ENVIRONMENT AND ECOLOGY

INTRODUCTION

The word 'environment' means surrounding in which organisms live. It is the sum total of conditions that surround us at a given point in time and space. The environment can be biotic (living) or abiotic (physical or non-living). It influences the growth and development of living forms. Environment regulates the life of the organisms including human beings. Human beings interact with the environment more vigorously than any other living beings. Ordinarily, environment refers to the materials and forces that surround the living organism. It provides us with all the resources for leading a comfortable life.

Components of Environment	
Abiotic	**Biotic**
Light	Human beings
Temperature	Animals
Soil	Green & Non-green Plants
Atmospheric gases	Decomposers
Weather	Parasites
	Bacteria
	Fungi
	Protozoa

Ecology may be defined as the scientific study of the relationship of living organisms with each other and with their environment. The term ecology was first coined in 1869 by the German biologist Ernst Haeckel. It has been derived from two Greek words, 'oikos', meaning home or estate and 'logos' meaning study. The emphasis is on relationships between organisms and the components of the environment namely abiotic (non-living) and biotic (living).

Environment is the surrounding in which the organisms live whereas the ecosystem involves the interaction between the environment and the organisms living in it.

LEVELS OF ECOLOGICAL ORGANIZATION

Individual

An individual is any living thing or organism. Normally, individuals do not breed with individuals from other groups. The individuals perform all of the life processes independently. For Example, The Tiger (Pantheratigris) is a type of an individual organism; The Royal Bengal Tiger (Pantheratigris) is a species of tiger among others like the Sumatran tiger. (Pantheratigrissumatrae) etc. Similarly, The Elephant is an Individual type of organism. Among them, the African elephant (Loxodonta Africana), Asian Elephant (Elephasmaximus) are different species.

Population

The population is a group of individuals belonging to the same species. They are found in a particular geographical area of varying scales and sizes. Every individual species is represented in populations. The populations of Royal Bengal Tiger can be seen in Sundarbans etc. whereas Sumatran tigers can be seen in Pacific islands of Sumatra.

Community

Community is an organized ecological unit in which organism interact through various associations such as predation, competition, mutualism and parasitism, linked to each other via feeding relationships and are adapted to the prevailing physical environmental surroundings. It is a naturally occurring assemblage of species population which occurred together in specific geographical space and time. These individuals interact with one of the same species as well as with the other species.

Types of Communities: On the basis of size and degree of relative independence, communities may be divided into two types:

• Major Communities: A major community is the smallest ecological unit which is able to sustain itself and is self-regulating. These are large sized and relatively independent of other communities. They depend only on the sun's energy from outside. A major community is a combination of floral community, faunal community and a microbial community. For Example, a pond, a forest, a grassland or lake.

• Minor Communities: Minor communities are smaller ecological units that are not individually self-sustaining and rely on interactions with other communities. They make up major communities and are dependent on neighboring communities.

Structure of a Community: Communities may be small, consisting of a limited number of species in a small space, or large, comprising several species populations in a large area. Community structure is the composition of a community, including the number of species in that community and their relative numbers. Different factors like climatic patterns, interactions between organisms, the density of species, the frequency of disturbances and abundance of species influence the structure of a community.

Characteristics of a Community: In a community, the number of the species and size of their population vary greatly. The environmental factors determine the characteristic of the community and its pattern. The features within communities are highly variable. Some of them are under:

• Dominance: At each trophic level, one or two species exert more dominance over the function and structure of the community. These dominant species impact on the population and activities of other organisms, thus affecting the nature of the community. The ecological dominants may change the abiotic conditions of a habitat over a period. However, all the species are important for the balanced functioning of the community. For example: In a forest, though a dominant tree species may control the availability of light to other plants, the temperature in the lower canopy, and the availability of nutrients to other organisms, their reproduction may depend on pollination by a rare insect.

• Interdependence: In a community, plants, animals and microbes have a fundamental dependence on at least one other, although most organisms will engage in multiple interactions. These interactions can be nutritional, reproductive or protective.

