

Chapter 25 Ecosystem

25.0 INTRODUCTION

The term ecology comes from the Greek words i.e.

- 'Oikos' meaning 'the family household'
- 'Logos' meaning 'the study of'

This term was first used by 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 both physical and biological conditions.

25.1 ECOSYSTEM

It is the major unit of ecology.

The 'eco' part of the word is related to the environment and the 'system' part means a collection of related parts that function as a unit.

Definition

A biological community together with the associated abiotic environment constitutes an ecosystem.

Components of Ecosystem

It consists of two basic interacting components i.e.

- 1) The living or biotic, components consist of animals, plants, fungi, microorganisms etc.
- 2) The physical or abiotic components, consisting of atmosphere, climate, soil and water.

Levels of Ecosystem

The ecosystem has many levels.

1) Individual Level

Individual organism, including man, both respond to and influence the physical environment.

2) Population

Population is a group of interbreeding individuals (same species) occurring together in space and time.

- Populations of plants and animals in the ecosystem do not function independently.
- Some populations compete with other populations for resources such as food, water or space.
- In some cases. One population is the food resource for another.
- Two populations may mutually benefit each other.

3) Community

All populations within an ecosystem are known as a community.

4) **Biome**

Major types of ecosystems, those that occupy broad geographical regions are called biomes.

- Each biome consists of combination of plants and animals in the fully developed climax community.
- Each biome is characterized by a uniform life form of vegetation such as grass or coniferous trees.
- Some major terrestrial biomes i.e. forest, grassland and desert. Combined the biome of earth together form the planetary ecosystem.

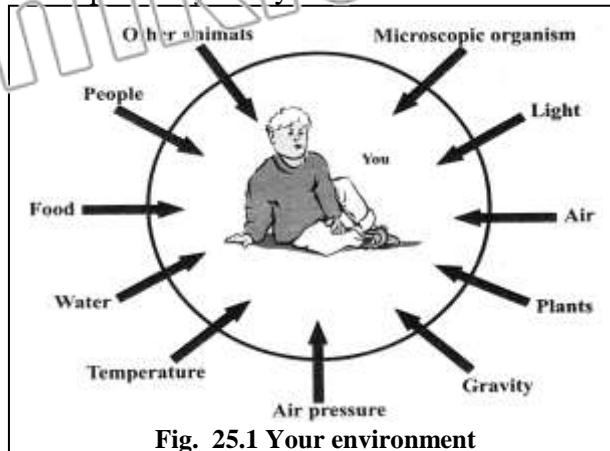


Fig. 25.1 Your environment

QUESTIONS RELATED TO ABOVE ARTICLE

Define ecosystem? Explain its various components. (GRW 2022, RWP 2022)

What factors in the environment can affect all living things? Are they important to survive in biome? (Exercise Question ii)

25.1.1 Biosphere

Definition

Biosphere is thin layer of earth in which all living organisms exist.

Limits of Biosphere

It is spread over the surface of earth extending about 8–10 kilometers above in atmosphere and also same distance in depths of oceans.

Components

a) **Habitat**

The actual location of place where an organism lives is called its habitat.

b) **Niche**

- A niche is defined as the role a species plays in a community including behavior and influence.
- Habitat and niche are closely related.
- It was first proposed by an American Ornithologist Joseph Grinnell in 1917. According to him, niche is an ultimate distributional unit within which a species is restrained by the limitations of its physical structure and its physiology.
- Charles Eton considered the niche as the basic role of an organism in the community including behavior and influence i.e. specie's occupation.

QUESTIONS RELATED TO ABOVE ARTICLE

Define the following terms

- (i) Habitat
- (ii) Niche
- (iii) Food web
- (iv) Succession

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

What is biosphere? What must the biosphere provide for living things? Why a biosphere on moon is absent? (Exercise Question iv)

25.1.2 Autecology

Definition

Study of a single population's relationship to its environment is called autecology

Example

For example, study of effect of water pollution on growth and yield of 50 to 100 soybean plants.

25.1.3 Synecology

Definition

Study of relationship of different communities to their environment is called synecology or community ecology.

Example

In synecology we study origin, structure, composition, history and dynamics of community.

Levels of Integration

While studying the community, we come across three levels of integration i.e.

