# Environment

1. **Abiotic or Non-living components** include the physical (climatic), edaphic (nature of soil) and chemical. For example temperature, light, pressure, humidity, precipitation, wind, mineral elements of soil and composition of air. Some of these environmental factors serve as resources (air, soil and water) while others act as regulatory factors (light, temperature and pressure etc).

   **(i)Inorganic substances:** Inorganic substances like carbon, nitrogen, oxygen, water, carbon di-oxide, calcium, phosphorus and their inorganic compounds. These are available as free form or dissolved in water and may be adsorbed on the soil particles.

   **(ii)Organic compounds:** These are carbohydrates, proteins, lipids, nuceltic acids etc. This material is present in dead organic matter. These are broken into the simple compounds by decomposers in ecosystem for recycling of matter.
   **(iii)Climatic factors:** These are factors present in the environment such as temperature, humidity, light, wind, rainfall an atomospheric gaseous etc. Study of specific Ecosystem: Lets take a example of fresh water pond to understand the function of individual components.

2. **Biotic or Living components** include All living organisms found in the environment including plants, animals and microorganisms.

   (i) **Producers**: The role of producers is to prepare food to provide nutrition to the other organisms present in the ecosystem. There are two types of producers; photoautotrophs and chemotrophs.
   **Photoautotrophs:** These are green plants which can trap sun light to form carbohydrate, simple sugar from carbon di-oxide and water. This process is known as photosynthesis and these organisms are called as photoautotrophs. Chemoautotrophs: Few bacteria such as sulfur bacteria, nitrifying bacteria, can be able to utilize free energy released from the chemical reactions to prepare organic food with it. They are called chemoautotrophs and the process is known as chemosynthesis.

   (ii) **Consumers:** These are mainly the animals. They are unable synthesize their own food and depends on producers. They utilizes the oxygen being released from the producers as well. Several comsumers doesn't get the food from the producers but they are depended on consumers itself. As a result, consumers are related to each other through multiple food chains. There are many types of consumers and we will discuss in details about these consumer in the subsequent lecture. The consumers are known as heterotrophs.

(iii) **Decomposers:** These are mainly bacteria and fungi. Their primary purpose in the ecosystem is to decompose the complex organic material into the simple inorganic material so that it can be use for producers to prepare food.

**Ecology**

Ecology is the scientific study of the relationship and interactions between organisms and their environment. The term ecology is derived from a Greek word Oekologie where "oikos" meaning "household"and "logos" means "the study of".

**TYPES OF FOOD CHAIN**: There are two different types of food chains; grazing food chain and detritus food chain.

**Grazing food chain:** In the grazing food chain, solar energy is entrapped by the plants and then biomass, in tuen eaten by the herbivorous, and these are subsequently been consumed by a variety of carnivorous. These are longer food and these food chains end at the decomposer level. Here are two typical example of this type of food chain to understand this type of food chain.

**Detritus food chain**: Unlike grazing food chain, detritus food chain starts with the dead organic matter either from fallen leaves or dead animal bodies. This food chain doen't depends on solar energy. Common example of detritus food chain is marsh land where mangrove leaves fall into the warm, shallow water (Figure 39.4). The detritus eating animals ex. Bacteria, fungi and protozoan act upon the dead matter of dead leaves to covert them into simple inorganic substances. The detritivorous are subsequently eaten by insect larvae, grass shrimp, copepods, crabs, nematodes, bivalve mollusks, amphipods, mysids etc. In the last step, the detritus consumers are finally eaten by fishes.

**Food Web:** The different food chains are inter connected at various trophic level to develop a food web (Figure 39.5). For example, in grassland ecosystem, grass is consumed by the rabbit but in their absence, it may be eaten by the grazing cattle. Similarly, rat or mouse is eaten by snake but snake can be eaten by predatory birds. In contrast to food chain, food web has several distinct characteristic. (1) Food web are never straight. (2) Food web is formed due to interlinking of food chains. (3) A food web in the ecosystem brings alternate source of food. The complex food web gives better stability to the ecosystem. Most of the animals are polyphagous and they feed on more than one kind of organism. If the availability of one particular animal is decresing in the ecosystem, they start eating alternate animal. As a result, it gives chance to other animal to reproduce and grow in number and in addition, it gives chance to predator to survive.

