MODULE 3

An ecosystem is a geographic area where plants, animals, and other organisms, as well as weather and landscape, work together to form a bubble of life.
Ecosystems contain biotic or living, parts, as well as abiotic factors, or nonliving parts. Biotic factors include plants, animals, and other organisms.

The structure of an ecosystem can be split into two main components, namely:

- Biotic Components
- Abiotic Components

Biotic Components

Biotic components refer to all living components in an ecosystem. Based on nutrition, biotic components can be categorised into autotrophs, heterotrophs and saprotrophs (or decomposers).

- Producers include all autotrophs such as plants. They are called autotrophs as they can produce food through the process of photosynthesis. Consequently, all other organisms higher up on the food chain rely on producers for food.
- Consumers or heterotrophs are organisms that depend on other organisms for food. Consumers are further classified into primary consumers, secondary consumers and tertiary consumers.
    - Primary consumers are always herbivores as they rely on producers for food.
    - Secondary consumers depend on primary consumers for energy. They can either be carnivores or omnivores.
    - Tertiary consumers are organisms that depend on secondary consumers for food. Tertiary consumers can also be carnivores or omnivores.
- Decomposers include saprophytes such as fungi and bacteria. They directly thrive on the dead and decaying organic matter. Decomposers are essential for the ecosystem as they help in recycling nutrients to be reused by plants.

Abiotic Components

Abiotic components are the non-living component of an ecosystem. It includes air, water, soil, minerals, sunlight, temperature, nutrients, wind, altitude, turbidity, etc.

The functions of the ecosystem are as follows:

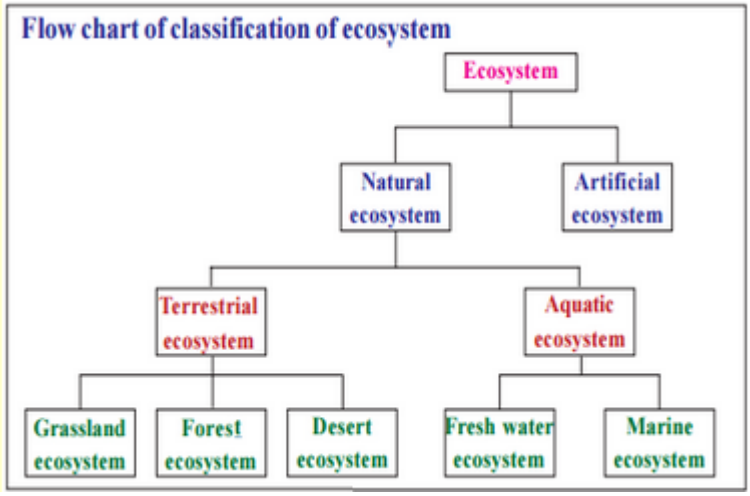
1. It regulates the essential ecological processes, supports life systems and renders stability.

2. It is also responsible for the cycling of nutrients between biotic and abiotic components.
3. It maintains a balance among the various trophic levels in the ecosystem.
4. It cycles the minerals through the biosphere.
5. The abiotic components help in the synthesis of organic components that involve the exchange of energy.

Types of Ecosystem

An ecosystem can be as small as an oasis in a desert, or as big as an ocean, spanning thousands of miles. There are two types of ecosystem:

- Terrestrial Ecosystem
- Aquatic Ecosystem



Terrestrial Ecosystem

Terrestrial ecosystems are exclusively land-based ecosystems. There are different types of terrestrial ecosystems distributed around various geological zones. They are as follows:

1. Forest Ecosystem
2. Grassland Ecosystem
3. Desert Ecosystem

Forest Ecosystem

A forest ecosystem consists of several plants, particularly trees, animals and microorganisms that live in coordination with the abiotic factors of the environment. Forests help in maintaining the temperature of the earth and are the major carbon sink.

Grassland Ecosystem

In a grassland ecosystem, the vegetation is dominated by grasses and herbs. Temperate grasslands and tropical or savanna grasslands are examples of grassland ecosystems.

Desert Ecosystem

Deserts are found throughout the world. These are regions with little rainfall and scarce vegetation. The days are hot, and the nights are cold.

Aquatic Ecosystem (Refer classroom notes)

is the habitat for water-dependent living species including animals, plants, and microbes.

Aquatic ecosystems are ecosystems present in a body of water. These can be further divided into two types, namely:

1. Freshwater Ecosystem
2. Marine Ecosystem

Freshwater Ecosystem (Refer classroom notes)

The freshwater ecosystem is an aquatic ecosystem that includes lakes, ponds, rivers, streams and wetlands. These have no salt content in contrast with the marine ecosystem.

Marine Ecosystem (Refer classroom notes)

The marine ecosystem includes seas and oceans. These have a more substantial salt content and greater biodiversity in comparison to the freshwater ecosystem.

