Unit 10

Ecological Principles

Unit Map

10.A The Environment

Ecology The term ecology was coined by Ernst Hackel. The ecology word is derived from Greek words oikos means household and *a logo means* study. Ecology is the branch of biology that deals with the interrelationship amongst organisms and interactions between organisms and their environment.

Environment The literal meaning of environment is surroundings. Environment comprises of all biotic and abiotic components that surrounds an organism and have an impact on its growth and development.

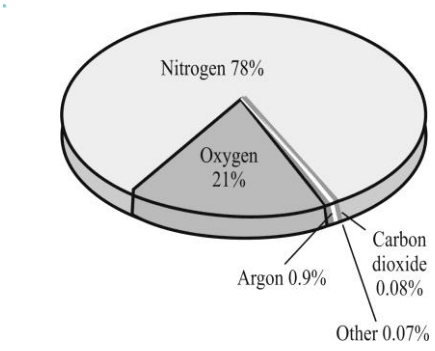
Environmental factors Environmental factors leads to direct or indirect changes in the form and functioning of organisms. There are mainly two types of environmental factors-Physical or abiotic factors and the living or biotic factors. The physical factors are mainly arranged in three groups

i. **Climatic**
ii. **Topographic**
iii. **Edaphic factors**

10.A.1 Physical environment/Abiotic environment

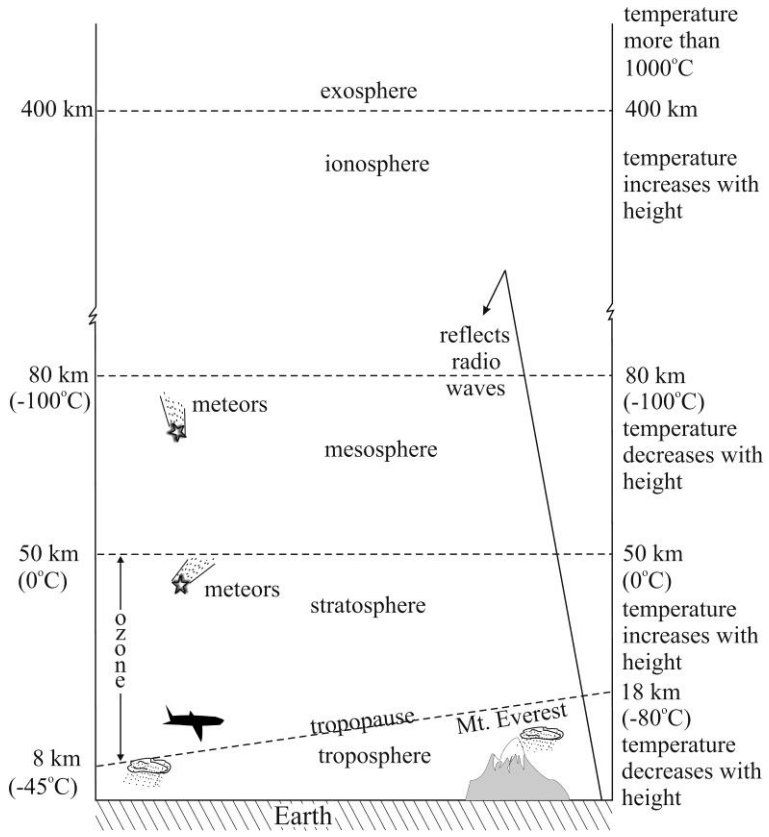
The physical environment includes the physical and chemical factors which make up an ecosystem. It includes factors like soil, air, water, atmosphere, humidity, rain, topographic factors and many more.

Atmosphere The gaseous envelope around the earth is known as atmosphere. It is comprised of various gases like nitrogen, oxygen, noble gases, carbon dioxide and various other gases. There are various layers of atmosphere like troposphere, stratosphere, mesosphere, ionosphere etc.