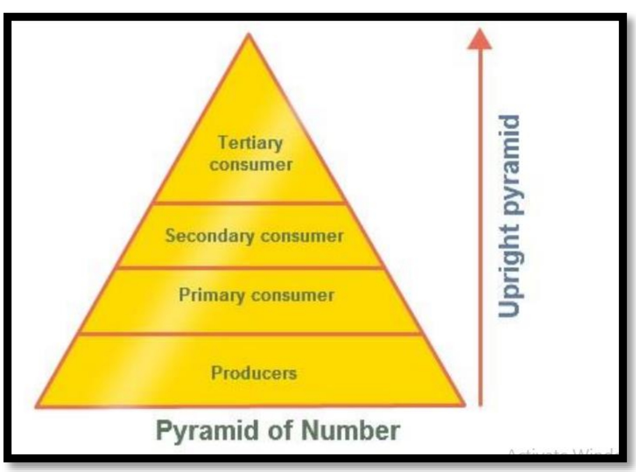
Ecological Pyramids: In a food chain, producers and consumers at different trophic level are connected in terms of number, biomass and energy. These

properties reduces from producers to consumers and representing these parameters for food chain gives a pyramid with a broad base and a tapering apex (Figure 39.6). Ecological pyramids can be of three types:
(a) Pyramid of Numbers
(b) pyramid of biomass
(c) pyramid of energy

**Pyramid of Numbers**

It is the graphic representation of number of individuals per unit area of various trophic levels. Large number of producers tend to form the base whereas lower number of top predators or carnivores occupy the tip. The shape of the pyramid of numbers varies from ecosystem to ecosystem. For example, in an aquatic ecosystem or grassland areas, autotrophs or producers are present in large number per unit area. The producers support a lesser number of herbivores, which in turn supports fewer carnivores.

**Upright Pyramid of Numbers** In upright pyramid of numbers, the number of individuals decreases from the lower level to the higher level. This type of pyramid is usually found in the grassland ecosystem and the pond ecosystem. The grass in a grassland ecosystem occupies the lowest trophic level because of its abundance.




Next comes the primary producers – the herbivores (for example – grasshopper). The number of grasshoppers is quite less than that of grass. Then, there are the primary carnivores, for example, the rat whose number is far less than the grasshoppers. The next trophic level is the secondary consumers such as the snakes who feed on the rats. Then, there are the top carnivores such as the hawks who eat snakes and whose number is less than the snakes.

The number of species decreases towards the higher levels in this pyramidal structure.

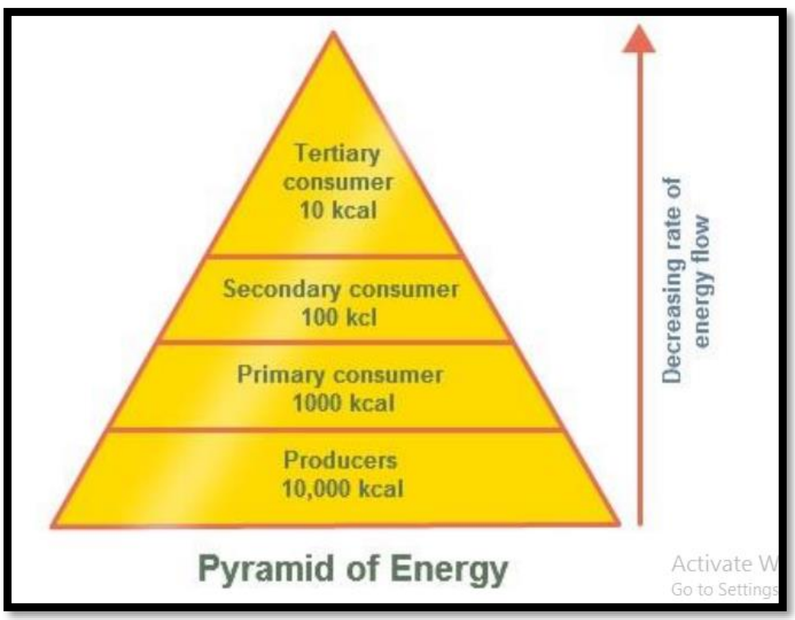
**Inverted Pyramid of Numbers**

Here, the number of individuals increase from the lower level to the higher trophic level. For example, the tree ecosystem.