Habitat

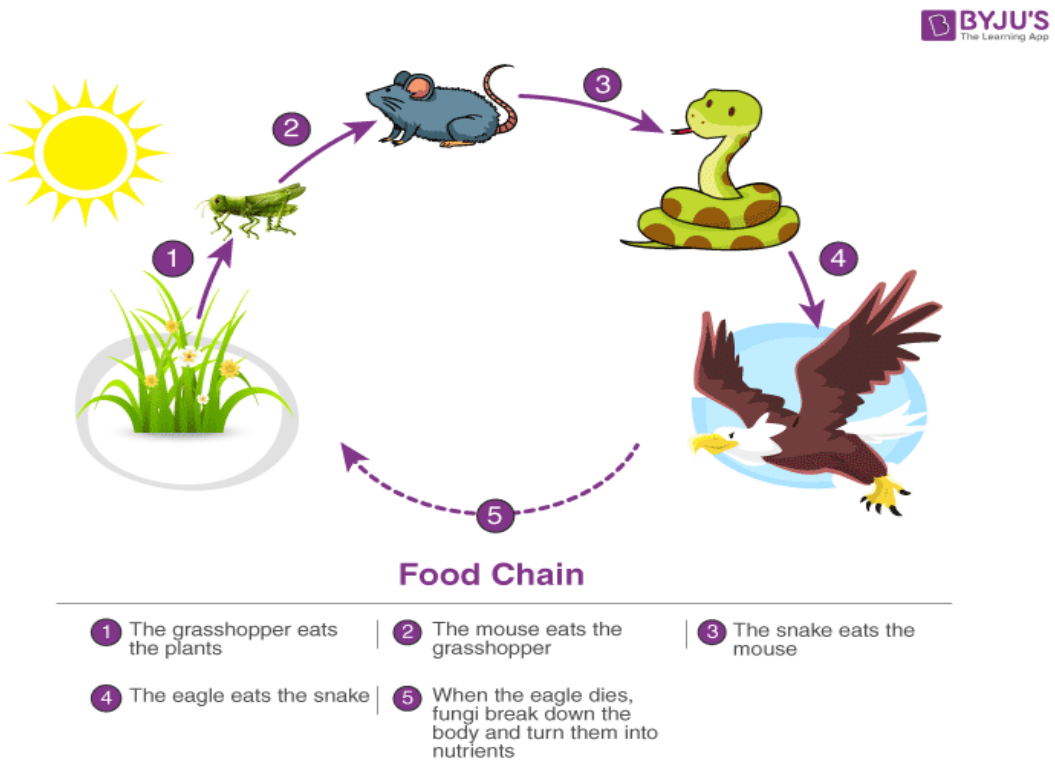
A habitat is a place where an organism makes its home. A habitat meets all the environmental conditions an organism needs to survive. For an animal, that means everything it needs to find and gather food, select a mate, and successfully reproduce.

Habitats can be broadly categorized into two types. They are terrestrial habitats and aquatic habitats. The animals that live in land are said to be in terrestrial habitats. There are wide range of terrestrial habitats like forests, grasslands, deserts, mountain ranges, coastal regions, wetlands, ice caps and wetlands.