- i) Individual
- ii) Population
- iii) Community

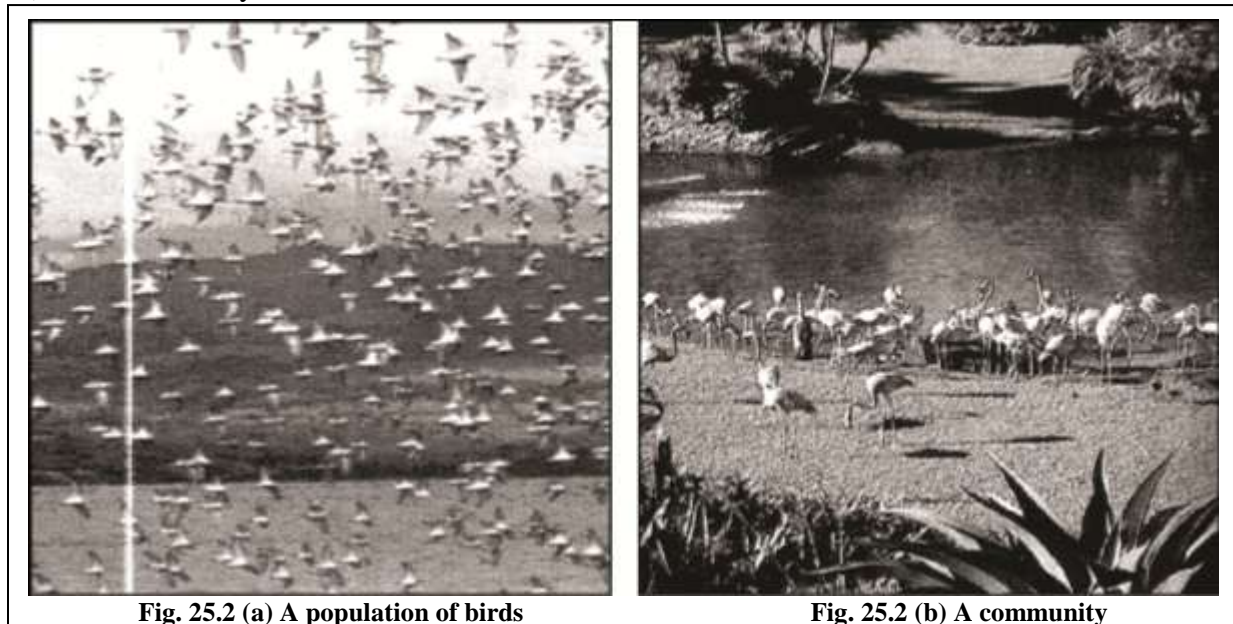


Fig. 25.2 (a) A population of birds

Fig. 25.2 (b) A community

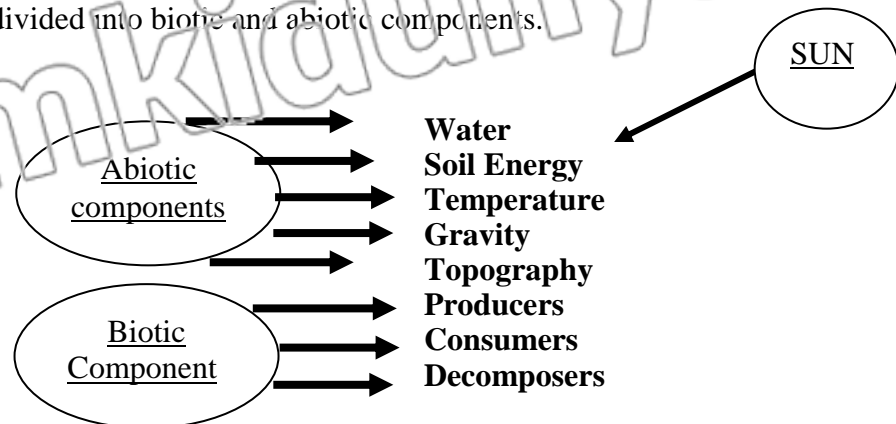
QUESTIONS RELATED TO ABOVE ARTICLE

Define Synecology.

(LHR 2005)

25.1.4 Components of Ecosystem

Ecosystem can be divided into biotic and abiotic components.



25.14. a Biotic Components of Ecosystem**Definition**

Living organisms of an ecosystem are called biotic components.

Components

An ecosystem is made up of three main biotic components i.e.

i) Producers

- These are 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.

ii) Consumers:

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

iii) Decomposers

- They obtain energy from dead and decaying plants and animals by causing their decomposition.
- They are mainly fungi and bacteria.
- They release chemical elements as ions especially of nitrates, ammonia, phosphates, potassium and calcium.

