to those of adjacent ecosystems. Their characteristics are specific to the plant and animal communities in the region. This is related to the geographical features of the area, the climate and the chemical composition of the soil. Together the cycles are responsible for maintaining life on earth. If mankind disturbs these cycles beyond the limits that nature can sustain, they will eventually break down and lead to a degraded earth on which man will not be able to survive.

Ecology as a discipline is focused on studying the interactions between an organism of some kind and its environment. In ecology, 'niche' refers to the role an organism or species play in its ecosystem. An organisms niches includes everything affected by the organism denying its lifetime.. Ecology has been variously defined by other investigators as "Scientific natural history", "the study of biotic communities, or "the science of

community population", probably the most comprehensive definition is the simple one most offers given' a study of animal and plants in their relations to eachother and to their environment.

Ecology may be studied with particular reference to animals or to plants, hence animal ecology an plant ecology. Animal ecology, however, cannot be adequately understood except against a considerable background of plant ecology.Ecology is basically concerned with four levels of biological organisation – organisms, populations, communities and biomes.

Ecology at the organismic level is essentially physiological ecology which tries to understand how different organisms are adapted to their environments in terms of not only survival but also reproduction. *The key elements that lead to much variation in the physical and chemical conditions of different habitats* are temperature, water, light and soil (abiotic) and also – pathogens, parasites, predators and competitors – of the organism with which they interacts constantly(biotic components).