



CHAPTER

25

ECOSYSTEM

Ecology:

it is branch of biology, which deals with the relationship of organisms to their living and non-living environment.

The term ecology comes from the Greek word **Oikos**, meaning “ the family house/should”, and **logy (or logos)**, meaning “the study of”.

The term originally was used by the German zoologist **Ernst Haeckel** in 1866. He called it oecologic and defined it as the study of the relationship of animals (organisms) to their environment.

Environment includes not only the physical but also the biological conditions under which an organism lives.

Relationship includes interactions with the physical world and with members of other species and the same species.

ECOSYSTEM

Definition:

“Community together with its non-living surrounding”.

Organisms interact with their environment within the context of the ecosystem. The **eco** part of the word related to the environment and the **system** part means a collection of related parts that function as a unit.

Components of Ecosystem:

The ecosystem consists of two basic interacting components, the living or biotic, and physical or abiotic factors.

1. Biotic Components:

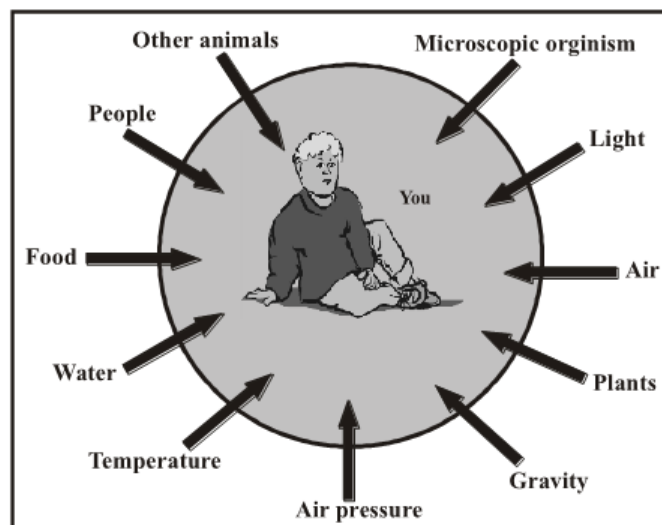
They include all living organisms including plants (producers) animals (consumers) and microorganisms (decomposers), supported by Biosphere. Biosphere is spread out over the surface of planet earth and also in same distance into depth of Oceans.

2. Abiotic Components:

Abiotic components include all non-living components such as air, water, soil, temperature, gravity, topography, and mineral etc. In ecological terms they are called as

- (a) **Atmosphere** ----- (Atmo — air, sphere — place)
- (b) **Hydrosphere** ----- (Hydro — water, sphere — place)
- (c) **Lithosphere** ----- (Litho — earth — soil, sphere---place)





LEVELS OF INTERACTION IN AN ECOSYSTEM

These ecosystem ha many levels of interaction.

1. **Individual level:**

This is the lowest level of interaction. All individuals or organisms including man, both respond to pond to and influence the living (biotic) and physical (abiotic environment).

2. **Population level:**

A population is a group of interbreeding individuals of same species occurring together in space and time.

3. **Community level:**

All populations living together in space and time constitute a community.

4. **Biome level:**

A biome is a major regional community primary determined by climate.

5. **Biosherelevel:**

Biosphere is a thin layer (zone) of planet earth in which all living organisms exist.

HABITAT AND NICHE

Habitat:

The actual location or place, where an organism live.

Ecological Niche:

Niche is defined as the ultimate distributional unit with in which a species is restrained by the limitation of its physical structure and its physiology.

Niche is known as the profession of an organism. It describes the basic role of an organism in the community – what it does, its relationship to its food and enemies etc.

In 1917, **Joseph Grinnell** and American scientists who study about birds first proposed the term niche in ecology.

Charles Eton, considered the niche the basic role of an organism in the community – what it does, its relationship to its food and enemies. he defined the niche as the species occupation.



AUTECOLOGY

Definition:

The study of relationship of a single population to its environment is called “Autecology”.

Example:

For example if we study 50 to 100 plants of soybean for effect of water pollution on their growth and yield, we are studying the single or one population of soybean plant.

SYNECOLOGY / COMMUNITY ECOLOGY

The study of relationship of different communities (group of populations) to environment is called Synecology or community ecology.

At different places in an environment when we study all the populations at the same time than it will be synecology.

Studying the community or synecology...

