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ECOLOGY & ENVIRONMENTAL BIOLOGY

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ECOLOGY & ENVIRONMENTAL BIOLOGY

(For U.G. Students of all Indian Universities)

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PREFACE

This book is meant for undergraduate (B.Sc.) students of all Indian Universities to understand the ecology and environmental biology in easily understandable language.

We owe our special gratitude to the Principal and Management for their moral support and providing necessary facilities.

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We express our sincere thanks to all Members and Chairman, Board of Studies in Botany, S.R.T.M. University, Nanded (M. S.), Dr. B. A. M. University, Aurangabad (M.S.) and North Maharashtra University, Jalgaon (M.S.) for their help in this regard.

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Lastly, we thank our publisher for publishing this book in very short period.

Helpful suggestions for improvement of this book are welcome.

Dr. D. P. Gadgile
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Dr. R. S. Gaikwad
Dr. V. R. Patil

CONTENTS

INTRODUCTION

Ecology is branch of life science, which deals with the study of relationships between living things and their physical environment. The word ecology was coined by Ernst Haeckel in 1869.The term ecology is derived from Greek words namely Oikos= home and Logos= study. There are many definitions of ecology. E.P. Odum (1969) defined the ecology as "the study of interrelationship between living things and environment'. Charels Elton (1927) defined the ecology as "the study of living organisms (animal and plants) in relation to their habits and habitats." Krebs (1985) defined ecology as "the scientific study of the relations that determine the distribution and abundance of living things."

On the basis of taxonomic affinities ecology classified in to two types: plant ecology and animal ecology. Based on the level of organisms or individuals, ecology divided in to two types : autoecology and synecology. Autoecology is the study of individual organisms in relation to the environment. Synecology is the study of whole communities of organisms.

Scope of Ecology

- The knowledge of ecology helps in controlling the environmental pollution.
- Ecology gives information about conservation awareness.
- Ecology play important role in human welfare.
- Ecology helps to control soil erosion and deforestation.

- The knowledge of ecology is being applied in food production, agriculture, agronomy and horticulture.
- Plant ecology is directly related to sivics and siviculture.
- Ecology helps to find out the alternative food sources and new energy sources.

Levels of Organization in Ecology

There are five main levels of organization in ecology:

a) Individual: Individual is any living thing. Individuals have its own environment with which interacts.

b) Population: It includes all groups of individuals of the same species (of plants, animals, micro organisms etc.) which live together in one geographical area at the given time.

c) Community: A community is an assemblage of populations of diverse species occupying a particular area.

d) Ecosystem: Ecosystem is the structure and functional unit of ecology. The term refers to all the non-living factors and all the communities that established in a particular area.

e) Biosphere: Biosphere is the sum of all the ecosystems established on earth.

Summary

- ✓ Study of interrelationship between living organisms and environment is known as ecology.
- ✓ Dictionary meaning of ecology is study of organism at home.
- ✓ Study of environment relation to species and whole community are known as autoecology and synecology respectively.

- ✓ Ecology helps to control pollution, soil erosion, deforestation and its knowledge is applied in agriculture and conservation.

Question Bank

Q.1. What is ecology?
Q.2. Define ecology and give its scope

MCQ (Multiple Choice Questions)

1. Study of relationships of organism with each other and their environmental surrounding is known as _____.
   a) Ecology b) Anatomy
   c) Embryology d) Histology

2. Who coined term ecology _____.
   a) Ernst Haeckel b) Odum
   c) Charels Elton d) Krebs

3. Study of individual organisms in relation to the environment _____.
   a) Synecolgy b) Autoecolgy
   c) Ecology d) None of the above

4. Study of whole community in relation to the environment _____.
   a) Synecolgy b) Autoecolgy
   c) Ecology d) None of the above

1. Introduction

Answers of Multiple Choice Questions (MCQ)

1.	(a)	2.	(a)
3.	(b)	4.	(a)

2

ECOLOGICAL (ENVIRONMENTAL) FACTORS

Environment is the sum total of all living and non-living factors that surround and potentially influence an organism. Simply environment means surroundings. Environmental factors affect the existence, organization and metabolisms of living organisms. Ecological factors are usually divided into two types:

A) Abiotic factors and
B) Biotic factors

A) Abiotic Factors

Abiotic factors are also known as physical ecological or non-living environmental factors. Abiotic factors are subdivided into following types:

a) Climatic factors
b) Topographic factors
c) Edaphic factors
d) Catastrophes

a) Climatic Factors

Climatic factors mainly includes: i) Light ii) Temperature iii) Water iv) Atmosphere.

i) Light

Light is an important climatic factor in the ecosystems because it constitutes the chief supply of energy for organisms. The sole source of light in ecosystem is sun. Light play significant role in ecosystem. On the basis of light penetration, the ocean has been separated into three zones: a) **euphotic zone** b) **disphotic zone** and c) **aphotic zone.** Euphotic zone and disphotic zones are measuring up to 50 meters depth and 80 to

200 meters depth respectively. Aphotic zone is lie below the 200 meters in depth. On the basis of light requirement, plants have been categorized into main two types: a) **heliophytes** and b) **sciophytes.** Heliophytes require low light for best growth. Sciophytes grow best in diffused light. It is one of the most important climatic factors for many important processes of plants and animals. Light influences numerous physiological processes of plants and animals. In plants, light affects the process of photosynthesis, chlorophyll development, flowering, seed germination, fruiting, transpiration, stomatal movement, plant movements etc. In animals, light affects the metabolism, pigmentation, eye development, reproduction etc. Light also play vital role in biological rhythms of plants and animals.