Layers of atmosphere

- **Troposphere** It is the lowest layer of atmosphere which extends from 8-18 km (8 Km near the poles, 18 Km near the equator) from the surface of earth and where all climatic changes and cloud formation takes place. In this layer dust particles and water vapors are present. There is a thin buffer zone which shows the transition between troposphere and stratosphere is called ***tropopause.*** Temperature in this layer decreases with increasing heights i.e. 1°C for 165 meters of ascent. It is defined as normal lapse rate. This layer contains dust particles and 90% of the earth's water vapor.
- **Stratosphere** This layer is present above the troposphere and extends from 8-18 to 30-50 km. This layer is comprised of very little water vapors, carbon dioxide, dust particles and air masses clouds are almost absent. There is presence of ozone layer in this layer, which is formed from oxygen due to intense solar radiations. This ozonosphere protects us from ultraviolet radiations as it absorbs them. There is transition layer between stratosphere and mesosphere called as ***stratopause.***
- **Mesosphere** This is the third layer over the stratosphere extending up to 30 Km. In this temperature decrease with height and reaches up to 100°C at the height of 80 Km.
- **Ionosphere** This layer is present above mesosphere and extends from 80-400 km height. In this layer atoms gets ionized and it protects earth surface from cosmic rays. This thin layer is responsible for absorbing most energetic photons from



the sun and reflects radio waves making radio communication possible.

- **Exosphere** The exosphere is the highest layer of the atmosphere. It extends from the top of the thermosphere up to 10,000 km (6,200 mi; 33,000,000 ft).

  This is the upper limit of our atmosphere. The atmosphere here merges into space in the extremely thin air. Air atoms and molecules are constantly escaping to space from the exosphere. In this region of the atmosphere, hydrogen and helium are the prime components and are only present at extremely low densities. This is the area where many satellites orbit the Earth. The exosphere contains free-moving particles that may migrate into and out of the magnetosphere or the solar wind.

➢ **Light**

Light is the primary source of energy for all living organisms. The visible range of light from 400-700 nm is actively used by plants for photosynthesis. Other than this light also includes ultraviolet light rays, infra red rays, cosmic rays etc. The factors like quality of light, intensity of light and the length of light period play an important part in an ecosystem. Different plants have different requirement of light this leads to stratification of an ecosystem like some plants grow well in bright light and are known as heliophytes whereas other plants require shady conditions for their growth and thus known as sciophytes. There are number of physiological processes of plants which are dependent upon light which include some of them explained below; ***photosynthesis, transpiration, seed germination, growth and flowering.***

- **Photosynthesis** Photosynthetically active radiation of light spectrum is 400-700 nm. Light plays important role in photosynthesis. Maximally plants absorb blue and red light for photosynthesis.
- **Photonasty and phototropism** The phenomenon of opening and closing of flowers of some plants is known as photonasty. There is another similar to it which is called as ***nyctinasty***, this is referred to folding of leaves in response to darkness. Phototropism is the directional movement of plants in response to light like the plant shoots bend towards the source of light this is known as ***positive phototropism***. These types of movements are observed in plants in response to light.
- **Photoperiodism and Phenology** It can be defined as the relative length of daylight and darkness that affects the physiology and behaviour of an organism. The length of the light period plays important role in an ecosystem. Plants can be divided into short day plants (Chrysanthemum), Long day plants (spinach), day neutral plants (Maize) depending upon length of the photoperiod to which they respond. Phenology is referred to the timing of seasonal activities of organisms and it is also usually controlled by photoperiodism like bird migration, hibernation, animal breeding, flowering, dormancy etc.
- **Transpiration** is the evaporation of water into the atmosphere from the leaves and stems of plants. Plants absorb soil water through their roots and this water can originate from deep in the soil. (For example, corn plants have roots that are 2.5 meters deep, while some desert plants have roots that extend 20 meters into the ground). Plants pump the water up from the soil to deliver nutrients to their leaves. This pumping is driven by the evaporation of water through small pores called ***"stomates",*** which are found on the undersides of leaves. Transpiration accounts for approximately 10% of all evaporating water. The remaining 90 percent is mainly supplied by evaporation from oceans, seas, and other bodies of water (lakes, rivers, streams).
- **Seed Germination** For non-dormant seeds, germination starts when a seed is provided with water as long as the

temperature is appropriate. The uptake of water by dry seed is called ***imbibition*** (imbibition means to drink: seeds imbibe water, you do not imbibe seeds). As seeds imbibe water, they expand and enzymes and food supplies become hydrated. Hydrated enzymes become active and the seed increase its metabolic activities to produce energy for the growth process. In addition, the water causes turgor pressure to increase in the cells and they are able to enlarge.

As you will see in the movies of germinating seeds, the first part of the seedling to emerge from the seed coat is the root (also called the ***radical***). The emergence of the root is typically used as the first indication that a seed is viable. Eventually the shoot will also expand and emerge from the seed.