25.14 b Abiotic Components of Ecosystem**Definition**

Non-living components of ecosystem are called abiotic components.

Components

In ecological terms, they are;

i) Atmosphere

‘Atmo’ meaning ‘air’.

‘Sphere’ meaning ‘place’.

It includes air, wind, temperature, light etc.

ii) Hydrosphere

‘Hydro’ means ‘water’.

‘Sphere’ means ‘place’.

It includes water and dissolved minerals.

iii) Lithosphere

‘Litho’ means ‘earth or soil’.

‘Sphere’ means ‘place’.

It includes soil and minerals.

25.1.5 Food Chain**Definition**

Transfer of food from one organism to another through process of eating and being eaten is called food chain.

Example

Eagle may eat blue bird; blue bird eats insects (caterpillar) and caterpillar feeds on grass or green leaves.

25.1.6 Food Web**Definition**

Different food chains are combined together to form food web.

Trophic Levels

All food chains and food webs begin with a green plant (producer) and may consist of three to five links or trophic levels.

T₁ is the first trophic level of producers including all green plants, grass and phytoplankton.

T₂ is second trophic level of primary consumers.

T₃ is third trophic level of secondary consumers.

T₄ is fourth trophic level of tertiary consumers.

T₅ is fifth trophic level of decomposers.

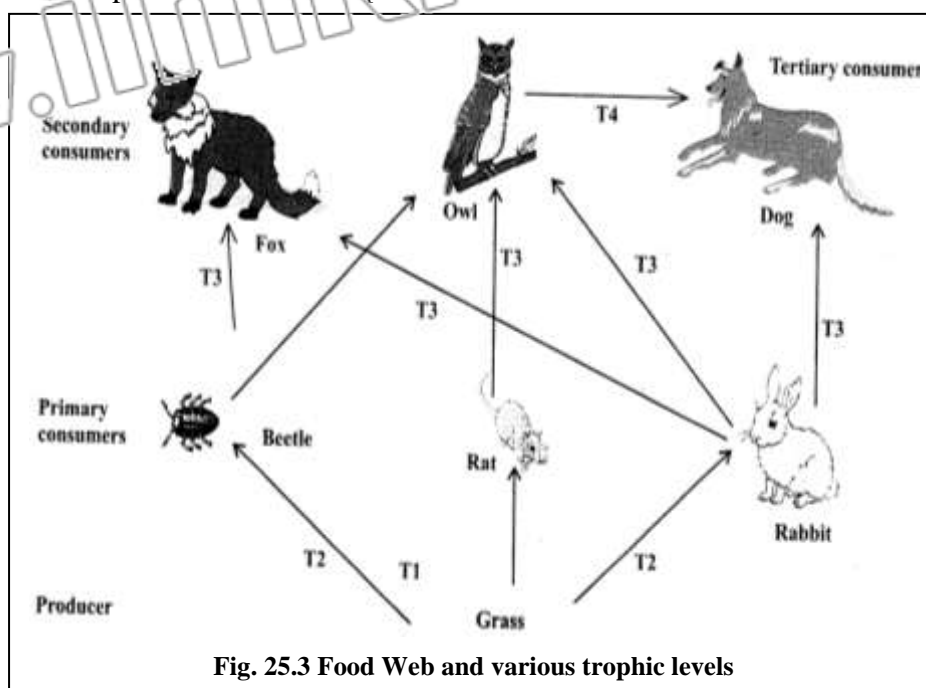


Fig. 25.3 Food Web and various trophic levels

Stability of Food Web

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

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

QUESTIONS RELATED TO ABOVE ARTICLE

Explain food web with diagram.

Explain food web and its trophic levels.

(LHR 2017)

Define ecosystem. Explain its various biotic components.

(GRW 2017)

Describe the components of ecosystem.

(GRW 2018)

Compare food chain with food web.

(RWP 2019, SGD 2021)

Define ecosystem. Discuss its components and their interaction.

(LHR 2021)

What is food web? Give its significance. Draw a food web.

(LHR 2022)

Discuss food chain and food web with graphic sketch.

(DGK 2022)

Write a note on food the chain and food web.

(SGD 2022)

What can you conclude about all the physical and biological factors in an environment?

(Exercise Question iii)

25.2 SUCCESSION

Definition

Succession is a sequence of changes in the community structure of an ecosystem over a period of time.

Features

- i) It acts as a community relay.
- ii) Plants and animals replace one another in a sequence that is at least predictable.
- iii) Community changes alter the ecosystem in ways that favors the competitors and species to replace their predecessors in somewhat predictable manner until a stable, self-sustaining climax community is reached.
- iv) The precise changes occurring during succession are as diverse as the environment in which succession occurs.