**Pyramid of Energy**

It is a graphical structure representing the flow of energy through each trophic level of a food chain over a fixed part of the natural environment. An energy pyramid represents the amount of energy at each trophic level and loss of energy at each is transferred to another trophic level.

**Energy pyramid**, sometimes called trophic pyramid or ecological pyramid, is useful in quantifying the energy transfer from one organism to another along the food chain.

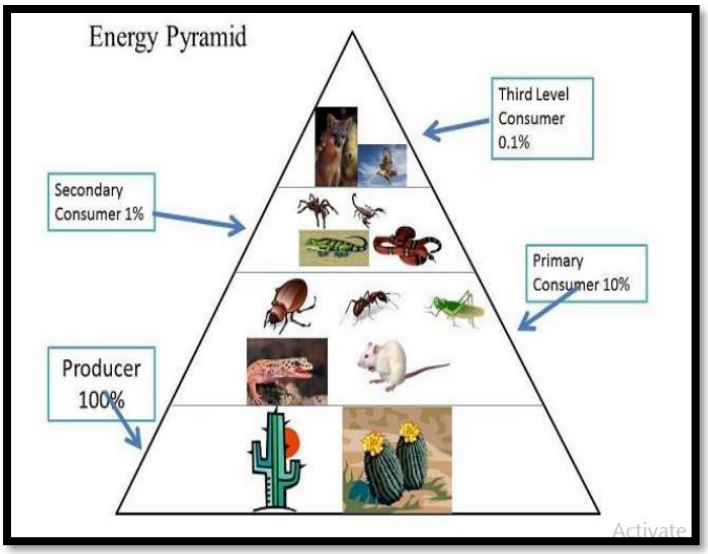



**Pyramid of Biomass**

As the name suggests, the Biomass Pyramids show the amount of biomass (living or organic matter present in an organism) present per unit area at each trophic level. It is drawn with the producers at the base and the top carnivores at the tip. Pyramid of biomass is generally ascertained by gathering all organisms occupying each trophic level separately and measuring their dry weight. Each trophic level has a certain mass of living material at a particular time called standing crop, which is measured as the mass of living organisms (biomass) or the number in a unit area.

**Upright Pyramid of Biomass**

Ecosystems found on land mostly have pyramids of biomass with large base of primary producers with smaller trophic level perched on top, hence the upright pyramid of biomass.




The biomass of autotrophs or producers is at the maximum. The biomass of next trophic level, i.e. primary consumers is less than the producers. Similarly, the other consumers such as secondary and tertiary consumers are comparatively less than its lower level respectively. The top of the pyramid has very less amount of biomass.

**Inverted Pyramid of Biomass**

On the other hand, a reverse pyramidal structure is found in most aquatic ecosystems. Here, the pyramid of biomass may assume an inverted pattern. However, pyramid of numbers for aquatic ecosystem is upright.

In a water body, the producers are tiny phytoplankton that grow and reproduce rapidly. In this condition, the pyramid of biomass has a small base, with the producer biomass at the base providing support to consumer biomass of large weight. Hence, it assumes an inverted shape.

**Flow of energy in food chain:** Sun is the ultimate source of energy on earth and plants utilizes it to produce food for rest of the member of the ecosystem. Only the 1% of the total energy fall on green part of leaves is changed into the potential energy of the organic substances, the rest of the energy dissipates as heat. To explain the flow of energy, lindermann proposed the law of ten per cent law. This law proposed that during transfer of food energy from one trophic level to the other, only 10% is stored at higher trophic and the rest 90% is lost in respiration, decomposition and waste in the form of heat (Figure 39.8). For example, 5000 jules fall on leaves, it will convert only 50 jules into the chemical form (food). It will be eaten by rabbit, he will get only 5 jules (10% of 50 jules) on next trophic level. Rabbit will be consumed by carnivorous and they can be able store only 0.5 jules (10% of 5 jules).