If germination occurs in darkness, root growth slows after the shoot emerges and shoot elongation accelerates. This behavior increases the chance that the seedling will emerge from soil into the light where it will be able to obtain energy from sunlight by photosynthesis. Once a seedling emerges into the light, the plant undergoes dramatic changes such as turning green and producing leaves. This light-dependent developmental transformation is called ***photomorphogenesis.***

- **Growth and flowering** plants use light to do photosynthesis, which takes carbon dioxide and sunlight to produce sugar. If we keep a plant without sunlight it will not grow. So, light is necessary for growth of the plants. Without light plant cannot survive. They use a certain gas called ***carbon dioxide (CO_2)*** for food which is also what we release as waste from cellular respiration.

➢ **Temperature**

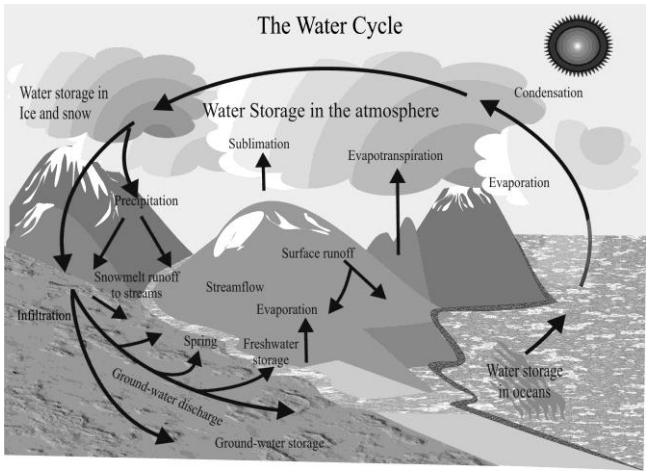
Different temperature zones depending upon different topography, vegetation, season, altitude, latitude influences activities of plants and other organisms. Depending upon different temperature zones organisms can be divided into categories like Stenothermal, Eurythermal. Stenothermal are the organisms which live in uniform temperature throughout year whereas eurythermal are the organisms which live in areas where there are different temperatures at different times of the year. Some of the effects of temperature on ecosystem are explained below

- **Thermoregulation and Homeostasis** According to the external temperature, the regulation of internal body temperature is known as ***thermoregulation.*** Animals are divided into two categories depending upon the response to external temperature-ectothermic and endothermic i.e., cold blooded animals and warm blooded animals respectively. Warm blooded animals are the animals that maintain a fixed body temperature despite changes in external environment whereas cold blooded or poikilothermal animal change their body temperature in response to external environment. Ectothermic animals undergo hibernation to protect themselves from extreme low temperatures and in extreme hot conditions they protect themselves by seeking shady places, formation of cysts, spores, winter eggs etc. Homeostasis is referred to the phenomenon of maintaining internal environment despite changes in the external environment.

➢ **Water**

Water is very essential part of life of all organisms and depending upon the availability of water the habitats of plant and animals vary. Nearly 71% of earth's surface is covered with water in the form of glaciers, water bodies, ice caps etc. About 97% of this proportion occurs in oceans and only 3% of this is fresh water. Depending upon water requirements plants can be classified as hydrophytes, xerophytes and mesophytes.

- **Hydrophytes** These are the plants, which grow in water like *Water lily, Apluda, Ranunculusscleratus*.
- **Mesophytes** These are the plants, which have average water requirements like roses and sweet peas.
- **Xerophytes** These are the plants, which grow in, dry conditions or water scarce conditions like cactus, succulents, Acacia, Tamarix, Casuarina. To survive in water scarce conditions these plants have some adaptations like-sunken stomata, small leaves or absence of leaves, thick cuticles, reversed stomatal rhythms etc.



➢ **Water cycle**

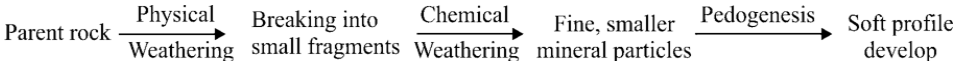
In water cycle there is recycling of water and this cycle is energized by solar energy. The main two processes involved are evaporation and condensation. Freshwater gets evaporated from sea water by sun rays and then bring back to the sea by condensation of water vapors in the form of rain. When rain falls some water percolates into the ground and saturates the earth surface. The top of the saturation layer is called as ***groundwater table***.