- we have to see the various aspects of community like the origin, structure and composition of the community.
- We have to consider the history of community and also the dynamics of it because community is not a fixed entity but different changes are going to occur at different time.
- While studying the community we come across three levels of integration.
 - (i) Individual,
 - (ii) Population,
 - (iii) Community.

INTERACTIONS BETWEEN BIOTIC AND ABIOTIC COMPONENTS

The main processes occurring in an ecosystem include feeding (in the form of food chain and web) and the circulation of chemical elements (biogeochemical cycles), together with the energy flow through the ecosystem.

An ecosystem is made up of three main biotic components.

1. The producers.
2. The consumers.
3. The decomposers.

Producers:

Producers are the green photosynthetic plants, which capture and bring light energy into the ecosystem. They are able to manufacture organic food from simpler inorganic substances. They are autotrophic organisms.



Consumers:

Consumers are all the organisms, primarily animals, which obtain energy directly or indirectly from the producers as ready-made organic food. They are mainly heterothrophic organisms.

Decomposers:

Decomposers are mainly the **fungi** and **bacteria**, which obtain their energy from the dead and decaying plants and animals. They release chemical elements as ions. The chemical ions are nitrates, ammonia, phosphates, potassium and calcium etc.

- Decomposers are very important in an ecosystem because they help in the recycling of nutrients present in dead bodies of animals and plants. Life could not sustain without decomposers.

FOOD CHAIN OR PROCESS OF EATEN & BEING EATEN**Definition:**

Food chain is the transfer of food energy from the source in plants through a series of organisms with repeated stages of eating and being eaten or process of eaten & being eaten or process of eaten & being eaten.

Examples:

1. Grass → Insects → Bluebirds → Eagle
2. Grass → Cow → Man
3. Grass → Mole → Fox → Bacteria.

FOOD WEB OR “COMBINATION OF MANY FOOD CHAIN”

In natural ecosystems, many food chains interact in a complex way to form a food web.

Food webs are not really straight forward, because most animals eat more than one type of food at different times and each organism may be the food of more than one organism. As fox does not feed entirely on rabbit but also takes beetles, rats etc.

All the food chains and food webs begin with green plants (producers) and may consist of three to five links per trophic levels.

Explanation:

In food web, there are more complex trophic levels or food links e.g.,

- Food chain T1 is the first trophic or producer level which includes all green plants, grass, and phytoplankton.
- T2 Second trophic level --- primary consumers.
- T3 Third trophic level --- secondary consumers.
- T4 Fourth trophic level --- tertiary consumers.

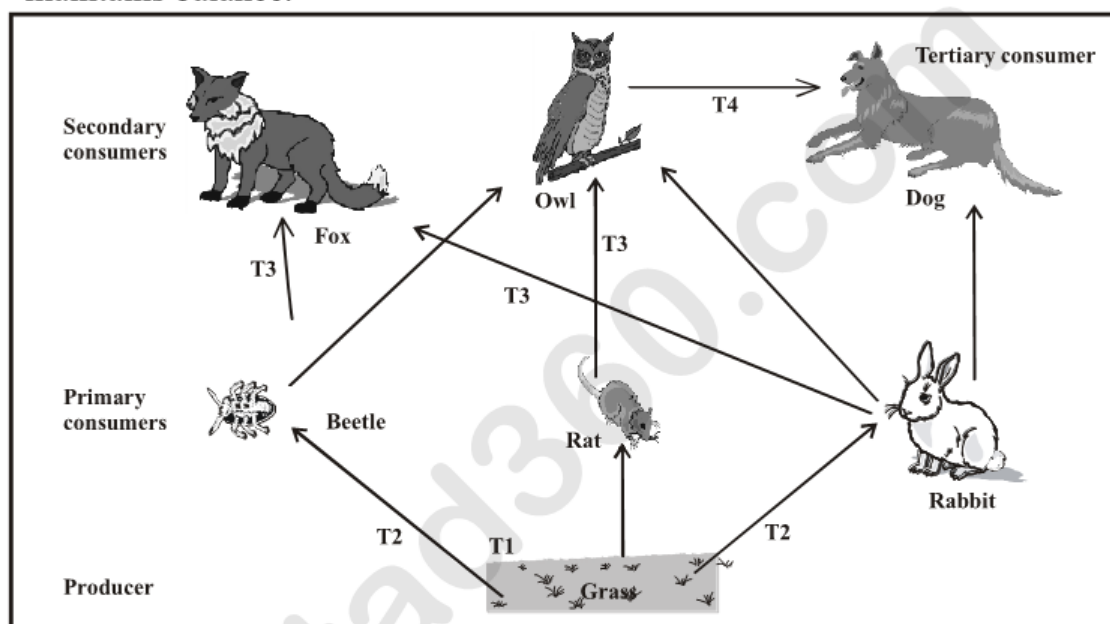


FOOD WEB AND THE STABILITY OF ON ECOSYSTEM

The variety of pathways in food web helps maintain the stability of the ecosystem.