ii) Temperature

As like the light, temperature is also an important climatic factor in the ecosystem. It play essential role in ecosystem. Temperature affects distribution of plants. On the basis of temperature condition, total vegetation of world is divided into four groups: a) megatherms b) microtherms c) mesotherms and d) hekistotherms. Megatherms plants require high temperature throughout the year. e.g. tropical rain forest. Microtherms require low temperature for their best growth. e.g. coniferous forest. Mesotherms grow in high and low temperature alternatively. e.g. deciduous forests. Hekistotherms need very low temperature for their best growth. e.g. alpine forest. On the basis of temperature gradients, lake is divided into three strata: a) epilimnion b) metalimnion and c) hypolimnion. In epilimnion layer, temperature decreases slowly. In metalimnion stratum, temperature falls rapidly. Hypolimnion is bottom zone of lake where no temperature gradient is evident. On the basis of thermoregulation, animals are classified into two groups: a) homeothermic and b) poikilothermic. Homeothermic animals keep their body temperature constant irrespective of environmental temperature. These animals are known as endothermic or warm-blooded animals. e.g. birds, mammals etc. Poikilothermic animals are not able to maintain their body temperature at constant level. These animals are known as ectothermic or cold-blooded animals. e.g. snakes, frogs, fishes etc. In plants, temperature influences the distribution,

photosynthesis, respiration, transpiration, reproduction, seed germination, growth, development etc. In animals, it influences the metabolism, reproduction, sex ratio, growth, development, pigmentation, morphology, distribution etc.

iii) Water

Water is an essential factor for the growth and development of both plants and animals. Water play vital role in various organic chemical processes, for example water molecules are used during the photosynthesis. In ecosystem water is present in several forms. Rain fall is main source of water in ecosystem. Annual rainfall decides the vegetation of any ecosystem. Humidity in air or atmospheric water is different source of water in ecosystem. Humidity in air influences the transpiration in plants. Few plants like orchids, mosses etc. make direct use of this form of water. Humidity in air affects the germination of spores of microbes (bacteria, fungi etc.).

iv) Atmosphere

Arial mantle surrounding the earth is known as earth's atmosphere. The term atmosphere is derived from Greek words namely atmos= vapor and sphaira = sphere.

Composition of Earth's Atmosphere

Atmosphere contains the gases like nitrogen (78%), oxygen (21%), argon (0.9%), carbon dioxide (0.03%) and trace gases (neon, helium, krypton, xenon etc.). It also contains water vapor in small amounts.

Layers of Earth's Atmosphere

Earth's atmosphere is divided into following four layers:

i) Troposphere
ii) Stratosphere
iii) Mesosphere
iv) Ionosphere

i) Troposphere: It is stratum closest to the earth surface. It is about 18-20 km from earth surface. Water vapours, clouds, dust and precipitation found in this layer. In this layer, temperature typically decreases up to -60° C.

ii) Stratosphere: Next to troposphere, stratosphere is present. It is about 50 km from earth surface. In this layer, thin layer of ozone is present. Ozone absorbs the ultraviolet radiation from the sun. In this layer, temperature increases up to 90° C.

iii) Mesosphere: This layer present after stratosphere. This layer starts at 50 km from earth surface and extends up to 90 km. Top of this layer is coldest zone of earth's atmosphere. In this layer, temperature decreases up to -90° C.

iv) Ionosphere: Above the mesosphere is the ionosphere. This layer is also known as thermosphere. This layer starts at 90 km from earth surface and extends up to 500 to 1000 km. In this layer, ionized particles occur. It is very thin layer. In this layer, temperature increases beyond 1000° C.

b) Topographic Factors

Topographic factors are also known as physical geographical factors. Topographic factors include altitude, steepness of the slope and direction of mountains. Topographic factors influence the distribution of plants and animals.

c) Edaphic Factors (Soil)

Edaphic factors are also known as soil factors. Edaphic factors related to properties of soil. The word soil is derived from the Latin word solum (= earthy material in which plants grow). Soil provides water, mineral nutrients and support to the plants. The discipline of science which deals with the study of soil is called as soil science or pedology.

Soil Components

Soil is complex mixture of following components:

I) Inorganic matter
II) Organic matter
III) Soil water
IV) Soil air
V) Living organisms.

I) Inorganic matter: Inorganic matter or minerals matter is present in the form of particles of varying size: gravel, stones, sand, clay and silts.

II) Organic matter: Soil organic matter is present in small amount but it is very important because it is major source of the key soil nutrients viz. phosphorous, nitrogen and sulphur, it induces the water holding capacity of soil. Soil organic matter is

present in the form of litter, duff and humus. Litter is undecomposed organic matter. Litter includes all fresh and dead organic matter of plants and animals fallen recently on the ground. Litter decomposes slowly and when it is partly decayed, it is called duff. Humus or humic substance is completely decayed organic matter. Humus is black colored, amorphous and colloidal mixture of complex organic matter.

III) Soil water: Soil water is present in the four forms: hygroscopic water, chemically bound water, gravitational water and capillary water. Hygroscopic water is present around the soil particles in the form of thin film. Chemically bound water presented as hydrated oxides of iron, aluminum, silicon etc. Gravitational water percolates deep into soil in response to gravitational force of the earth. Gravitational water constitutes ground water. Hygroscopic water, chemically bound water and gravitational water is not available to the plant. Capillary water is present among fine capillaries produced by soil particles. Capillary water is available to the plant. Different minerals on being dissolved in the soil water form a solution called soil solution.

IV) Soil air: Soil air occupies the pore spaces within soil. The soil air is varying from atmospheric air in numerous important ways. It contains more CO_2 and less O_2 as compare to the atmospheric air.

V) Living organisms: Living organisms of soil includes bacteria, fungi, algae, viruses, arthropods, protozoans, nematodes, molluscs, earthworms etc.

Soil Formation

Soil formation occurs in following two stages:

A) Weathering
B) Pedogenesis

A) Weathering: It is first step of soil formation. During weathering, soil forming rocks are break down into small particles. Weathering of soil forming rock is take place by following three processes:

a) Physical weathering
b) Chemical weathering
c) Biological weathering

a) Physical weathering: In this process, weathering of soil forming rocks is take place due to action of physical agents like water (rain), heat (temperature), freezing, gravitation, ice melting etc.

b) Chemical weathering: In chemical weathering, hydration, hydrolysis, oxidation-reduction, carbonation and chelation of soil forming rocks caused weathering of rock.

c) Biological weathering: In biological weathering, fungi, bacteria and lichens break down the soil forming rocks into small particles.

B) Pedogenesis: Weathering is followed by pedogenesis. It is biological, biochemical and geochemical phenomenon. During pedogenesis, weathered rock is converted into true soil by living organisms such as lichens, bacteria, fungi, algae, micro arthropods, earthworms, millipedes, centipedes etc. Pedogenesis is responsible for addition of organic compounds, minerals and dead organic matter into soil.