• Stratification: Communities usually display some form of stratification, by which the populations that make up the community are distributed into defined horizontal or vertical strata. Some organisms may occupy more than one stratum, moving between the layers often on a diurnal basis. For example, a bird that feeds on the forest floor during the day but roosts within the canopy.

• Diversity: It is the variation in the ecosystem of the region or over the whole planet. It considers both the number of species in the community and their relative abundance. Communities with high species diversity have been found to be comparatively more stable.

• Ecotone: Communities occur in a range of different sizes, and the boundaries of each are often not well defined. An ecotone is a transitional area between two biomes, where communities meet and integrate. Ecotones are considered areas of great environmental importance. As well as providing an area for a large number of species, they often experience influx from animals looking to nest or searching for food.

Ecosystem

An ecosystem is a community of plants and animals interacting with each other in a given area, and also with the abiotic components of the environment such as air, water, sun and soil. The ecosystem relates to the way that all these different organisms live and interact with each other. It is a place like a forest, Taiga, Grassland, desert, coral reefs, stillwater, or a river stream. (Note: Ecosystem has been dealt in detail in the next Chapter)

Biome

Biomes are very large ecological units characterized by a major vegetation type and associated fauna adapting to a specific climate zone. A Biome is not an ecosystem, but it can be seen as a form of a massive ecosystem. The boundaries and abundance of organisms in a biome is often defined by abiotic factors such as climate, relief, geology, soils and vegetation. Many units of an ecosystem may be found in one biome. Moreover, no two biomes are alike.

Biomes play a crucial role in sustaining life on earth. For example, the Aquatic biome is home to millions of fish species and the source of the water cycle. It also plays a very important role in climate formation. The terrestrial biomes provide foods, enrich the air with oxygen and absorb carbon dioxide and other bad gases from the air. They also help regulate climate

Classification of Biomes: There are five major categories of biomes on earth. In these five, there are many sub-biomes, under which are many more well-defined ecosystems.

• Desert Biomes: They are the Hot and Dry Deserts, Semi-Arid Deserts, Coastal Deserts and Cold Deserts.

• Aquatic Biomes: Aquatic biomes are grouped into two, Freshwater Biomes (lakes and ponds, rivers and streams, wetlands) and Marine Biomes (oceans, coral reefs and estuaries).

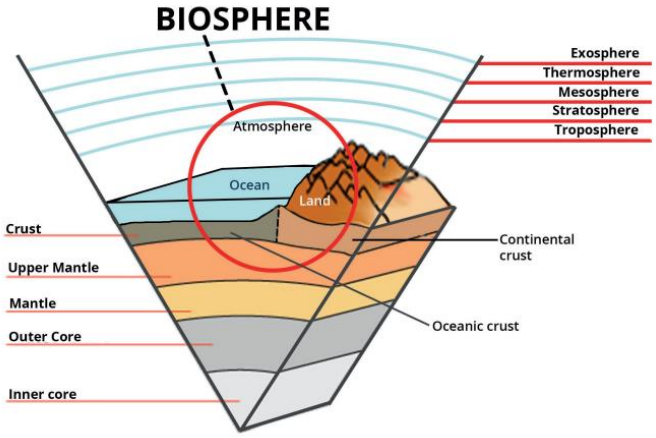
• Forest Biomes: There are three main biomes that makeup Forest Biomes. These are the Tropical Rainforest, Temperate and Boreal Forests (also called the Taiga).

• Grassland Biomes: There are two main types of grassland biomes: the Savanna Grasslands and the Temperate Grasslands.

• Tundra Biomes: There are two major tundra biomes— The Arctic Tundra and the Alpine Tundra.

Biosphere

The biosphere is made up of parts of the earth where life exists. It extends from the deepest root systems of trees to the dark environment of ocean trenches, to lush green rainforests and high mountaintops. The biosphere refers to the realm of living organisms and their interactions with the environment i.e. atmosphere, hydrosphere and lithosphere. It contains all life forms on earth. It is that part of the earth in which many smaller ecosystems exist and operate.