Start and End of Succession

- Few hardy invaders, which start the succession, are called pioneers.
- Diverse and relatively stable form at the end of succession is called climax community.

25.2.1 Major Forms of Succession

Succession of dry land takes two forms i.e.

- (i) Primary succession
- (ii) Secondary succession

Primary Succession

Ecosystem is forged from a bare rock, sand or clear glacial pool, where there is no trace of previous life, is called primary succession.

It requires thousands of years to be completed.

Secondary Succession

Formation of a new ecosystem after an existing ecosystem is disturbed (as in case of forced fire or an abandoned farm field) is called secondary succession.

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

Types of Primary Succession

Primary succession is of two types:

- a) *Hydrosere* which starts in a pond
- b) *Xerosere* which starts on dry habitat

25.2.2 Xerosere Succession

It starts in totally dry habitat.

Plants growing in xeric condition 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, other have leaf modification.

Following stages are associated with xerosere.

25.2.2 (a) Crustose Lichen Stage

It refers to land, lifeless structure or any external protective layer surface on the rock. Special types of lichens get impregnated in the form of crust.

- They can live in extreme conditions.
- Their surface is wet due to rain and dew-drops.
- They absorb water during dry season.
- They are quiescent or dormant, normally desiccated during dry season.

25.2.2 (b) Foliage Lichen Stage

In this stage, the lichens are just like crumpled leaves attached at one point

- It produces shade to the crustose lichens as a result of which their growth is reduced or decreased. The area becomes rough with more and more fissure and depressions develop.
- Common examples are *Dermatocarpon*, *Permelia* etc.
- This stage sets porous soil with some litter for moss stage.

25.2.2 (c) Moss Stage

- It is the third stage with mosses like *Polytrichum*, *Tortula* etc.
- They compete with lichens for water and penetrate much deeper in soil as compared to the lichens adding more humus to the soil.

25.2.2 (d) Herbaceous (Plant) Stage

Small seedling of herbaceous plants now establishes due to the more availability of moisture, humus and soil for anchorage.

25.2.2 (e) Shrub Stage

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

25.2.2 (f) Climax Forest

Establishment of woody plants is facilitated by improved soil. The shade of these plants inhibits the growth of most plants other than mosses, lichen, a few ferns etc.

Woody plants dominate and this stage in succession remains same if no change occurs in environment to upset the balance. It is stable stage in succession, the woody forest is considered to be the climax stage for this region.

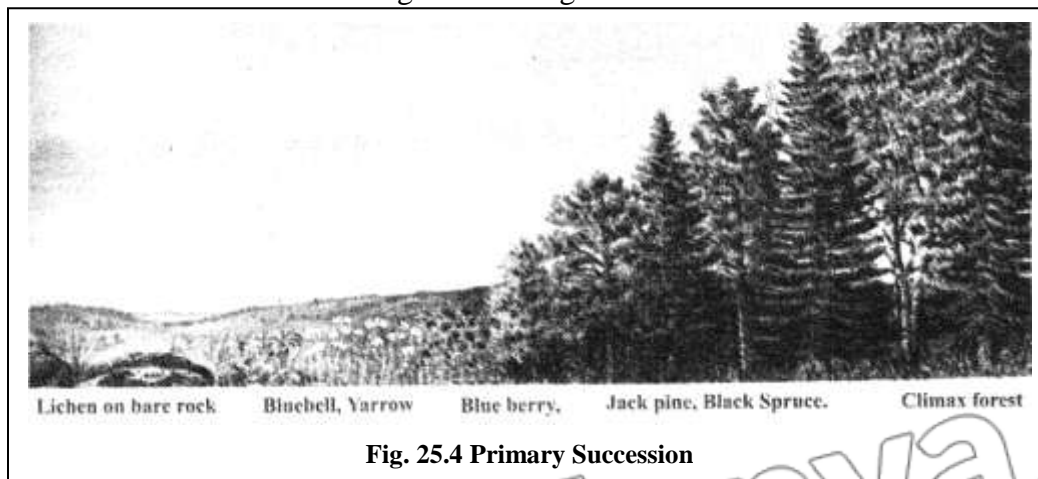


Fig. 25.4 Primary Succession



QUESTIONS RELATED TO ABOVE ARTICLE

What is succession? Describe process of succession on a dry soil.