For example,

- Owls prey on rabbits and mice.
- If a disease reduces the rabbit population, fewer plants are consumed.
- The larger plant population produces more fruit and seeds.
- Which, in turn, support a larger mouse population.
- The increased number of mice becomes the major food source for the owls.
- The rabbit population gradually increases.
- These primary consumers again become a food source for the owls. Thus nature maintains balance.



Food web and various trophic levels

SUCCESSION

Definition:

“Succession is a gradual change in the community structure of an ecosystem over a period of time”.

Explanation:

A community changes or alters the ecosystem in ways that favour the competitors and species replace one another in somewhat predictable manner until a stable, self-sustaining climax community is reached. Succession is a kind of community relay” in which assemblages of plants and animals replace one another in a sequence that is at least somewhat predictable.

The precise changes occurring during succession are as diverse as the environments in which succession occurs, but certain general stages can be recognized.

Pioneer: Succession starter are few hardy invaders.

Climax Community: Relatively stable diverse community.



MAJOR FORMS OF SUCCESSION ON LAND

Succession of dry land takes two major forms, primary succession and secondary succession.

1. Primary Succession:

During primary succession an ecosystem starts from a bare rock, sand or clear glacial pool where there is no trace of previous life.

- The formation of an ecosystem from scratch is a process often requiring thousand of years.

During on the habitat, primary succession may be of following types.

(i) Hydrosere:

Primary succession that start in a period is called hydrosere.

(ii) Xerosere:

Primary succession that start on a bare rock or a dry habitat is called Xerosere.

2. Secondary Succession:

During secondary succession a new ecosystem develops after an existing ecosystem is disturbed as in case of forced fire or an abandoned farm field.

- It happens much more rapidly than primary succession because the previous community has left its marks in the form of improved soil and seeds etc.

XEROSERE AND ITS STAGES

Succession on dry habitat is called “xerosere”. Plants growing in xeric (dry) conditions are called xerophytes, which are able to withstand prolonged periods of water shortage. Succulent plants such as the cacti have water stored in large parenchyma tissue, others have leaf modifications.

Xerosere had following different stages.

(a) Crustose Lichen Stages:

- This is the first life form on the dry rock, where special types of lichens get impregnated in the form of crust.
- Crustose lichens can live in extreme condition.
- Some time their surface is wet due to rain and dew drops.
- They are quiescent or dormant and are normally desiccated during dry season.

(b) Foliose Lichen Stage:

- In this stage the lichens are just like trampled leaves with lobed or irregularly folded margins, attached at one point.
- It produces shade to the crustose lichens as a result of which their growth is reduced or decreased.
- The vicinity becomes rough with more and more fissure (crack or gap) and depression develop.
- Common examples are *Dermatocarpon*, *Permellia* etc.
- Now soil is more porous with some litter of lichens and it can support other plants such as mosses etc.



(c) Moss Stage:

- This is the third stage with mosses like, *polytrichum*, *Tortilla* etc.
- They complete with lichens for water and penetrate much deeper in the soil as compared to the lichens.
- They add more humus to the soil.
- Ultimately most of the lichens disappear.

(d) Herbaceous (Plant) Stage:

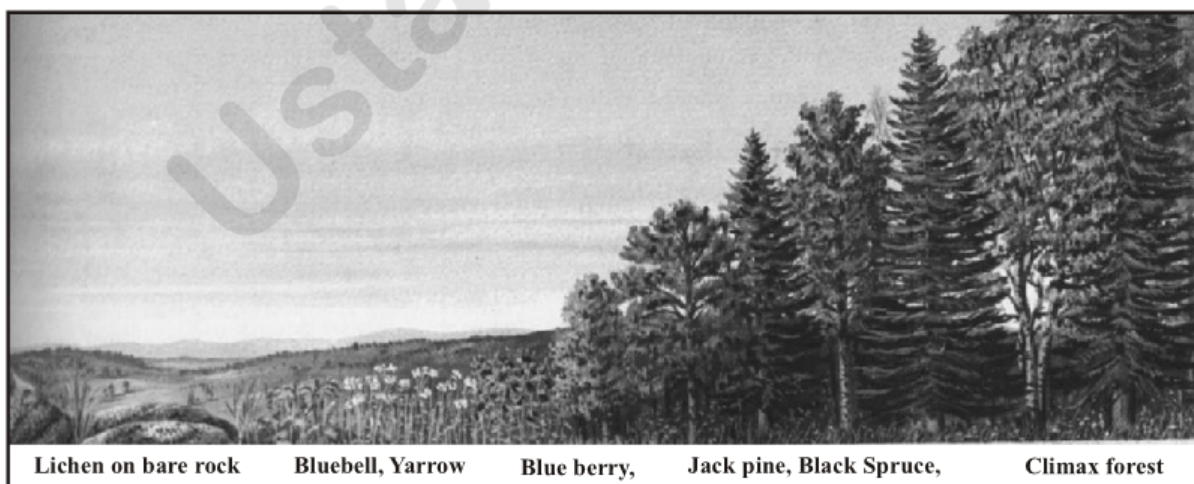
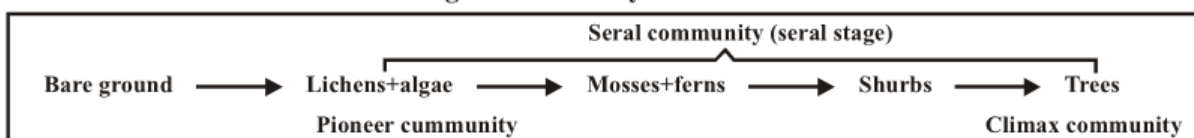
- Small seedlings of herbaceous plants now establish due to the more availability of moistures, humus and soil for anchorage.
- A few mosses remain after competition with herbs.

(e) Shrub Stage:

- Shrubby plants now start growing, dominating, and shadowing herbaceous plants.
- Herbaceous plants die and add more humus to the soil.

(f) Climax Forests:

- The soil is improved to an extent that it now allows the growth and establishment of woody plants.
- The shade of these plants inhibits the growth of most plants other than a few mosses, lichens, and some ferns etc.
- Woody plants dominate and this stage in succession remains essentially the same if nothing change in the environment to upset the balance.
- because it is a stable stage in succession, the woody forest is considered to be the climax stage for this region.

**Fig. 25.4 Primary Succession**

PREDATION

Definition: It is relationship between a predator and a prey.

Predator:

Definition:

An animal that captures and immediately kills other live animals for the purpose of food is called predator.

Prey:

Definition:

The animal that is caught and eaten by a predator is called prey.

Significance of Predation:

Predator – prey relationship has a significant effect on the distribution and abundance of organisms.

1. Maintains the Stability:

The predator – prey interaction helps maintaining the ecosystem stable.

- e.g., if a prey population increases it will support more predation as a result the population of the latter also increases.
- If the prey is killed in large numbers, then its population size will be reduced. As a result the predator's population also decreases.
- Thus food relationship of predator – prey creates a balance.

Examples:

Cat/mouse, Fox/rabbit, Seal/fish, Frog/mosquito, Hawk/small bird etc.

PARASITISM

Definition: This is an association between a host and a parasite.

Parasite is an organism, which depend upon a live organism for food shelter, protection etc.

Host is the organism, which provides the parasite with food, protection and conditions for its biological survival. The parasite may or may not harm the host.

Infestation:

Some of the parasites cause diseases. Diseases in living organisms caused by parasites are called infestation.

Examples:

1. Tape worm infestation.
2. Liver fluke infestation.

Ectoparasites:

The parasite which live outside the body of the host e.g., Fungi causing dandruff in hair, leech, mosquito, lice etc.

Endoparasites:

They live inside the body of the host e.g, tape worm in intestine of man liver flukes, many round worms, bacteria, *Entamoeba*, *Trypanosoma* etc. Moreover a parasite may be.



SYMBIOSIS

Definition:

An association between organisms, belonging to different species, which live together for mutual benefit or one partner gets benefit and other is neither benefited nor harmed, is called symbiosis.

There are two types of symbiosis:

- A. Mutualism
- B. Commensalism

A. Mutualism:

Mutualism is the type of symbiotic relationship in which both the partners get benefit from each other.

(i) Root Nodules and Bacteria:

The legume plants, pea and bean are the hosts to symbiont bacteria (*Rhizobium*), which inhabit the roots forming root nodules.