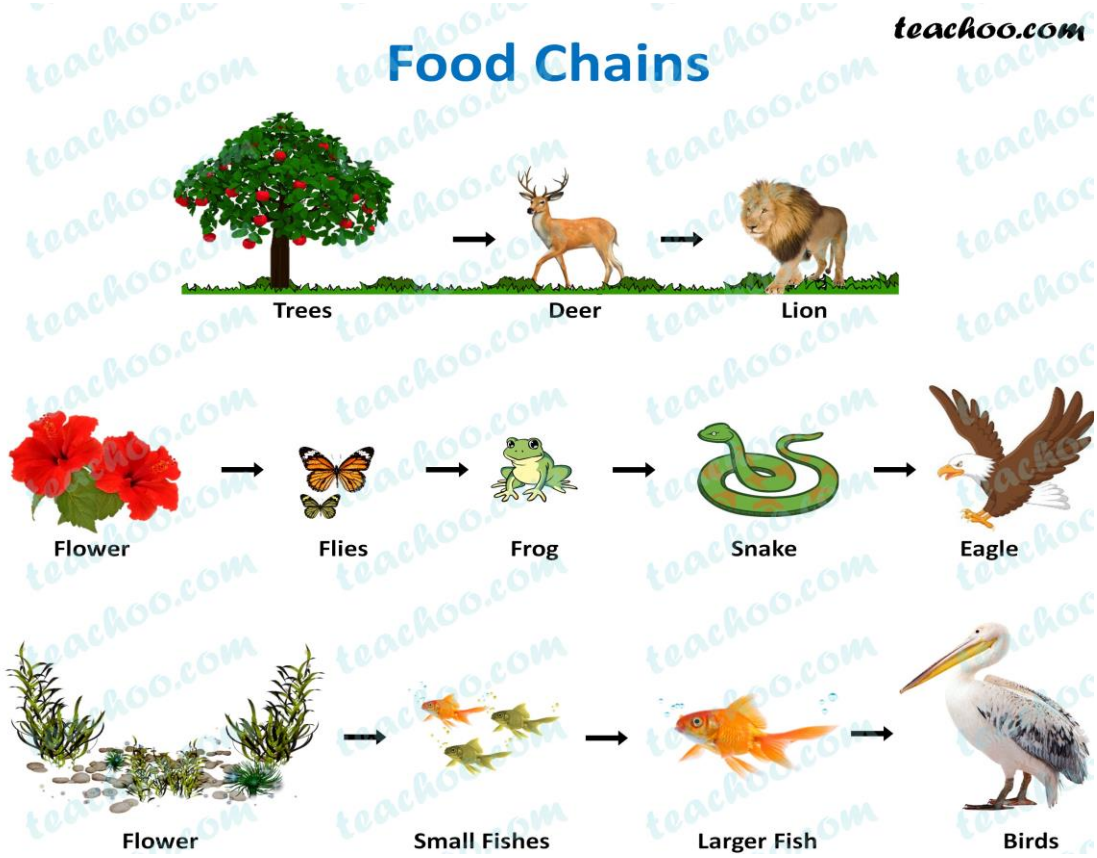
Food Chain

1. The sequence of living organisms in a community in which one organism consumes another organism to transfer food energy is called a food chain.
2. The sun is the ultimate source of energy on earth. It provides the energy required for all plant life. The flow of energy from a producer, to a consumer and eventually, to an apex predator or a detritivore is called the food chain.

Eg.Grasshopper →Mouse→ Cobra → Brown Snake Eagle



*(see points 1-5 in above diagram it is expected in answers in pointwise form)



(Explain food chain examples, name who is the producers, primary consumers, sec. consumers, herbivores and carnivores properly) No Drawings please

What is meant by the carrying capacity?

1. Carrying capacity can be defined as a species' average population size in a particular habitat. The species population size is limited by environmental factors like adequate food, shelter, water, and mates. If these needs are not met, the population will decrease until the resource rebounds.
2. Carrying capacity, or the maximum number of individuals that an environment can sustain over time without destroying or degrading the environment, is determined by a few key factors: food availability, water, and space.
3. In simple words Carrying capacity the maximum number of individuals of a species that an environment can support

4. The IPAT Equation is an attempt to describe the impact of population, affluence and technology on the environment.

The IPAT Equation: I = P x A x T

I = (PAT) is the mathematical notation of a formula put forward to describe the impact of human activity on the environment.