(LHR 2017, LHR 2018)

Describe two major forms of succession.

(GRW 2019)

Describe different stages of succession in xerosere.

(RWP 2021)

Define succession. Discuss succession on land.

(Exercise Question v)

25.3 PREDATION AND ITS SIGNIFICANCE

Definition

- An animal that preys other animals is a predator. A predator is a consumer.
- The animal that is caught is the prey.
- The overall process is called predation.

Significance & Relation

The sizes of populations of predator and prey are related to each other. The size of each population is determined by the size of the other.

- If number of prey is large, this leads to an increase in number of predators. As predator feeds upon the prey, the number of prey begins to fall.
- The number of predators decreases with decrease in prey as they have smaller food supply. As the number of predators decreases, the number of prey begins to increase. This food relation ship of predator-prey creates a cycle.

Examples

Cat and mouse, fox and rabbit, seal and fish, frog and mosquito, hawk and small birds.

25.4 PARASITISM AND ITS SIGNIFICANCE

Definition

This is an association between a host and a parasite, which involves providing the parasite with food, protection and conditions for its survival.

Significance

- Parasite may or may not harm the host.
- Mostly, they cause diseases in their host.
- Diseases in living organisms which are caused by parasite are called infestations.

Types & Examples

There are two types of parasites

- Ectoparasites; living outside the body of host e.g. fungi causing dandruff in hair.
- Endoparasites; living inside the body of the host e.g. tapeworm in intestine of man.

25.5 SYMBIOSIS

Definition

It is an association between two organisms, which brings benefit to both the organism.

Types

There are two important types of symbiosis.

25.5 (a) Mutualism

Definition

It is association in which both organisms are benefited.

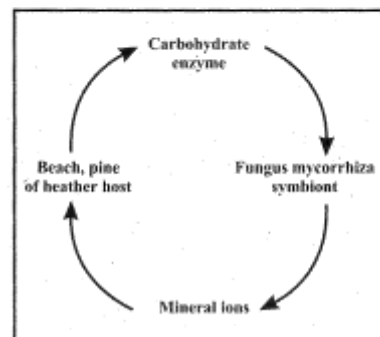
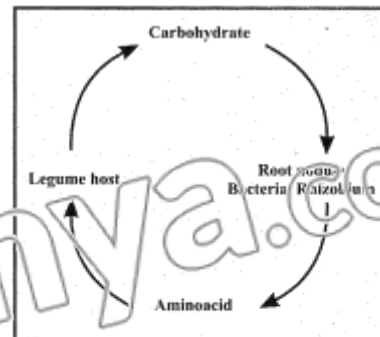
Examples

i) Lichens

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

ii) Root Nodules

The legume plants (pea and bean) are hosts to symbiont bacteria, which inhabit the roots forming root nodules. The root nodules bacteria fix nitrogen in soil air, converting it into amino acids, which the host uses. In return host provides bacteria with food and protection.



25.5 (a . ii) Mycorrhiza

It is an association between the roots of plants growing in acid soil and certain fungi. The host is pine, beech or heather and it provides the fungus with an enzyme to digest carbohydrates in leaf litter.

In return the fungus symbiont passes mineral ions from soil to the host.

25.5 (a . iii) Insects & Flowers

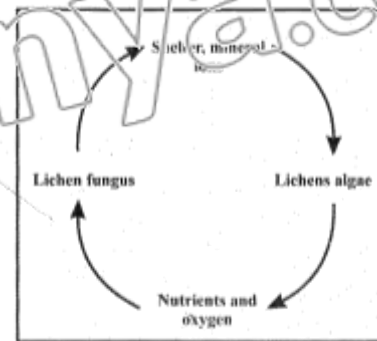
The insects get nectar from the flower. The flowers are able to reproduce because the insects carry pollen from flower to flower.

25.5 (b) Commensalism**Definition**

In this type of relationship only one organism is benefited from the relationship. The other is not affected at all.

Example

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

**QUESTIONS RELATED TO ABOVE ARTICLE**

Describe predation and parasitism and their significance.

Describe the symbiotic relationships in organisms.

(SGD 2019)

Describe symbiosis mutualism.

(FSD 2021)

What is predation? Write significance of predation.

(FSD 2021, FSD 2022)

25.6 GRAZING**Definition**

Many animals like rabbits, goat, sheep, cows, buffaloes and horses feed on grasses. This mode of feeding is called grazing and these animals are called grazers.

Effects

Grazing is very important factor in determining the ecosystem.