Soil Profile

Soil profile is vertical layered structure of soil. It is different in each terrestrial ecosystem. Soil profile is normally distinguished into following five distinct zones or layers (horizons):

I) O – horizon
II) A – horizon
III) B - horizon
IV) C - horizon
V) R- horizon

I) O – horizon: O-horizon is topmost layer present above the mineral matter. It is mainly composed of fresh fallen leaves and organic debris or partially decomposed dead organic residues. This layer is well developed in forest while poorly developed in grasslands. This layer is almost not present in desert. This horizon is sub-divided into following two layers:

i) O1-horizon
ii) O2-horizon

i) O_1-horizon: O_1 layer composed of freshly fallen dead leaves, other parts of plants (branches, flowers, and fruits) and dead residue of animals.

ii) O_2-horizon: O_2 horizon is present just below the O_1 layer. O_2 horizon consists of organic debris or partially decomposed dead organic residues. Microbes such as bacteria, fungi, actinomycetes etc. commonly occur in O_2 horizon.

II) A – horizon: A - horizon is upper most layer of the soil. Hence it is known as top soil. This horizon is divided into following two sub-layers:

i) A1-horizon
ii) A2-horizon

i) A_1-horizon: This horizon is rich in humus or organic matter. It is dark colored layer.

ii) A_2-horizon: It is zone of maximum leaching of minerals. So it is rich in mineral. It has little organic matter. It is light colored layer. It contains root of plants. This zone is also known as **eluvial zone** or **zone of leaching** or **podsolic zone.**

III) B – horizon: It is composed of dark colored and coarse textured particles. In this horizon, silica rich clay, organic matter, hydrated oxides of iron, aluminum etc. are present. B - horizon is also known as **zone of illuviation** or **illuvial zone** because minerals from A-horizons are leached and concentrate in this region. The two layers A and B together form the **mineral soil** or **solum.**

IV) C – horizon: C - horizon is made up of less weathered large pieces of parent rock.

V) R- horizon: It is made up of unweathered parent rock or bed rock at the surface of which percolated soil water is collected.

d) Catastrophes

Catastrophes is a sudden, extensive, or notable disaster. Catastrophes include volcanic eruption, floods, earthquakes, fire etc. It is responsible for loss of life to greater or lesser extent.

B) Biotic Factors

Biotic factors include all the living organisms in an ecosystem. The biotic factors of an ecosystem occur in the ecological organizational categories, and they comprise the food chains in the ecosystems.

Biotic Interactions

Interactions between living organisms are known as biotic interactions. According to Odum (1971) interactions between populations of species in a community are broadly categorized into two types: a) Positive biotic interactions b) Negative biotic interactions.

a) Positive Biotic Interactions

In positive biotic interactions, two individual (partner or species) are benefited or one partner is benefited and the other neither benefit nor harms. The positive interactions are of following types:

1) Commensalism
2) Mutualism

1) Commensalism: In commensalism, one individual (partner or species) is benefited but the other neither benefited nor harmed.

Examples of Commensalism

i) Epiphytes: The plants, which grow on other plants are known as epiphytes. Most common example of epiphytes is orchids.

ii) Epizoans: Some algae grow on shells of animals.

iii) Climbers: Climbers (plant with weak stem) use other plant as their support.

iv) Crab use mantle cavity of oyster as shelter.

v) E. coli lives in human intestine.

2) Mutualism: In mutualism, both individuals (partners or species) are benefited. Mutualism is divided into following two types:

I) Obligate mutualism
II) Facultative mutualism

I) Obligate mutualism: It is type of mutualism where both the partners are benefited and it is permanent and obligatory association. **Lichens** (Mutualistic relationship between algae and fungi), **nitrogen fixing bacteria** living in root nodules of **legumes plants, mycorrhizae** (Mutualistic relationship between fungi and roots of higher plants), **coral reef** (Mutualistic relationship between coelenterates and algae), pollination, dispersals of fruits and seeds by animals etc. are common examples of obligate mutualism.

II) **Facultative mutualism:** It is also known as **protocooperation**. In this type, both the partners are benefited but it is not obligatory association. For example **sea anemone** is carried by the **crab** to the fresh feeding site.

b) **Negative biotic interactions:**

In negative biotic interactions, only one species is benefited and other is harmed or either one or two individual (partner or species) are harmed. Negative biotic interactions are categorized into following types:

1) Predation
2) Parasitism
3) Competition

1) Predation: It is a relationship between predator and prey, in which predator kills prey. Predator is larger than prey. Examples of predators and preys are: a tiger (predator) and a deer (prey), carnivorous plants (predator) and insects (prey), grazing and browsing animals (predator) and plants (prey) etc.

2) Parasitism: It is a type of interaction where one species is benefitted and other is harmed. The benefitted species is called as **parasite** and harmed is called as **host**. Parasite is always smaller than host. On the basis of the parasite position on the host, the parasite is classified into two types: **endoparasites** and **ectoparasites**. Parasites that live inside the body of host are called endoparasites and those that live on the body surface of host are called as ectoparasites. Fungi, bacteria and viruses are parasite on the plants and animals. *Cuscuta* plants parasite on other plants. Amoeba, pig's round worm, liver flat worms, lice, flies, ticks, mites, wasp larvae, etc. are parasites on animals. Parasitism may be partial or total.

3) Competition: Competition occurs when two different individuals into a community have the same needs for environmental resources such as food space, light, water, mineral nutrition etc. Competition is of two types- interspecific and intraspecific. Interspecific competition occurs between individuals of the different species. Intraspecific competition occurs between the individuals of same species.