However, living organisms are mostly confined to the areas that receive solar radiation which includes the atmosphere, the land surface, upper layers of soil and the upper region of water bodies. In the ocean, the biosphere does not end where light ceases and goes a little further as gravity enables the energy flow to continue downward. Similar to the existence of underwater biosphere, it extends upwards in the atmosphere to a certain limit. On high mountains, like the Himalayas, the limit above which chlorophyll bearing plants cease to exist is around 6.2 km.

Division of Biosphere: The biosphere is made up of three parts, called the atmosphere hydrosphere, and lithosphere. They have been described below:

Atmosphere: The term 'atmosphere' refers to the layer of gases, commonly known as air, which surrounds the earth. It is one of the necessary conditions for the existence of life. It encompasses the earth from all sides and is held by the earth's gravity. The atmosphere protects us from harmful rays, regulates temperature between day and night and warms the surface of the earth to ensure that the earth remains habitable.

The atmosphere contains many gases including some pollutants and greenhouse gases. The most abundant gas in the atmosphere is nitrogen followed by oxygen and argon, an inert gas. Gases like carbon dioxide, nitrous oxides, methane, and ozone are trace gases that account for about a tenth of one percent of the atmosphere.

Composition of the Atmosphere	
Constituent	**Percentage (By Volume)**
Nitrogen	78.08
Oxygen	20.95
Argon	0.934
Carbon Dioxide	0.036
Neon	0.002
Helium	0.0005
Krypton	0.001
Xenon	0.00009
Hydrogen	0.00005

Structure of Atmosphere: The atmosphere consists of different layers with varying density and temperature. The different layers are troposphere, stratosphere, mesosphere, thermosphere and exosphere.

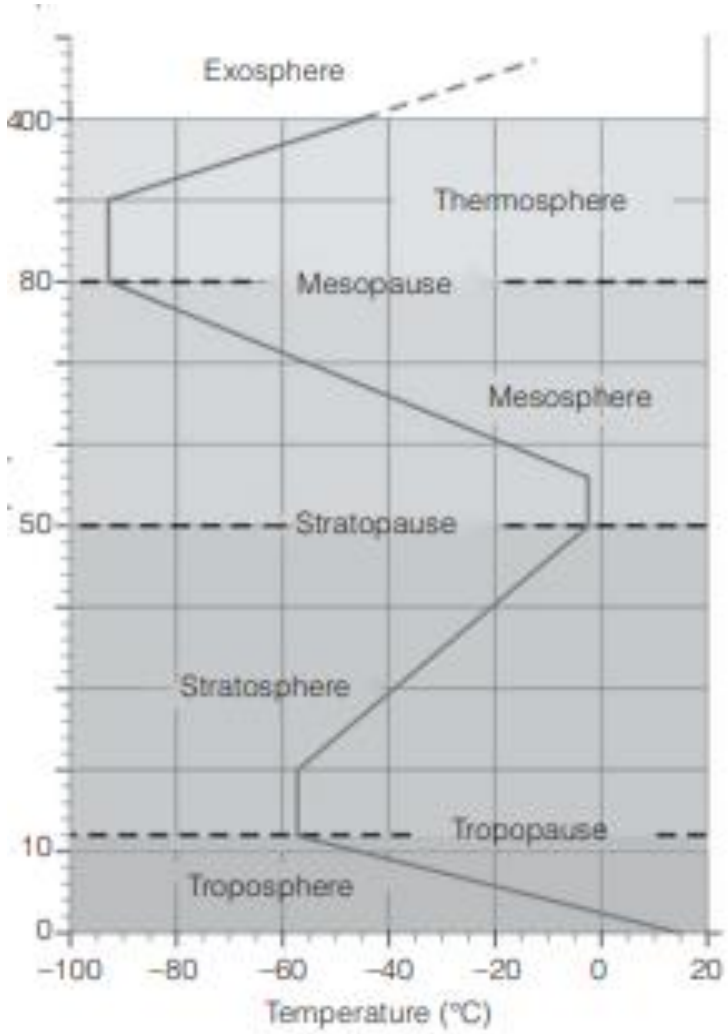
• Troposphere: The lowermost layer of the atmosphere is the 'Troposphere'. The layer contains dust particles and water vapour. All climate and weather changes take place in this region.