- These bacteria fix nitrogen, converting it into amino acids, which the host uses.
- In return, host provides bacteria with food and protection.

(ii) Mycorrhizae:

Mycorrhizae is an association between certain **fungi and the roots of plants**. The host may be pine, beech, heather or any other plant.

Plant gives food and it also provides the fungus with an enzyme to digest carbohydrates in leaf litter.

In return the fungus more efficiently absorbs and passes mineral ions from the soil to the host. It also releases some growth factors in plant.

There are two types of mycorrhizae:

- (a) **Endomycorrhizae** – when fungal hyphae penetrate into the cells of the root.
- (b) **Ectomycorrhizae** – when fungal hyphae are present in interstitial spaces of root tissue.

(iii) Lichens:

Lichens are dual organism composed of symbiotic association of algae or living within a fungus mycelium. The lichens grow on exposed rock surfaces and are important colonizers of bare ground (see succession).

The fungus gets food from alga, while might get protection by the fungus from intense sunlight and desiccation or the minerals absorbed by the fungus might be transferred to the alga.

B. Commensalism:

This is the type of symbiotic relationship where only one organism gets benefit from the relationship, the other is neither benefited nor harmed. For example:

Sharks and Remoras:

Sharks may have small fish called remoras (sucker fish) attached to them. As the shark feeds, the remoras pick up the scraps. The remoras benefit from this relationship the shark is not affected at all.



GRAZING

Many animals like rabbits, goat, sheep, cow, buffalo and horses feed on grasses.

Definition:

The mode of feeding on grass is called grazing and these animals are known as grazers.

These animals live in pastureland where they feed on grasses, herbs and shrub.

Moderate Grazing:

Moderate grazing is very helpful to maintain grassland ecosystem. Grasses are very tolerant of grazing but most of the tree seedlings are not. Moderate grazing destroys the competitors and helps the grass to grow well.

Over-Grazing:

If too many animals are kept on pasture, they eat the grasses down to the root.

Through grasses are more resistant than herbaceous plants and have ability to regrow very fast, but the hooves of grazing animals trample the soil into hard layer.

As a result of which rain water will not penetrate this soil. It runs off from the upper surface removing the topsoil with it. The final result of over grazing is totally barren land. Over grazing may lead to desertification.

Under Grazing:

If there is no grazing at all, the herbs, shrubs or small trees grow and grassland is spoiled.

BIOGEOCHEMICAL CYCLES

The back and forth movements of chemical elements organism and environment along particular circular paths are known as biogeochemical cycles.

Explanation:

The chemical elements essential for life in living organisms are called biogenic elements or nutrient elements.

Macronutrients are nutrients that are required by organism in large amount like, water, carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, and calcium.

Micronutrients are elements required by organisms in small quantity or in trace amount like zinc, molybdenum, iron and iodine.

The nutrients cycles are known as biogeochemical cycles as the nutrients move from living to non-living and back to living portions of ecosystem in a cyclic manner.

THE NITROGEN CYCLE

Definition:

The process by which the limited amount of nitrogen is circulated and re-circulated throughout the world of living organism and non living environment is known as the nitrogen cycle.



Explanation:

The chief reservoir of nitrogen is the atmosphere. In fact, nitrogen makes up 78 percent of the gases in atmosphere. Since most living things, however cannot use elemental atmosphere nitrogen to make amino acid and other nitrogen containing compounds. They are dependent on nitrogen in the atmosphere, shortage of nitrogen in the soil is often the major limiting factor in plant growth.

PRINCIPAL STEPS OF NITROGEN CYCLE

Three principal steps of nitrogen cycle are Ammonification, Nitrification, and assimilation.

1. Ammonification:**Definition:**

The process of conversion of nitrogen of amino acids etc to ammonia and ammonium ions is known as ammonification.

Explanation:

- Much of the nitrogen found in the soil is the result of the decomposition of organic material and is in the form of complex organic compounds, such as protein, amino acids, nucleic acid and nucleotides.
- These nitrogenous compounds are usually rapidly decomposed into simple compounds by soil – dwelling organisms chiefly bacteria and fungi.
- These micro – organisms use the proteins and amino acids and release excess of ammonia (NH_3) or ammonium ions (NH_4^+).