Summary

- ✓ Ecological factors are of two types: abiotic factors and biotic factors.
- ✓ Abiotic factors include climatic factors, topographic factors, edaphic factors and catastrophes.
- ✓ Light, temperature, water and atmosphere are known as climatic factors.
- ✓ Altitudes of the place, steepness of the slope, direction of the mountain chains are known as topographic factors.
- ✓ Soil contains inorganic matter, organic matter, soil water, soil air and living organisms.
- ✓ Soil is formed from soil forming rocks.
- ✓ Soil formation is completed into two stages: weathering and pedogenesis.
- ✓ Weathering of rock is first step of soil formation.
- ✓ Weathering is followed by pedogenesis.
- ✓ During pedogenesis, weathered rock is transformed into true soil.
- ✓ Pedogenesis adds organic compounds, minerals and dead organic matter into soil.
- ✓ Vertical layered structure of soil is known as soil profile.
- ✓ Soil profile is normally distinguished into five distinct horizons: O – horizon, A – horizon, B - horizon, C – horizon and R- horizon.
- ✓ O-horizon is topmost layer. It is mainly composed of fresh fallen leaves and organic debris or partially decomposed dead organic residues.
- ✓ A - horizon is top soil. This horizon is rich in humus or organic matter and mineral.
- ✓ B – horizon contain dark colored and coarse textured particles.
- ✓ C – horizon has less weathered large pieces of parent rock.
- ✓ R- horizon contain unweathered bed rock at the surface of which percolated soil water is collected.
- ✓ Catastrophic is notable disaster.
- ✓ Biotic interactions are of two types: positive biotic interactions and negative biotic interactions.
- ✓ Positive interactions include commensalism and mutualism.

- ✓ In commensalism, one species is benefited but the other neither benefit nor harms.
- ✓ In mutualism, both partners are benefited.
- ✓ Predation, parasitism and competition are types of negative interactions.
- ✓ Predation is interaction between predator and prey, in which predator kills prey.
- ✓ In parasitism, one species is benefitted and other is harmed. The benefitted species is called as parasite and harmed is called as host.
- ✓ Competition occurs when two different individuals into a community have the same needs for environmental resources such as food space, light, water, mineral nutrition etc. Competition may be interspecific and intraspecific.

Question Bank

Q.1. **Explain in detail abiotic and biotic ecological factors.**

Q.2. **Discuss in brief mechanism or phenomenon of soil formation.**

Q.3. **Write a short notes on**

- **a) Soil components**
- **b) Soil profile**
- **c) Commensalism**
- **d) Mutualism**
- **e) Predation**
- **f) Parasitism**
- **g) Competition**

MCQ (Multiple Choice Questions)

1. **Light is _____.**
   a) Climatic factors b) Topographic factors
   c) Edaphic factors d) None of the above

2. **Temperature is _____.**
   a) Climatic factors b) Topographic factors
   c) Edaphic factors d) None of the above

3. **Topographic factors include _____.**
   a) Altitudes of the place b) Steepness of the slope
   c) Direction of the mountain chains d) All of the above

4. **Topographic factors are _____.**
   a) Abiotic factors b) Biotic factors
   c) Both a & b d) None of the above

5. **Stratum closest to the earth surface is _____.**
   a) Troposphere b) Stratosphere
   c) Mesosphere d) Ionosphere

6. **Ionosphere is also known as _____.**
   a) Troposphere b) Stratosphere
   c) Mesosphere d) Thermosphere

7. **B – horizon of soil profile is also known as _____.**
   a) Eluvial zone b) Zone of leaching
   c) Podsolic zone d) Zone of illuviation

8. **In mutualism, both individuals (partners or species) are _____.**
   a) Benefited b) Harmed
   c) Both a & b d) None of the above

9. **In parasitism, one individual (partner or specie) is benefited and other is _____.**
   a) Benefited b) Harmed
   c) Both a & b d) None of the above

2. Ecological (Environmental) Factors

Answers of Multiple Choice Questions (MCQ)

1.	(a)	2.	(a)	3.	(d)
4.	(a)	5.	(a)	6.	(d)
7.	(d)	8.	(a)	9.	(b)

❖ ❖ ❖

Concept of Habitat and Ecological Niche

Habitat

The habitat is Latin word and its dictionary meaning is 'it inhabits' or 'it dwells'. A **habitat** is the actual place in the environment where an organism found. In other words a habitat is the place in the environment where an organism lives.

Ecological Niche

The term ecological niche was first time coined by naturalist Joseph Grinnell (1917). Probably niche word is derived from the Middle French word nicher (= nest). The term ecological niche is frequently misunderstood and misused. The word habitat not at all confused with ecological niche. A habitat is the location where as ecological niche is the role of that organism in the ecosystem. An ecological niche includes all of the factors that species requirements to stay alive, stay healthy and reproduces. According to Grinnellian (1917), ecological niche is the sum of the habitat necessities and behaviors that permit a species to persist and produce offspring. According to Charles Elton (1927), the 'niche' of an animal means its position in the biotic environment, its relations to food and enemies." According to G.E. Hutchinsonian (1965) niche is ann-dimensional hyper-volume.

Fundamental and Realized Niche

The terms fundamental niche and realized niche were introduced by G.E. Hutchinsonian in 1965. The niche that exists in the absence of competitors and predators is known as **fundamental niche**. In other words, a fundamental niche is the range of environmental conditions in which each of the species

stay alive. In the actual life, a niche is limited in extent by the presence of relations with other species. The niche that exists in the presence of competitors and predators is known as **realized niche**. In other words, the realized niche is the range of environmental conditions in which a species is actually found. The fundamental niche is larger than the realized niche. The realized niche of a species may differ from place to place because of the presence of different predators and competitors.

Ecological Equivalents

Ecological equivalents are organisms that occupy similar ecological niches but live in different geographical regions. For example Kangaroo of Australian grassland ecosystem is ecological equivalent to cow of Indian grassland ecosystem.

Resource Partitioning and Character Displacement

Resource partitioning occurs when two species divide out the same resource. Root system of some desert plant is best example of resource partitioning. As a consequence of resource partitioning, certain characteristics may allow individuals to get resources in their partitions more fruitfully. Selection of these characteristics decreases competition with individuals in other partitions and leads to a divergence of features. This is called character displacement. It is also known as niche shift. Character displacement reduces the competition between two species. Evolution of two species of finches on the Galapagos Islands is best example of character displacement.

Summary

- ✓ Actual place in the environment where an organism found is known as habitat.
- ✓ An ecological niche comprises all of the factors that species requirements to stay alive, healthy and reproduces.
- ✓ Naturalist Joseph Grinnell (1917) first proposed the term ecological niche.
- ✓ The niche that survives in the absence of competitors and predators is known as fundamental niche while niche that survives in the presence of competitors and predators is known as realized niche.