• Stratosphere: The Stratosphere lies above the tropopause and extends up to a height of 50 km. Ozone layer lies in the stratosphere which shields us from harmful ultraviolet radiations.

• Mesosphere: Above stratosphere, the mesosphere extends up to a height of 80 km. The temperature, in this layer, starts decreasing with increase in altitude and reaches up to minus 100°C at the height of 80 km.

• Thermosphere: The thermosphere lies above the mesopause and is a region in which temperatures again increase with height. This temperature increase is caused by the absorption of energetic ultraviolet and X-Ray radiation from the sun. This region of the atmosphere above about 80 km is also called the "ionosphere", since the energetic solar radiation knocks electrons off molecules and atoms, turning them into "ions" with a positive charge.

• Exosphere: The exosphere is the uppermost region of Earth's atmosphere as it gradually fades into the vacuum of space. The exosphere is the very edge of our atmosphere. This layer separates the rest of the atmosphere from outer space. The exosphere has gases like hydrogen and helium, but they are very spread out.



Hydrosphere: Water is a vital component for all forms of life that exist on the surface of the earth. Fortunately, the Earth has plenty of water on its surface, allowing our existence without which we cannot survive. This water component of the earth is called hydrosphere. The Hydrosphere includes the oceans, seas, lakes, ponds, rivers and streams. It covers about 70% of the surface of the Earth.

The hydrosphere, like the atmosphere, is always in motion known as the Hydrological Cycle. These motions can be observed at two different scales. At the small scale, the motion of rivers and streams can be easily seen, while the motion of the water within lakes and ponds is less obvious.

The characteristics of the ocean which affects the motion of the currents are its

• Temperature: Warm water is less dense or lighter and therefore tends to move up toward the surface, while colder water is denser or heavier and therefore tends to sink towards the bottom.

• Salinity: Salty water is also denser or heavier and thus tends to sink, while fresh or less salty water is less dense or lighter and thus tends to rise toward the surface.

• Winds: The energy in the wind gets transferred to the ocean at the ocean surface affecting the motion of the water there. The effect of wind is largest at the ocean surface.

• Gravity: The earth's own gravity combined with the Sun's and the Moon's affect the motion of the Ocean currents.

Lithosphere: Lithosphere is the rigid outermost shell or the hard top layer of the earth. It is made up of rocks and minerals and covered by a thin layer of soil. It is an irregular surface with various landforms such as mountains, plateaus, plains and valleys. The lithosphere is broken up into large and small plates.

These plates move relative to each other, typically at rates of 5 to 10 cm per year and interact along their boundaries, where they converge, diverge, or slip past one another. Such interactions lead to most of Earth's seismic and volcanic activity. Plate motions cause mountain building when plates push together or converge, and also leads the continents and oceans to form fractures, where plates pull apart or diverge and result in different landforms, are found over the continents and also on the ocean floors.

The lithosphere is of two types- Oceanic Lithosphere (associated with oceanic crust) and Continental Lithosphere (associated with continental crust).

OBJECTIVE OF ECOLOGICAL STUDY

The importance of ecology lies in the comprehensive understanding of its objectives. The important concepts discussed below throw light on various aspects of ecology:

(i) The local and geographical distribution and abundance of organisms (habitat niche, community, bio-geography).

(ii) Temporal changes in the occurrence, abundance and ac-tivities of organisms (seasonal, annual, successional, geo-logical).

(iii) The inter-relationship between organism in population and communities (population ecology).

(iv) The structural adaptations and functional adjustment of organisms to their physical environment.

(v) The behaviour of organism under natural conditions (ethology).

(vi) The evolutionary development of all these inter-relations (evolutionary ecology).

(vii) The biological productivity of nature and its relations with mankind.

(viii) The development of mathematical models to relate in-teraction of parameters and predict effects (systems analysis).