2. Nitrification:**Definition:**

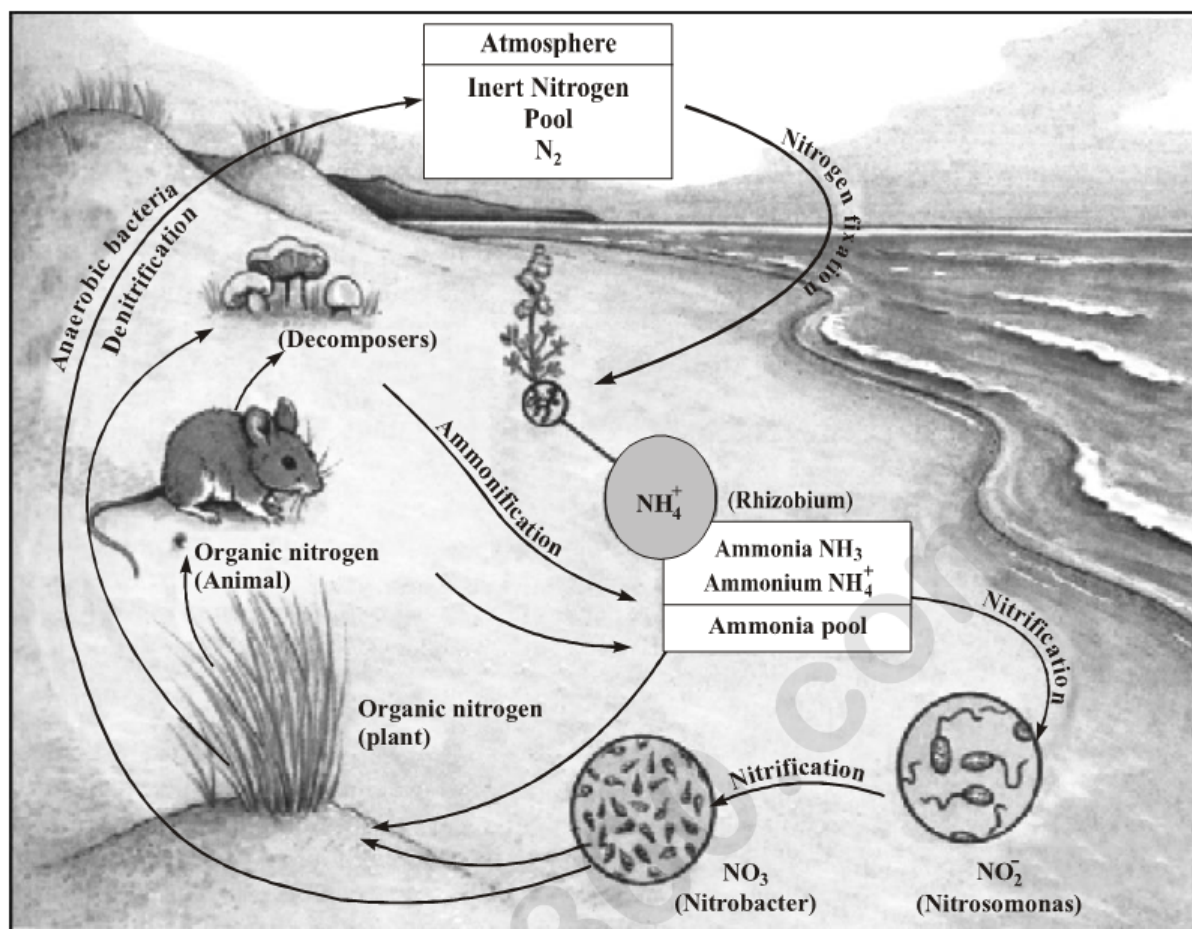
This is a process during which ammonia or ammonium ions are oxidized to nitrates, by bacteria present in soil, is known as Nitrification.

Nitrifying bacteria are responsible for nitrification.

- (a) **Nitrosomonas** --- converts ammonia to nitrites.
- (b) **Nitrobacter** --- converts nitrites into nitrates.

Although the plants can utilize ammonium directly, nitrate is the form in which most nitrogen moves from the soil into the roots.





3. Assimilation:

Once nitrates are within the plant cell they are reduced back to ammonium. This assimilation process requires energy. The ammonium ions thus formed are transferred to carbon – containing compounds to produce amino acids and other nitrogenous organic compounds needed by the plant.

Nitrogen depletion & Its Remedies

Nitrogen Fixation:

The cycle is maintained despite these losses primarily by the activities of the nitrogen – fixing bacteria, which incorporate gaseous nitrogen from it into organic, nitrogen containing compounds.