- ✓ Ecological equivalents are organisms that occupy similar ecological niches but live in different geographical regions.
- ✓ Resource partitioning happens when two species divide out the same resource.
- ✓ Character displacement decreases the competition among two species.

Question Bank

Q.1. Discuss in detail concept of ecological niche.
Q.2. Write a short notes on
a) Habitat
b) Ecological niche
c) Fundamental and realized niche
d) Ecological equivalents
e) Resource partitioning and character displacement

MCQ (Multiple Choice Questions)

1. Place in the environment where an organism lives is known as_____.
   a) Habitat b) Ecological niche
   c) Both a & b d) None of the above
2. The term ecological niche was first time coined by_____.
   a) Hutchinsonian b) Grinnell
   c) Charles Elton d) None of the above
3. The niche that exists in the absence of competitors and predators is known as_____.
   a) Fundamental b) Realized niche
   c) Both a & b d) None of the above
4. The niche that exists in the presence of competitors and predators is known as_____.
   a) Fundamental b) Realized niche
   c) Both a & b d) None of the above

3. Concept of Habitat and Ecological Niche

Answers of Multiple Choice Questions (MCQ)

1.	(a)	2.	(b)
3.	(a)	4.	(b)

Population Ecology

A group of individuals of the same species, which live together in one geographical area at the given time is known as **population. Population ecology** is the division of ecology that studies the structure or characteristics, dynamics and regulation of populations. Study of the very important statistics of a population and how they alter over time is known as **demography.**

Characteristics of a Population

Population has following important characteristics or group attributes:

I) Density
II) Natality
III) Mortality
IV) Dispersals
V) Dispersion
VI) Life tables
VII) Age distribution
VIII) Biotic potential

I) Density

The size of population is represented by its elementary property called density. Density is number of individuals per unit area or volume at given time. Density of population can be determined directly by counting or by sampling.

II) Natality

Natality is capacity of individuals of population to produce new individual. Natality increases the size of population.

III) Mortality

Mortality is rate of death of individuals in population. Mortality decreases the size of population.

IV) Dispersals

Population dispersal is the movement of individuals into or out of population area. It takes place in following three ways:

i) Emigration
ii) Immigration
iii) Migration

i) Emigration: Emigration is the one way outward movement of individuals from population area. In simple words; emigration is outward migration.

ii) Immigration: Immigration is the one way inward movement of individuals into population area. In simple words; immigration is inward migration.

iii) Migration: Migration is episodic departure and return of individuals to same area.

V) Dispersion

Dispersion refers to the spatial distribution of individuals within boundaries of the population. Individuals in a population may be distributed in following three general patterns:

a) Clumped
b) Uniform
c) Random.

a) Clumped: In clumped dispersion, individuals are aggregated in groups or patches (Fig.4.1). Individuals aggregate in patches may be due to patchy environmental conditions or food sources. Population of plants and fungi often shows clumped dispersion.

b) Uniform: In uniform dispersion, individuals are uniformly or regularly dispersed (Fig.4.1). For example: artificially planted trees, crop plants in crop lands, some plants shows uniform distribution by secreting chemicals that inhibits the germination and growth of other organisms. Animals often exhibit uniform dispersion influenced by social interaction such as territoriality.

c) Random: In random dispersion, spacing is irregular and position of each individual is fairly independent of the others

(Fig.4.1). Random dispersion occurs in the absence of strong attraction or repulsion among individuals in a population or when environment is very uniform. This dispersion is not common in nature. For example: plants which grow from windblown seeds shows random dispersion.

Fig.4.1: Patterns of Population Dispersion

VI) Life Tables

Age-specific summary of the death and survivor of a population is represented in the form of table is known as **life table.** It is made by following fate of a cohort (group of individuals of the same age) from birth until death. Data in a life table is represented in the form of graph, known as **a survivorship curve.** Survivorship curves are of following three types:

a) Type-I
b) Type-II
c) Type-III

a) Type-I: This type of curve is highly convex (Fig.4.2). It is flat at the start, reflecting low mortality rates during the early and middle life, then it falls down sharply as mortality rates increase in old age. This curve is characteristic of species in which mortality rate is low during early and middle life. Humans and many other large mammals show this type of curve.

b) Type-II: This is diagonal and intermediate curve (Fig.4.2).This curve is characteristic of those species where mortality rate is constant over life span. Some lizards, annual plants, hydra, gray squirrels and most rodents show such curve.

c) Type-III: This is highly concave curve (Fig.4.2). This curve drops sharply at the start because of high mortality rate during young stage, but then flattens out as mortality rates falls for those small number of individuals that have survived to a definite age. Organisms showing this type of curve produce large number of offsprings but provide little or no parental care. Many fish species, long-lived plants, and marine invertebrates show this type of curve.

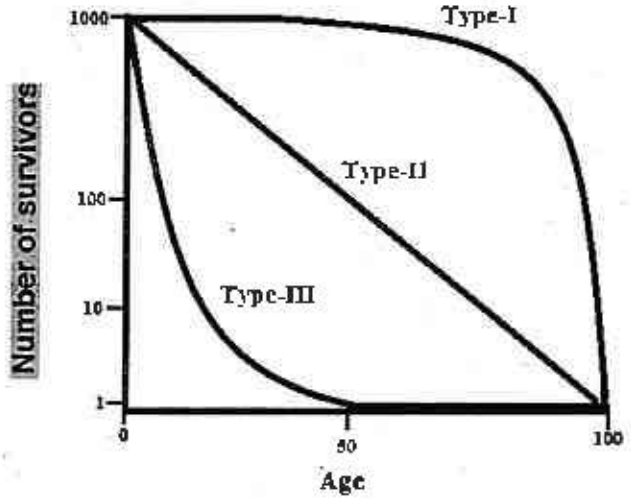

Fig. 4.2: Three Main Types of Survivalship Curves

VII) Age Distribution (Age Structure)

Proportion of relative number of individuals at each age group is called age distribution. Age distribution is an important population characteristic which significantly affects the both natality and mortality of the population. **Pre-reproductive, reproductive and post- reproductive** are three ecological ages or age groups in population. There are following three types of age structure in different types of population:

a) Growing population
b) Stable population
c) Diminishing population

a) Growing Population: This type of age structure is characterized by very large percentage of young individuals. The graphic representation of this population is that of pyramid **shaped** (Fig.4.3a).