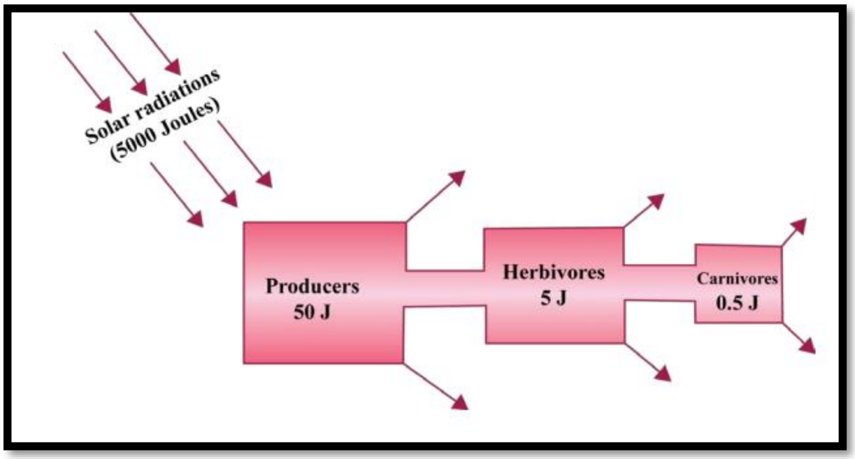



**Fig- Flow of energy in food chain**

## Population Ecology

Population ecology is the study of populations in relation to the environment, including environmental influences on population density and distribution, age structure, and population size.

**Population Size** is represented by the letter N, and it equals the total number of individuals in a population. The larger a population is, the greater its generic variation and therefore its potential for long-term survival. Increased population size can, however, lead to other issues, such as overuse of resources leading to a population crash.

**Population Density** refers to the number of individuals in a particular area. A low-density area would have more organisms spread out. High-density areas would have more individuals living closer together, leading to greater resource competition.

**Population Dispersion:** Yields helpful information about how species interact with each other. Researchers can learn more about populations by studying they way they are distributed or dispersed.

**Uniform dispersion** refers to organisms that live in a specific territory. One example would be penguins. Penguins live in territories, and within those territories the birds space themselves out relatively uniformly.

**Random dispersion** refers to the spread of individuals such as wind-dispersed seeds, which fall randomly after traveling.

**Clustered or clumped dispersion** refers to a straight drop of seeds to the ground, rather than being carried, or to groups of animals living together, such as herds or schools. Schools of fish exhibit this manner of dispersion.

### Natality (birth rate)

Birth rate is the rate at which new individuals are added to a particular population by reproduction. It is simply a broader term covering the production of new individuals by birth, hatching, by fission, etc. The natality rate may be expressed as the number of organisms born per female per unit time. In human population, the natality rate is equivalent to the birth-rate. Birth rate or Natality (B) = Number of births per unit time/Average population. It is generally expressed as number of births per 1000 individuals of a population per year. Birth rates are affected by factors such as nutrition, fertility and abiotic conditions. Natality varies from organism to organism. It depends upon the population density and environmental factors. It is a general rule that if the population density is usually low, the birth rate is also low. This is so because the chances of mating between males and females are low. If population density is unusually high, the birth rate may also be low due to poor nutrition or physiological or psychological problems related to crowding. There are two types of natality.

**Maximum natality:** Also called as absolute or potential or physiological natality, it is the theoretical maximum production of new individuals under ideal conditions which means that there are no ecological limiting factors and that reproduction is limited only by physiological factors. It is a constant for a given population. This is also called fecundity rate.

**Ecological natality**: Also called realized natality or simply natality, it is the population increase under an actual, existing specific condition. Thus it takes into account all possible existing environmental conditions. Natality usually increase with the period of maturity and then falls again as the organism gets older.