There are two types of nitrogen fixation:

Symbiotic Nitrogen Fixation:

This type of nitrogen fixation is carried out by the microorganisms like *Rhizobium* that live symbiotically in the root nodules of leguminous plants.

Just as all organisms are ultimately dependent on photosynthesis for energy they all depend on nitrogen fixation for their nitrogen.

Fertilizers:

Soil nitrogen resources are also strengthened by the addition of nitrogen fertilizers by the man himself.



THE FLOW OF ENERGY IN FOOD CHAIN

Flow of nutrients is cyclic i.e., they are used again and again but the flow of energy is linear because it flows only once through an ecosystem and is ultimately lost in the form of heat.

Energy in the form of radiant heat and light from the sun flows through an ecosystem passing through the different trophic levels (links) and radiates again back into outer space.

- The total amount of energy fixed by plants is gross primary production.

Biomass

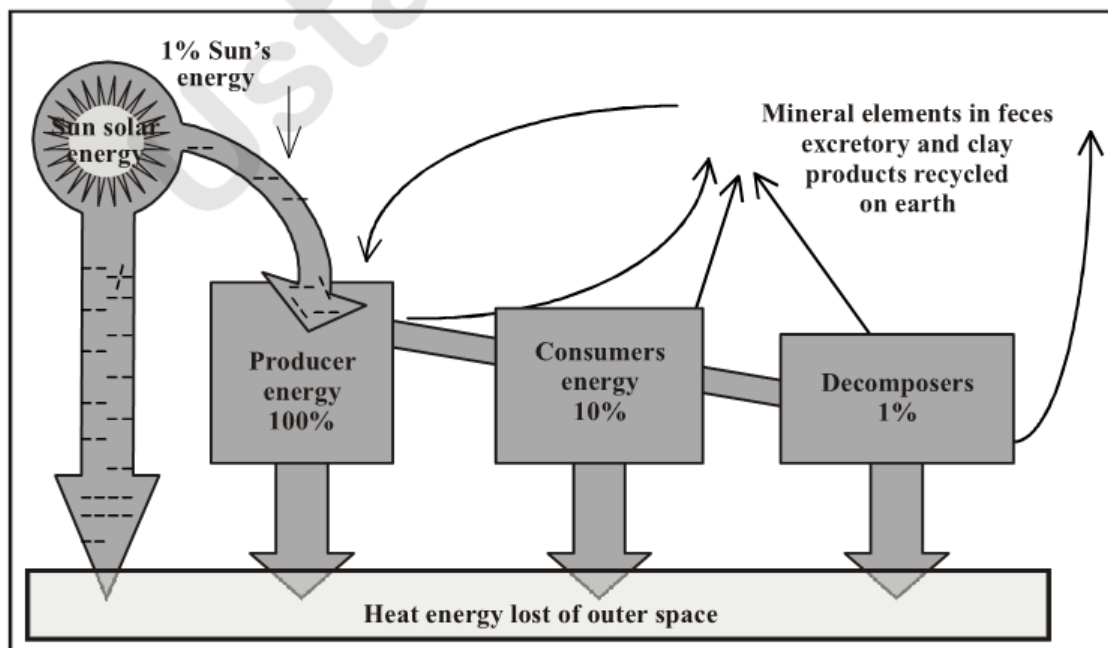
Definition:

The amount of energy left after plants have met their respiratory needs is net primary production, which shows up as plant biomass.

- About 1% of the total energy from the sun is trapped by the producers in an ecosystem.
- The remaining 99% of solar energy is used to evaporate water, heat up soil and then lost to the outer space.
- As energy is transferred from one trophic level to the next, from producers to primary consumers, between 80 to 90% of the original energy is lost as heat as a by-product of respiration.
- Decomposers are able to obtain energy by converting dead plant and animal tissues and waste into inorganic mineral ions.
- A continuous flux of energy from the sun prevents ecosystem from running down.