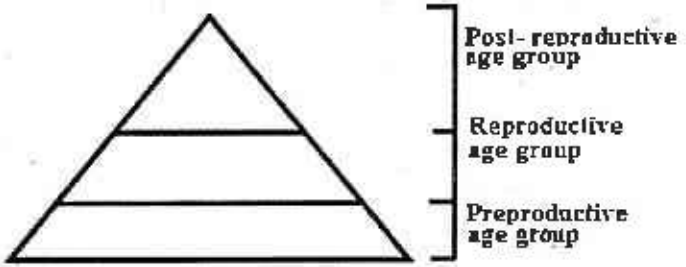

Fig.4.3a: Age Structure in Growing Population

b) Stable Population: In this type of age structure, the percentage of pre-reproductive and reproductive more or less equal in number whereas post- reproductive individuals are comparatively fewer in number. The graphic representation of such population is that of **bell shaped** (Fig.4.3b).

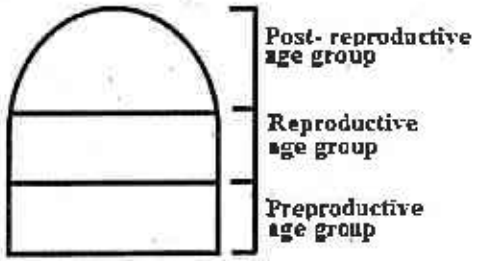

Fig.4.3b: Age Structure in Stable Population

c) Diminishing Population: In this population, birth rate is radically reduced so that the individuals in the pre-reproductive group are comparatively fewer than those of reproductive or post- reproductive group. The graphic representation of this population is that of **urn shaped (jug shaped)** (Fig.4.3c).

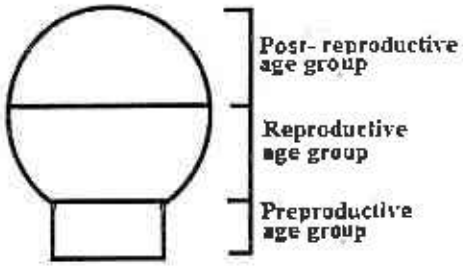

Fig.4.3c: Age Structure in Diminishing Population

VIII) Biotic Potential

Biotic potential is also known as reproductive potential. It is physiological capacity of individual to reproduce, to survive their progeny under natural condition. Biotic potential differs from one species to another.

Population Growth Forms

There are two types of population growth forms:

A) J-shaped growth form
B) S-shaped growth form

A) J-Shaped Growth Form

- J – shaped growth form is also known as exponential growth form.
- In this form, population size increase rapidly in exponential manner due to abundance of resources such as space and food.
- J-shaped growth form is characteristic of population introduced into new area having plentiful space and food.
- Exponential growth form is calculated by using following equation:
  $dN/dt = rN$
  Where:
  dN/dt = rate of growth of population
  r = intrinsic rate of increase per individual
  N= numbers of individuals in the population at time t.

- Exponential growth of population resulting in a J-shaped growth curve when the population size is plotted over time (Fig.4.4).
- Some insect population shows J- shaped growth curve.
- J- shaped growth curve comprises two phases: lag phase and exponential phase.
- Lag phase is initial establishment phase. In this phase there is no increase in population for some time.
- In exponential phase, rapid growth continues until enough food and space is available.
- After exponential phase, population may rapidly decline as resources are limited.

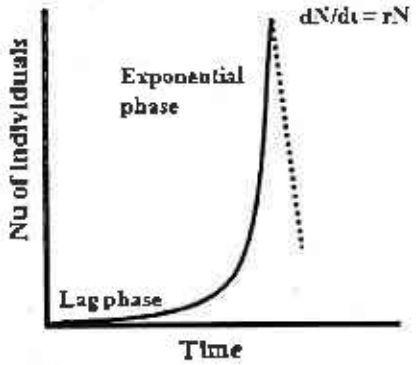

Fig.4.4. J-Shaped Growth Curve

B) S-Shaped Growth Form

- S-shaped growth form is also known as sigmoid growth form or logistic growth.
- Population shows logistic growth due to increase in environmental resistance.
- S-shaped growth form is explained by using logistic growth model.
- This growth form is calculated by using following logistic equation:
  $dN/dt = rN (K-N)/K = r n (1-N/K)$
  Where:
  dN/dt = rate of growth of population
  r = intrinsic rate of increase per individual

N= numbers of individuals in the population at time t
K= carrying capacity

- In this growth form, population grows more slowly as it near its carrying capacity.
- Carrying capacity is the maximum population size that environment can support.
- Logistic growth of population resulting in S- shaped growth curve when the population size is plotted over time (Fig.4.5).
- This curve divides into following three phases: lag phase, log phase and stationary or steady phase.
- In lag phase growth rate is very slow.
- Log phase is characterized by very rapid growth and in steady phase there is no growth.

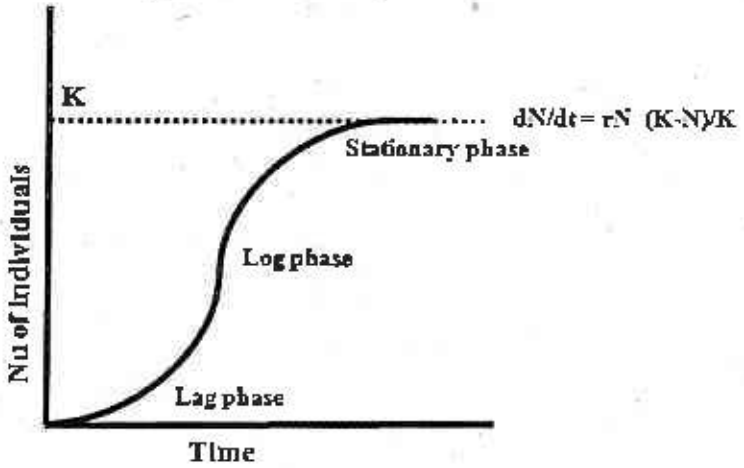

Fig.4.5: S-shaped Growth Curve

Population Regulation

Population growth is regulated by following factors:

A) Density-dependent factors
B) Density-independent factors

A) Density-Dependent Factors: These factors are intrinsic or biotic and depend on the number of individuals in the population. Some of the important density dependent factors include food, competition for resources territoriality, predation, disease etc.