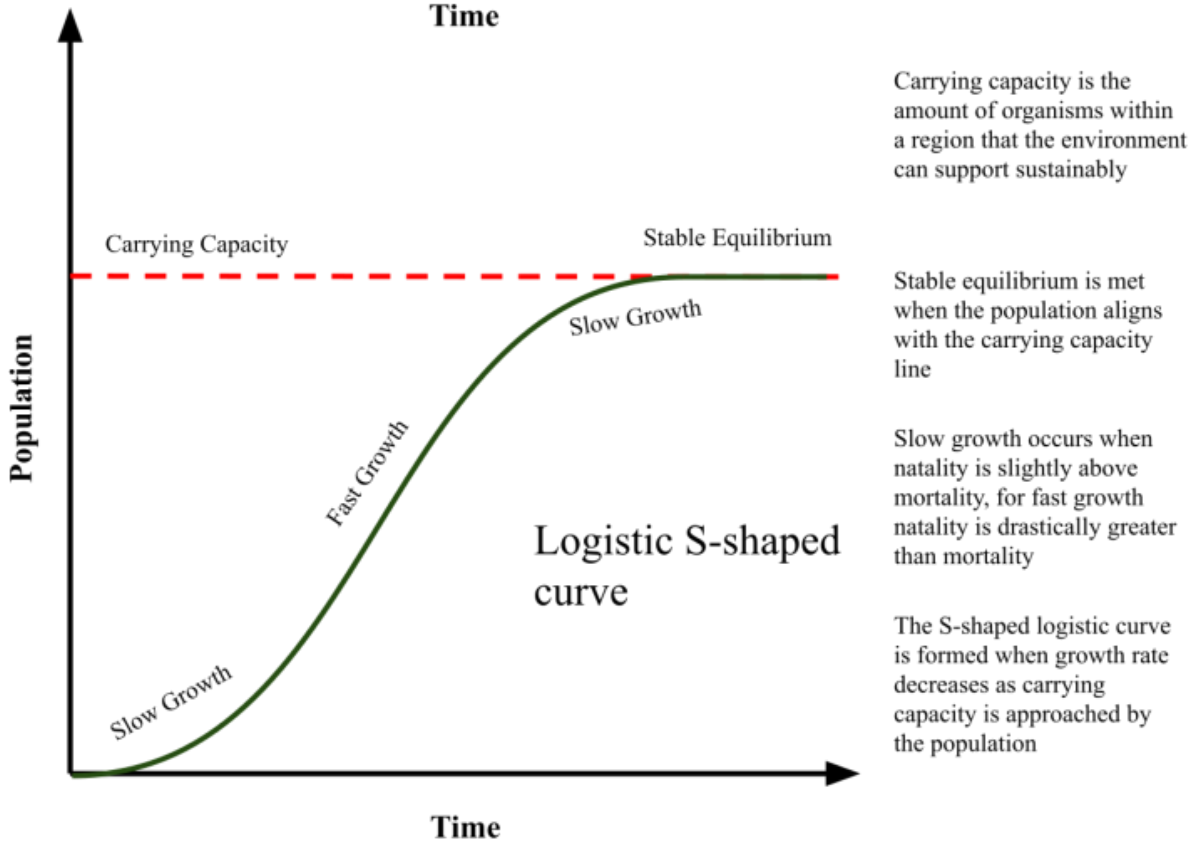
$$I = P \times A \times T$$

The expression equates human impact on the environment to a function of three factors: population (P), affluence (A) and technology (T).

Carrying Capacity Graph

5. Here, the carrying capacity (***symbol:*** *K*) for a biological species is marked by the red dotted horizontal line to describe the number of organisms that the environment can support sustainably for a given time.
6. Notice that it coincides with the ***stable equilibrium***, which refers to the population size that has reached a steady state as it aligns with the carrying capacity. This point indicates *"zero-growth"*.

Figure 1: Logistic Growth of Population Size Over Time



7. To calculate the carrying capacity (*K*), the equation for the change in population size can be used for deriving a formula for *K* (Ref.5):

$$\frac{dN}{dt} = rN\left(\frac{1-N}{K}\right)$$

8. The formula for calculating a change in population size

$$K = \frac{rN((1-N))}{\frac{dN}{dt}}$$

Carrying capacity formula
where *r* is the intrinsic rate of increase,
N is the population size,
and *dN/dt* is the change in population size.

Carrying Capacity Examples (compulsory any 1 example)

9. For example, a pond inhabited initially by ten turtles will be sustainable for the species' population. Because water, food, and space abound, the turtles can thrive and reproduce at an exponential rate. However, as the population grows, competition is intensified as well. Turtles compete for food, water, and space.

10. When the population seems stable, e.g. at a population of 100 turtles, then, it can be said that the carrying capacity for that area is 100 turtles

11. Another example is the tree population in a forest. Let's say a forest can have a carrying capacity of about a hundred trees. This means that the trees can grow without fiercely competing for sunlight, nutrients, and space. This also implicates that the new sprouts may not be able to thrive in the same manner because the tall and older trees will cast a shadow over them, making sunlight hard to access from down below.

What are limiting factors?

1. Limiting factors are the environmental conditions or resources that limit the growth or distribution of an ecosystem. These can be either physical or biological factors which are identified by the increase or decrease in growth or distribution of a population.

2. Limiting factors can also be split into further categories. Physical factors or abiotic factors include temperature, water availability, oxygen, salinity, light, food and nutrients; biological factors or biotic factors, involve interactions between organisms such as predation, competition, parasitism and herbivory.

3. Limiting factors are the factors that are not present in abundance.

4. A limiting factor is a factor or variable in the environment that has the potential to limit the growth, abundance, or spread of a population in an ecosystem.

5. These ingredients are in short supply. As a result, organisms compete for limited resources in the ecosystem.

6. E.g., In the process of photosynthesis, temperature, availability of light, carbon dioxide, and water act as limiting factors.

7. Limiting factors are theorized under Liebig's Law of the Minimum, which states that "growth is not controlled by the total amount of resources available, but by the scarcest resource".

8. The limiting resource within an ecosystem determines the carrying capacity (indicated in ecology by the letter, "K"), which is the maximum number of individuals in a population that a habitat can support without environmental degradation.

Explaination

In an ecosystem with unlimited resources, no predators and no disease, populations may experience exponential growth. The carrying capacity therefore acts as a moderator of population size; once limiting resources start to become depleted by increasing numbers of individuals, intraspecific competition occurs and the growth rate of the population begins to slow as individuals die or fail to reproduce. Eventually the growth rate levels off at a plateau – this

plateau is the carrying capacity. Once the carrying capacity of an environment has been reached, individuals may begin to search for resources elsewhere, migrating away from the original population and creating new populations. If the populations become separated indefinitely, this can lead to speciation.