- Moderate grazing is very helpful to maintain grassland ecosystem. It destroys the competitors and helps the grass to grow well.

- Overgrazing may lead to the transformation of grassland into a desert.

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

If too many animals are kept on pasture, they eat the grasses down to the root. Though 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 top soil with it.

The final result of overgrazing is totally barren land.

25.7 BIOGEOCHEMICAL CYCLES**Definition**

Process through which different chemicals circulate between environment and living organisms in form of cyclic way is called biogeochemical cycle.

Essential Nutrients Required by Organisms

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

- Macronutrients are elements required by organisms in large amount like water, carbon, hydrogen, oxygen, nitrogen, phosphorous, sulphur and calcium.
- Micronutrients are elements required by organisms in small quantity or in trace amount like zinc, molybdenum, iron and iodine.

25.7.1 The Nitrogen Cycle**Definition**

The process by which nitrogen is circulated and re-circulated throughout the world of living organisms is known as nitrogen cycle.

Main Reservoir of Nitrogen

The chief reservoir of nitrogen is the atmosphere. Nitrogen makes up 78% of the gases in atmosphere.

Organisms cannot use elemental atmospheric nitrogen to make amino acid and other nitrogen containing compounds, they are depending on nitrogen present in soil minerals.

Stages of Nitrogen Cycle

Three principal stages of nitrogen cycle are;

- 1) Ammonification
- 2) Nitrification
- 3) Assimilation

25.7.1 (a) Ammonification

Most of the nitrogen found in the soil is the result of the decomposition of organic materials and is in the form of complex organic compounds such as protein, amino acids, nucleic acid and nucleotides.

These nitrogenous compounds are decomposed into simple compounds by soil-dwelling organisms chiefly bacteria and fungi.

These microorganisms use the protein and amino acids and release excess of ammonia (NH_3) or ammonium ions (NH_4^+). This process is known as ammonification.

25.7.1 (b) Nitrification

Several bacteria in soil are able to oxidize ammonia or ammonium ions. This oxidation is known as nitrification.

25.7.1 (c) Assimilation

Nitrate is the form through which most nitrogen moves from the soil into the roots.

Once nitrate is within the plant cell, it is reduced back to ammonium in contrast to nitrification. 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 plants.

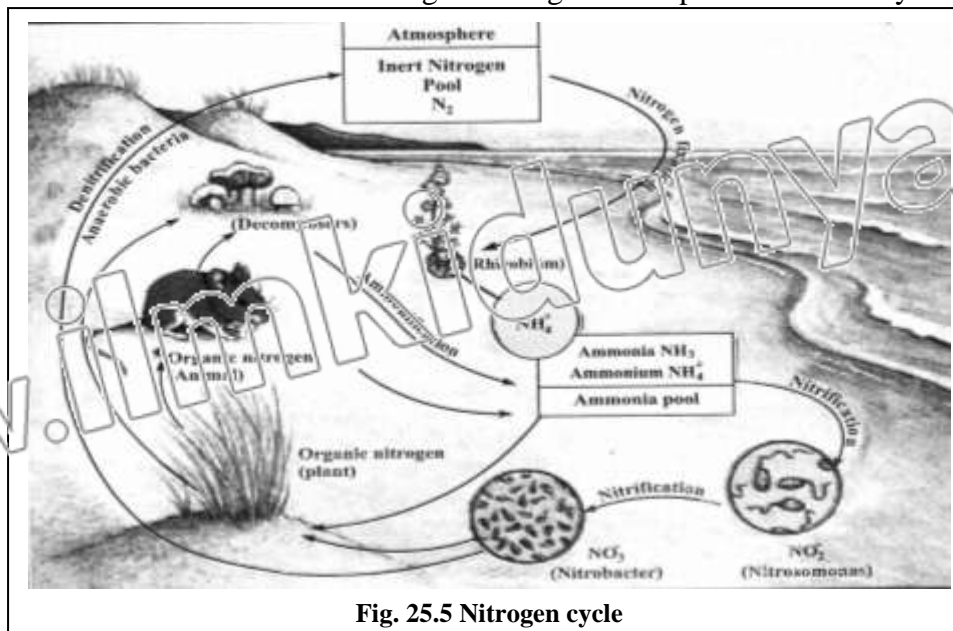


Fig. 25.5 Nitrogen cycle

NITROGEN DEPLETION AND ITS REMEDIES**Loss of Soil Nitrogen**

- Soil nitrates are lost from soil erosion, fire and water percolating down through the soil.
- Certain soil bacteria break down nitrates in absence of oxygen, releasing nitrogen back into the atmosphere and using oxygen for their own respiration. This process is known as denitrification.