B) Density-Independent Factors: These factors are intrinsic or abiotic and they do not depend on the number of individuals in the population. Drought, floods, cyclone, hurricane, fire, excessive rain or snow, earthquake, tidal wave, volcanic eruption etc. are important density -independent factors which regulate the population size of population.

r and K Selected Populations

r is the intrinsic rate of natural increase in population size which is density independent and *K is* the carrying capacity of a population which is density dependent.

A) r-Selected Populations

- Environment in which r-selected populations are likely to occur is variable and unpredictable.
- An r-selected population has high fecundity and high intrinsic rates of growth.
- Size of r-selected population is variable usually below the carrying capacity.
- They have low levels of parental investment in the young.
- They have high rates of mortality before individuals reach maturity.
- They associated with type iii survivorship curve.

B) K-Selected Populations

- Environment in which K-selected population is likely to occur is constant or variable but predictable.
- K-selected population has low rates of fecundity.
- Size of r-selected population is constant at or near carrying capacity.
- They have high levels of parental investment in the young.
- They have low rates of mortality as individuals mature.
- They associated with type i and ii survivorship curve.

Concept of Metapopulation and Demes

The metapopulation concept was introduced in 1969. Metapopulation is a network of spatially disjunctive populations, among which there is some immigration. Demes are collection or set of interbreeding organisms. It is smallest unit of individuals of population. Demes are local population.

Summary

- ✓ Assemblage of individuals of the same species which live together in one ecological area at the given time is known as population.
- ✓ Density, natality, mortality, dispersals, dispersion, life tables, age distribution and biotic potential are important attributes of population.
- ✓ Natality increases the size of population while mortality decreases the size of population.
- ✓ Movement of individuals into or out of population area refers to population dispersal. It takes place in three ways: emigration, immigration and migration.
- ✓ Emigration is outward migration while immigration is inward migration.
- ✓ Migration is periodic departure and return of individuals to same area.
- ✓ Dispersion is known to spatial distribution of individuals within boundaries of the population. Individuals in a population distributed in three general patterns: clumped, uniform and random.
- ✓ Age-specific summary of the death and survivor of a population is represented in the form of table is known as life table.
- ✓ Data in a life table is represented in the form of graph, known as a survivorship curve. Survivorship curves are of three types: a) Type-I, b) Type-II and c) Type-III.
- ✓ Type-I curve is highly convex.
- ✓ Type-II is diagonal curve.
- ✓ Type-III is highly concave curve.
- ✓ Proportion of relative number of individuals at each age group is called age distribution.

- ✓ Pre-reproductive, reproductive and post- reproductive are three ecological ages or age groups in population.
- ✓ Three types of age structures are present in different types of population: a) growing population, b) stable population and c) diminishing population.
- ✓ Biotic potential is physiological capacity of individual to reproduce, to survive their progeny under natural condition.
- ✓ J–shaped growth form is also known as exponential growth form.
- ✓ In exponential growth form, population size increase rapidly in exponential manner due to abundance of resources such as space and food.
- ✓ Exponential growth of population resulting in a J- shaped growth curve when the population size is plotted over time.
- ✓ S-shaped growth form is also known as sigmoid growth form or logistic growth.
- ✓ Population shows logistic growth due to increase in environmental resistance.
- ✓ Logistic growth of population resulting in S- shaped growth curve when the population size is plotted over time.
- ✓ Population growth is regulated by density-dependent factors and density-independent factors.
- ✓ *r* is the intrinsic rate of natural increase in population size which is density independent and *K is* the carrying capacity of a population which is density dependent.
- ✓ Metapopulation is a group of spatially disjunct populations, among which there is some immigration.
- ✓ Demes are collection of interbreeding individuals.

QUESTION BANK

Q.1. Give an account of the characteristics of population.

Q.2. Explain in brief factors that regulate the population growth.

Q.3. Write a short notes on

a) Survivorship curve

b) Life table

c) J-shaped growth form

d) S-shaped growth form

e) r and K selected populations
f) Regulation of population
g) Metapopulation and demes

MCQ (Multiple Choice Questions)

1. A group of individuals of the same species, which live together in one geographical area at the given time is known as _____.
   a) Population b) Community
   c) Ecosystem d) None of the above
2. Mortality _____.
   a) Decreases the size of population b) Increases the size of population
   c) Both a & b d) None of the above
3. Natality _____.
   a) Increases the size of population b) Decreases the size of population
   c) Both a & b d) None of the above
4. Emigration is _____.
   a) One way outward movement of individuals from population area
   b) One way inward ward movement of individuals into population area
   c) Both a & b
   d) None of the above
5. Immigration is _____.
   a) One way outward movement of individuals from population area
   b) One way inward ward movement of individuals into population area
   c) Both a & b
   d) None of the above
6. In clumped dispersion, individuals are _____.
   a) Aggregated in groups or patches
   b) Uniformly or regularly dispersed
   c) Both a & b d) None of the above

7. In uniform dispersion, individuals are _____.
   a) Uniformly or regularly dispersed b) Aggregated in groups or patches
   c) Both a & b d) None of the above
8. J – shaped growth form is also known as _____.
   a) Exponential growth form b) Sigmoid growth form
   c) Both a & b d) None of the above
9. Type-I survivorship curve is _____.
   a) Highly convex b) Highly concave
   c) Diagonal d) None of the above
10. Type-III survivorship curve is _____.
    a) Highly convex b) Highly concave
    c) Diagonal d) None of the above
11. Mortality rate is constant over life span in _____.
    a) Type-II survivorship curve b) Type-III survivorship curve
    c) Type-I survivorship curve d) None of the above
12. Humans and many other large mammals show _____.
    a) Type-II survivorship curve b) Type-III survivorship curve
    c) Type-I survivorship curve d) None of the above
13. Lizards, annual plants, hydra, gray squirrels and most rodents show _____.
    a) Type-II survivorship curve b) Type-III survivorship curve
    c) Type-I survivorship curve d) None of the above
14. The graphic representation of diminishing population is _____.
    a) Pyramid shaped b) Urn shaped
    c) Bell shaped d) None of the above
15. The graphic representation of stable population is _____.
    a) Pyramid shaped b) Urn shaped
    c) Bell shaped d) None of the above