(ix) The conservation and management of natural resources and pollution (applied ecology).

ASPECTS OF ECOLGY

Autecology and Synecology

Ecological studies are based on three basic principles: Habitat, Taxonomic group and levels of organizations. Depending upon the consideration of ecological unit as either individual or group of organisms, the levels of organization is divided into autecology and synecology.

Autecology

The study of interaction between individuals and its environment is known as "autecology" or

"ecology of individual".

In autecology, at a given time, we study the influence of individual's reactions to its natural environment and requirements together and affects of its interacting environment. In simple words how an organism or single species interacts (what it required and after interaction how it reacts) with its natural environment (i.e. under the present conditions prevailed by the organism).

Individual species contribute as the unit of autecology study.

In autecology, we study in details the morphology of individual effected by its prevailing environment, its geographical distribution based on the surrounding, influence of environment on the life cycle and growth of organism, its taxonomical position and several factors including those which effects different developmental stages of individual's life cycle.

Examples of Autecology

For instance, the influence of the change in temperature of the surrounding can highly influence the life cycle and developmental stages of individual. In brief, lizards, crocodiles and several other reptiles can hatch their eggs and sex of the baby is determined by the temperature at the time of hatching.

Best and classical example is provided by the Darwin's finches of Galapagos Island. Darwin, Zoologist, who went on a voyage, very finely observed the Galapagos Island and revealed that the birds habituating that Island, called Finches, differ in the shape and size of their beaks clearly indicating that different finches habituating different area and feeding on different vegetations evolved to survive and developed beaks of different size and shape.

Another example includes the adaptation of organism to higher altitudes. At higher altitudes, due to higher pressure, there is less availability of oxygen to body tissues, so the individual adapts to it by developing higher number of RBCs which can effectively and with high affinity bind to the oxygen molecules through haemoglobin. While the individual living in plain areas is susceptible to these sudden changes in oxygen levels and pressure and can be attacked by hypoxia condition.

Synecology

In 1896, Schrocter and Kirchner coined the term Synecology. Organisms of different species living in a group can affect each other's life in any possible way under their natural conditions.

It's a more complex condition. Unlike autecology, where single organism is the unit of study, in synecology "group of organisms" are considered as the unit of study. Therefore, an ecological approach "group of organisms" as the unit of study is termed as synecology.

Synecology can be divided into population, community ecology, and biome and ecosystem ecology.

Examples of Synecology

An example of synecology is side effects of acid rain to a pond ecosystem. As the acid rain falls in a pond, rich in flora and fauna (mainly with fish diversity), it directly and indirectly affects the health of population or community or total biome or pond ecosystem. Acid rain creates an unfavorable environment in the pond ecosystem by stimulating various chemical reactions attributed to the characteristic feature of acid rain.

A classical example includes, Gause's principle derived concept of Resource Partitioning where organism of different species compete for the same resources eg. Food, space etc. thereby, leading to partitioning of resources or habitat.

Autecology Vs Synecology

Autecology	Synecology
It is the study of individual organism or individual species or a population in relation to their environment	It is the study of group of organisms or many species or communities in relation to their environment
It is also called as population ecology	It is also called as community ecology
The study is at the level of an individual, a population or an entire species	Synecology is concerned with study of the highest level of biological organization; many populations in an area (called as community) interacting with each other and also with the environment. It can even be the study of an ecosystem
Autecology is comparatively simple experimental and inductive.	Synecology is complex, philosophical and deductive. (Refer: Inductive vs Deductive)
Autecology studies can be accommodated in a laboratory setup and data is interpreted using conventional mathematical tools**	Synecology studies refers to the interaction of a whole system and that cannot be accommodated in a laboratory setup as the system is naturally formed after interactions of hundreds of years such as a forest ecosystem
Example: Study of Zebra population in relation to its environment (may be factors like rainfall, hunting, lion population etc in a grassland ecosystem) see the figure (in dotted black lines)	Example: Study of entire grassland ecosystem (including all the species or communities) see the figure (in green thick border)

****