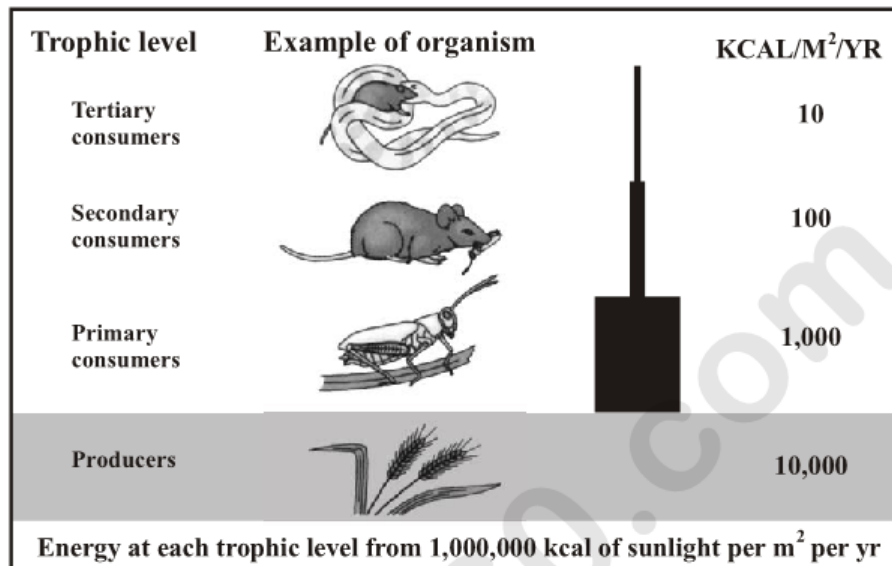
Number of Trophic levels and Energy:

A short food chain of two or three links supports a community more efficiently than a long chain of lives links where much of the original energy from the producers would never reach those organisms at higher trophic levels.



AN ENERGY PYRAMID

A pyramid is a structure formed by three triangles united together with flat base and narrow tip. Flow of energy through various steps of the ecosystem is like a pyramid having more energy in the producers and very small in consumers.



A pyramid of energy showing energy transfer in a community of organisms.



EXERCISE

Q.1 *Fill in the blanks.*

- (i) A group of similar organism living together in space and time is called _____.
- (ii) Organisms which can synthesize their own food are called _____.
- (iii) Animals, non-green plants and microorganism directly or indirectly depend upon green plants for their food so they are called _____.

ANSWERS

- | | |
|-----------------|----------------|
| (i) Population | (ii) Producers |
| (iii) Consumers | |

Q.2 *Write whether the statement is true or false and write the correct statement if false.*

- (i) At different places in an environment when you study one population, it will be synecology.
- (ii) Abiotic components include all living components.
- (iii) Primary succession may start in a pond-called reserve.
- (iv) The animal that is caught and eaten is the predator.
- (v) Endoparasites the inside the body of the host.

ANSWERS

- | | | | |
|-----------|------------|-------------|------------|
| (i) False | (ii) False | (iii) False | (iv) False |
| (v) True | | | |

Q.3 *Encircle the correct answer from the multiple choices.*

- (i) The study of relationship of an organism to their environment know as:
 - (a) Biology
 - (b) Ecology
 - (c) Zoology
 - (d) Mycology
- (ii) Similar group of individuals who can interbreed and produce organisms of their own kind forms a:
 - (a) Population
 - (b) Community
 - (c) Species
 - (d) Ecological Succession



- (iii) When living and non-living components interact to produce a stable system in which exchange of material with flow of energy takes place, it form a/an:
- (a) Environment (b) Ecosystem
(c) Stable community (d) Ecological succession
- (iv) The living organisms which can prepare their own food are:
- (a) Predators (b) Parasites
(c) Producers (d) Prey
- (v) The living organisms, which cannot prepare their own food, but obtain ready-made food from others, are:
- (a) Primary and secondary consumers (b) Secondary and tertiary consumers
(c) Only primary consumers (d) Consumers

ANSWERS

(i)	(b)	(ii)	(c)	(iii)	(b)	(iv)	(c)
(v)	(d)						

Q.4 Short Question:

(i) What are biogeochemical cycles?

Ans: See text.

(ii) Sketch three main steps in Nitrogen cycle.

Ans: See text.

(iii) Define grazing.

Ans: See text.

(iv) What percentage of sun energy reaches to plants?

Ans: See text.

(v) What is auto-ecology?

Ans: See text.

(vi) Define syn-ecology.

Ans: See text.



Q.5 Extensive Question:

- (i) **Define the environment? What must environment supply for insects, green plants, birds, animals and people?**

Ans: See text.

- (ii) **What factors in the environment can affect all living things? Are they important to survive in Biome?**

Ans: See text.

- (iii) **What can you conclude about all the physical and biological factors in an environment?**

Ans: See text.

- (iv) **What is biosphere? What the biosphere provide for living things? Why is a biosphere absent on moon.**

Ans: See text.

- (v) **Define succession. Discuss succession in a pond.**

Ans: See text.