Compensation of Loss by Nitrogen Fixation

Nitrogen fixing bacteria incorporate gaseous nitrogen from air into organic nitrogen-containing compounds.

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

Remedy for Nitrogen Depletion

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

QUESTIONS RELATED TO ABOVE ARTICLE

Describe the phenomenon of grazing. (FSD 2019)

Describe nitrogen cycle in detail. (LHR 2019, BWP 2021, SWL 2022)

Discuss nitrogen depletion and its remedies. (LHR 2022)

Describe nitrogen cycle in detail emphasizing three principal stages ammonification, nitrification and assimilation. (BWP 2022)

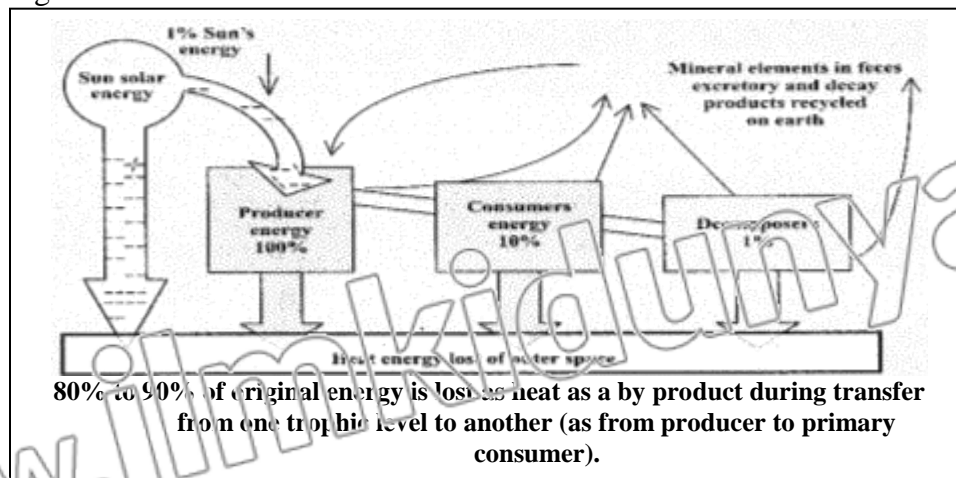
25.8 FLOW OF ENERGY IN FOOD CHAIN OF AN ECOSYSTEM

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

Energy Transfer

- The total amount of energy fixed by plants is *gross primary productions*.
- The amount of energy left after plants have met their respiratory needs is *net primary production*, which shows up as plant biomass.

A pyramid of energy can be constructed showing energy transfer in a community of organisms.



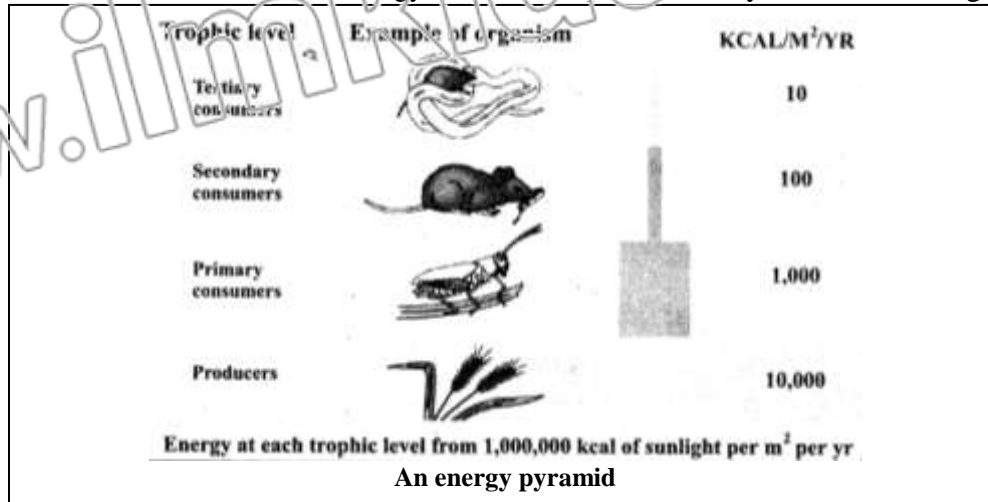
▲ A short food chain of two or three links supports a community more efficiently than a long chain of five links where much of the original energy from the producers would never reach those organisms at higher trophic level.