**Mortality**

Mortality refers to the number of deaths in population per unit time. Death rate is the rate at which the individuals die or get killed. It is the opposite of natality rate. Death rate is generally expressed as number of deaths per 1000 individuals of a population per year. Death rate in plants is affected by disease, nutritional deficiency and different natural and/or man made habitat destruction, whereas, in animals it is affected by disease, war, medical technology, improved health care, transportation development and nutrition. The lowest death rate for a given species under most favourable conditions is called potential mortality. The actual death rate is observed under existing conditions is called realized mortality. The realized mortality decreases with population size and population density. The percentage ratio of birth rate per death rate expressed in percentage is called Vital Index. It determines the normal rate of growth of a population.

**Minimum or Specific or Potential Mortality:** Also called specific or potential mortality, it represents the theoretical minimu loss of individuals under ideal or non-limiting condition. Thus, even under the best conditions individuals of a population would die of old age determined by their physiological longevity. So it is constant for a population.

**Ecological or Realized Mortality**: It is the actual loss of individuals under a given environmental condition. It refers to the death of individuals of a population under existing environmental conditions. Since it varies with environmental conditions, it is never constant. The maximum mortality occurs at the egg, larval, seedling and old age. Mortality is affected by a number of factors, such as, density, competition, disease, predation and environment. Death rates vary among the species and are correlated with birth rates. When the rate of natality is equal to the rate of mortality the population is stat

## Community

“A biotic community is a naturally occurring assemblage of plants and animals that live in the same environment, are mutually sustaining and interdependent, and are constantly fixing and dissipating energy.”

They are as follows: (i) Existence of diverse habitats with characteristic environmental conditions and (ii) Co-occurrence of different species whose tolerance ranges overlap with the environmental condition obtained in that habitat. When similar habitat conditions are repeated at another location, the same biotic community gets established there.

**Characteristics of Biotic Community:** Each biotic community consists of very diverse organisms belonging to different kingdoms of living things. The number of species and abundance of population in communities also vary greatly. The organisms in a community depend upon each other as well as upon the non-living environment for food, shelter and reproduction.

**Dominance:** A biotic community may have major categories of growth forms, such as trees, shrubs, herbs and mosses. Out of hundreds of species present in the community, relatively only a few exert a major controlling influence due to their large size, numbers of activities.

The phenomenon is called dominance. “Dominant species are those which are highly successful ecologically and which determine to a considerable extent the conditions under which the associated species must grow.”

The dominance in the community may be the result of co-action between two or more species. Different communities are generally recognized and named on the basis of dominant species occurring in them. For example, a forest community in which pine trees are dominant is called pine forest. Grassland represents a community which has grass species dominating over the other herbs. Sometimes, communities are named after environmental factors, such as desert community, marine community, mangrove vegetation, etc.

**Stratification:** Every biotic community has a vertical layering or stratification of organisms or environmental conditions. A number of examples can be cited to support the concept of community stratification from different habitats.

**Ecotone and Edge Effect:** The zone where two or more different communities meet and integrate, is called transition zone or ecotone. This zone of integration may be narrow or wide, local (e.g., a zone between field and a forest) or regional (e.g., the transition between forest and grass land). Ecotone contains few species from both communities. The total number of species is often greater in the ecotone than in the adjoining communities.

The ecotone or transition zone exhibits a shift in dominance of the conspicuous species of both sides. It may also include a number of highly adaptable species that tend to colonize such transitional areas. Because of this, the variety (i.e., species diversity) and density of life is often greatest in such areas.

This potential for the ecotone to act as a habitat for species found in neither major community is called edge effect. Thus the tendency of increased variety and density of some organisms at the community border is known as edge effect.

The organisms that occur primarily, or most abundantly, or spend the greatest amount of their time in junctions between communities are called edge species. A common example of the edge effect in action can be seen in those species of owl that live in or near ecotones between forests and grasslands. They depend on forest trees for nesting and do their hunting in the grassland, where they depend on field rodents for food.

**Keystone Species:** The species, which have much greater influence on community characteristics, relative to their low abundance or biomass, are known as keystone species. Such species play a vital role in controlling the relative abundance of other species. When keystone species is removed, it causes serious disruption in the functioning of the community. For example, in the tropical rain forests, the different species of figs are the keystone species as they produce large quantity of fruits. During the time of food scarcity, these fruits are consumed by monkeys, bats, birds, etc. Thus, by protecting the fig trees, the animals dependent on them are also conserved.