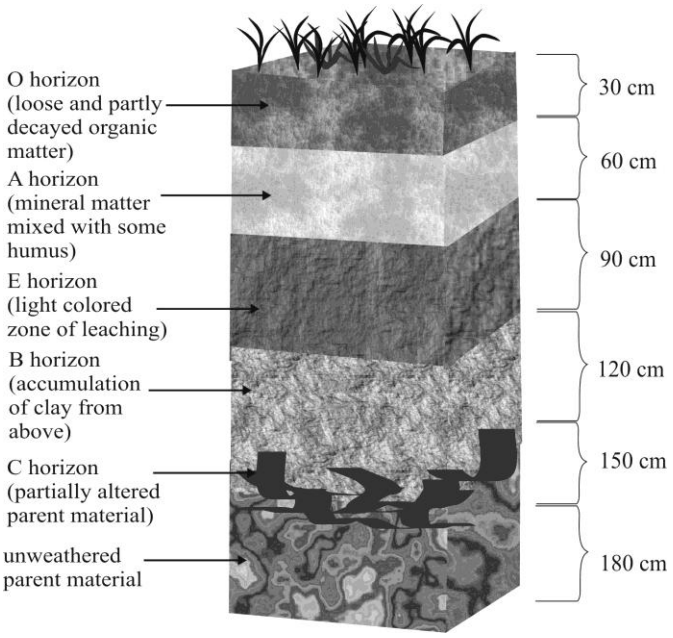
➢ **Wind**

Air currents arise due to uneven heating and rotation of earth. Wind carry water vapours which after condensation is recycled back to the surface of earth in the form of rain, snow and hail. Wind determines weather condition and thus affects plant and animal life directly as well as indirectly. Direct effects includes mechanical effects like leaf damage, deformation, lodging (bending of herbs and shrubs due to high speed of wind), dwarfing (permanent shortening of plant height), soil erosion, migration etc. Indirect effects include physiological effects like desiccation, salt spray which causes exosmosises and blocking of stomata, dwarfing etc.

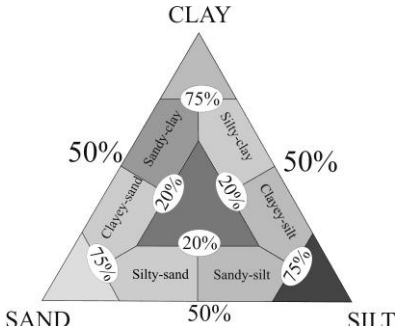
➢ **Soil**

Soil is formed by humification, eluviations and illuviation. The science which deals with the study of formation of soil is known as ***pedogenesis*** which is largely a biological process. Soil is composed of mainly five components-mineral matter (40%), organic matter (10%), soil moisture (25%), soil atmosphere (25%) and soil organisms. The quality of the soil depends upon the parent rock and the organic matter deposited over it.





- **Soil profile** Soil profile is referred to the presence of different soil layers in a vertical section one over the other with surface downward toward the parent rock. Soil profile includes different soil horizons; O, A, B, C, D.
- **Soil texture** is referred to the size of soil particles, proportion and arrangement of its constituents. There are mainly three types of soil textures-sandy, clay and loam (0.20-2.0 mm diameter). Clay soils are very suitable for plant growth as they have abundant capillary pores and high water holding capacity. Some of the negative points about this type of soil are that they are badly aerated and compact therefore difficult in ploughing. Sandy soils are well aerated, porous, loose and easy to cultivate but dry out quickly and contain few nutrients for growth. Loam soils have good characteristics of both sandy and clay soils like high water retention capacity, well aerated, sufficient amount of nutrient for growth and are easily cultivated.



- **Soil waters**

Soil water gets accumulated into soil due to rains and agricultural runoff. The water accumulated in the soil can be divided into three types, capillary water, hygroscopic water and gravitational water. Hygroscopic water is the water present as a thin film around each soil particle.

This water is absorbed by the soil particles and is not available for plants as it is firmly held by soil particles. Gravitational water is the water which percolates downwards through the soil under the force of gravity. Capillary water is the only water that is available to plant roots as it is present between spaces of soil particles.

- **Soil pH** The pH of soil has great influence on the growth and development of plants. The availability of certain minerals and biological activity of soil to a great extent depends upon the acidity and alkalinity of soil. Some plants grow best in acidic soils like ericas, ferns etc and some plants grow best in alkaline conditions like xerophytes.