Decomposers are able to obtain energy by converting plant and animal tissues and waste into inorganic mineral ions.

Energy Loss in Ecosystem

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 outer space.

- However, a continuous flux of energy from the sun prevents ecosystem from running down.



QUESTIONS RELATED TO ABOVE ARTICLE

Discuss the flow of energy in food chain of an ecosystem. (LHR 2018, LHR 2019, MTN 2022)

KEY POINTS**Age distribution**

The division of a population into different age groups is called age distribution. For example, in case of human population a chart is made. This chart has columns showing age 10, 20, 30, 40, 50, 60, 70, 80. Number of individuals of a population are added in each concerned column.

Climax community

A uniform community with dominant woody trees is called climax community. Generally, very little changes take place in a climax community. A climax community is generally represented by some dominant trees.

Trophic level

Each level of feeding is called trophic level. For example, producers form first trophic level, primary consumers form second trophic level and so on.

Succulent plants

The plants with fleshy stem or leaves are called succulent plant. These fleshy leaves or stems are used for the storage of water. For example, cacti

Humus

The decomposed organic matter present in the soil is called humus. It is formed by partial decomposition of dead plant leave and animals.

Limiting factor

The factor present in lowest amount in an ecosystem is called limiting factor. The limiting factor inhibit the growth of plant. For example, if there is small amount of CO₂ in the air. Then it becomes limiting factor. It can stop the process of photosynthesis.

EXERCISE

Q 1 Fill in the blanks.

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

Ans i) Population ii) Autotroph
iii) Heterotroph

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

Q 3 Encircle the correct answer from the multiple choices.

- i) The study of relationship of an organism to their environment is known as:
(a) Biology (b) Ecology
(c) Zoology (d) Mycology

- ii) Similar groups of individuals who can interbreed and produce organisms of their own kind forms a:
(a) Population
(b) Community
(c) Species
(d) Succession

- iii) When living organism and non-living components interact to produce a stable system in which exchange of material with flow of energy takes place, it forms a/an:

(a) Environment (b) Ecosystem
(c) Stable community (d) Ecological succession

- iv) The living organism 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

1	b
2	c
3	b
4	c
5	d

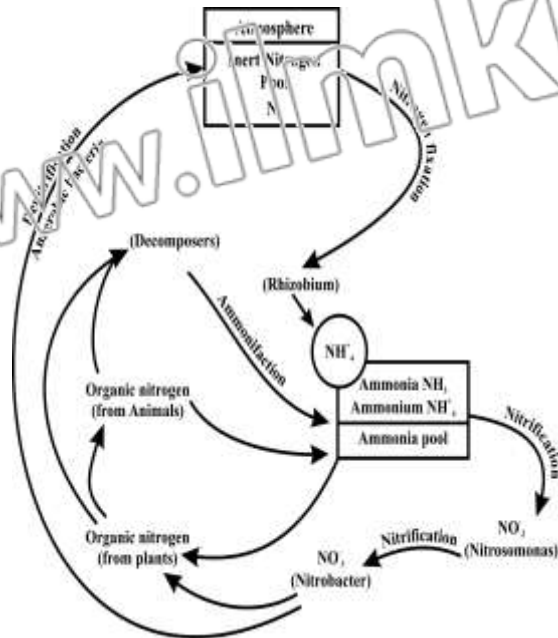
Q 4 Short Questions

- i) What is the biogeochemical cycle?

Ans: Process through which different chemicals circulate between environment and living organisms in a cyclic way is called biogeochemical cycle.

ii) Sketch the main steps in nitrogen cycle.

Ans:



iii) Define grazing.

Ans: Many animals like rabbits, goat, sheep, cow, buffalo and horses feed on grasses. This mode of feeding is called grazing and these animals are called grazers.

iv) What percentage of sun energy reaches to plants?

Ans: 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 is then lost to the outer space.

v) What is autecology?

Ans: Study of a single population's relationship to its environment is called autecology. For example, study of effect of water pollution on growth and yield of one soybean population.

vi) Define synecology.

Ans: Study of relationship of different communities with environment is

called synecology or community ecology.

Q 5 Extensive Questions.

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

(See article 25.1)

ii) What factors in the environment can affect all living things? Are they important to survive in biome?

(See article 25.1)

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

(See article 25.1)

iv) What is biosphere? What must the biosphere provide for living things? Why a biosphere on moon is absent?

(See article 25.1.1)

v) Define succession. Discuss succession on land.

(See article 25.2)