**Climax community**

Climax community is the stable end product of successional sequence or sere. It is a community that has reached a steady state of species composition, structure and energy flow, under a particular set of environmental conditions. Steady state indicates the dynamic nature of the climax. Also the end of successional change does not mean that community development has come to an end. As has been stated above, climax community is always in a state of flux and its structure undergoes changes due to birth, death and growth processes. However, these changes are less dramatic than the community transformations observed during succession.

**The characteristics of a climax community are**:

1. The climax community is able to tolerate its own reaction. 2. It tends to be mesic (medium moisture content) rather than xeric (dry) or hydric (wet).

3. The climax community is more highly organised.

4. The climax community with its more complex organisation has large number of species and more niches.

5. The organisms of earlier successional stages tend to be smaller, shorter-lived with a higher biotic potential (r-selected). In contrast, the species of climax community tend to be relatively large, long lived and with a low biotic potential (K-selected).

6. In climax community, energy is at a steady state (net primary production is zero), whereas, in immature stage of succession, gross primary production tends to be greater than community respiration, signifying accumulation of energy.

7. Immature ecosystems are temporary while in climax community the stability is high.

8. Climax communities show less broader changes and are more resistant to invasions than immature ecosystems.

There are following theories of the climax:

1. **Mono-climax Theory:**
   According to the mono-climax theory of succession (Clements, 1936), every region has one climax community toward which all communities are developing. He believed that climate was the determining factor for vegetation and the climax of any area was solely a function of its climate. Various terms such as sub-climax, dis-climax, post-climax, and pre-climax are used to describe the deviations from the climatically stabilized climax. These communities, controlled by topographic, edaphic (soil), or biotic factors are regarded as exceptions by the supporters of the mono-climax view.
2. **Poly climax Theory:** This theory was proposed by Tansley (1939) and later supported by Daubenmire (1966). The poly-climax theory of succession holds that many different types of vegetation as climax communities may be recognized in a given area. These will be climaxes, controlled by soil moisture, soil nutrients, activity of animals and other factors. According to this theory, climate is only one of the several factors, any of which may have a controlling influence on the structure and stability of the climax. This allows many climaxes in a climate region and is, therefore, called the poly-climax theory.

The difference between this theory and the mono-climax theory is largely a matter of emphasis on which factor is responsible for the stability of a climax. According to Krebs (1994), the real difference between two theories lies in the time factor of measuring relative stability. The climate varies on an ecological time scale as well as on a geological time scale. Succession in a sense, then, is continuous because we have variable vegetation approaching a variable climate.

**Ecological equivalence** Two species can occupy in same ecological niche in different geographical area. Similar type of climate results into the development of similar type of ecosystem in disjuncked area. When grassland will developed in any area, if the area has grassland climate. As a result desert will be formed in any area if the climate is of desert type. But there are different species of grass. These are similar type of species they occupy similar type of ecological niche. Such species are called ecological equivalence. Ecological equivalents are the species which occupy similar ecological niche in widely separated geographical areas.

**Examples-**

(A) Kangaroo is found in the grassland of Australia.
Antilope is found in the grassland of Africa. iii) Bison is found in the grassland of America these are ecological equivalents.
B. Tiger in India & Jaguar in America are ecological equivalents. C. Lion in India, Puma in Africa & America are the ecological equivalents.

**Ecological guild**

Concept of ecological guild was first introduced by Root (1967) and term also first used by Root. He described a group of species that exploit some classes of environmental resources in a similar guild. Def.- According to smith- guild is a group of species which forage for food in a similar way in a given habitat.

e.g.- Kangaroo and Sheep in Australia, they are taxonomically widely different and appearance are also different but they belong to same guild.

On the other hand Rabbit and Bandicoot they are quite similar in appearance but they belong to different guild.

So, guild is an assemblage of different types of species and a community is an assemblage of guild. So, guilds are ecological units of great taxonomic diversity.

e.g.- The biotic community comprises of number of guilds i.e.- I, II, III and each gilds consists of one or more species Biotic community can be described as assemblage of guild.