16. **The graphic representation of growing population is _____.**
   a) Pyramid shaped b) Urn shaped
   c) Bell shaped d) None of the above

17. **Food, competition for resources territoriality, predation, disease etc are _____.**
   a) Density dependent characters b) Density independent characters
   c) both a and b d) None of the above

18. **Floods, cyclone, fire, excessive rain or snow, earthquake, volcanic eruption etc. are _____.**
   a) Density dependent characters b) Density independent characters
   c) Both a and b d) None of the above

19. **An r-selected population has _____.**
   a) High fecundity b) High intrinsic rates of growth
   c) Both a and b d) None of the above

20. **High levels of parental investment in the young is characteristic of _____.**
   a) r-selected population b) k-selected population
   c) Both a and b d) None of the above

4. Population Ecology

Answers of Multiple Choice Questions (MCQ)

1.	(a)	2.	(a)	3.	(a)
4.	(a)	5.	(b)	6.	(a)
7.	(a)	8.	(a)	9.	(a)
10.	(b)	11.	(a)	12.	(c)
13.	(a)	14.	(b)	15.	(c)
16.	(a)	17.	(a)	18.	(b)
19.	(c)	20.	(b)		

❖ ❖ ❖

5
Community Ecology

A community is an assemblage of populations of diverse species occupying a particular area. It is also known as biotic community.

Characteristics (Attributes) of Community

Community has following important characteristics or group attributes:

1) Each community has **species diversity** i.e. community is made up of taxonomically different species. In community, species diversity has two components: **species richness** and **species evenness.** Species richness is number of different types of species and species evenness is abundance of individuals within each species.

2) In biological communities, a single species or group of species are more in numbers or have maximum size or productivity as compare to other species. Such single species or group of species influence the energy flow and affect the environment of other species. These species are known as **dominant species.**

3) Each community has its own structure and composition.

4) Community structure is very frequently diverse.

5) Each community has its own trophic structure or organisms grouped based on feeding habits.

6) Each community undergoes succession.

7) In community, keystone species are present.

Composition and Structure of Community

In each community, there are diverse species. Most communities are composed of combination of plants, animals, fungi and prokaryotes. Communities may be small or large. Community structure is very frequently diverse. Various species are distributed irregularly throughout the community resulting in **stratification.** The stratification in community may be horizontal or vertical.

Horizontal Stratification

Horizontal stratification comprises the zonation in the community. In aquatic bodies, mostly lakes and ponds, three different kinds of zones differentiated on the basis of light availability and depth of water. In pond and lakes, three types of zones are present i.e. littoral zone, limnetic zone and profundal zone. In each zone, organisms vary from each other.

Vertical Stratification

It refers to vertical distribution of organisms in community. In typical forest community, marked vertical stratification is present. In typical forest community five different vertical sub divisions are present. These vertical subdivisions are: a) subterranean part (which is formed of roots, tubers, earthworms, insects, protozoan and bacteria), b) forest floor (which is occupied by dead organic matter, litter, fungi, bacteria snails etc.), c) herbaceous vegetation, d) shrubs and trees. Grasslands community is characterized by vertical stratification. It has only two layers - a subterranean part and herbaceous part. Subterranean part consists of roots, rhizomes and debris of plants and animals. Herbaceous part consists of grasses, herbs and weeds.

Analysis of Plant Communities (Characters Used in Plant Communities)

Communities may be identified and recognized by following two types of characters:

A) Analytical Characters
B) Synthetic Characters

A) Analytical Characters

There are following two types of analytical characters:

a) Quantitative Characters
b) Qualitative Characters

a) Quantitative Characters

Quantitative characters are those that can be measured. They are given as follow:

i) Frequency
ii) Density
iii) Abundance
iv) Cover Area
v) Basal Area

i) Frequency: Frequency is degree of distribution of individual plant species in an area. It is generally expressed in terms of percentage occurrence. It is calculated by following equation:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}} \times 100$$

ii) Density: Density represents the numerical strength of plant species in a given plant community. It is represented by following equation:

$$\text{Density} = \frac{\text{Total number of plant species present in all quadrats}}{\text{Total number of quadrats studied}}$$

iii) Abundance: Abundance reflects the number of individuals of any species occurring per sampling unit. It is calculated by following equation:

$$\text{Abundance} = \frac{\text{Total number of plant species present in all quadrats}}{\text{Total number of quadrats in which the plant species occurred}}$$

iv) Cover Area: Cover area reflects the percent area occupied by the above ground parts of plant species per unit area.

v) Basal Area: Basal area represents the area occupied by plant stem bases.

b) Qualitative Characters

These characters are not measurable but calculated on the basis of various qualitative features. It includes following parameters:

i) Physiognomy
ii) Phenology
iii) Stratification
iv) Sociability
v) Vitality
vi) Life Forms

i) Physiognomy: Physiognomy expresses the external appearance of a community. It is vital feature that tells us about the organization of plant community. It is described on the basis of growth form of its dominant species. For example, a grassland community is dominated by grasses and forests community by trees.

ii) Phenology: Phenology represents the periodic occurrence of different events (like seed germination, vegetative growth, flowering, fruiting, seed formation etc.) in the life history of a plant species. All phonological events of plant species is recorded and presented diagrammatically in the form of a phenogram.

iii) Stratification: Various species are distributed irregularly throughout the community resulting in stratification. The stratification in community may be horizontal or vertical. Horizontal stratification comprises the zonation in the community. Vertical stratification refers to vertical distribution of organisms in community.

iv) Sociability: Sociability represents degree of organization between plant species. In community, plants may grow singly, in patches, in colonies or groups.

v) Vitality: Vitality represents the ability of normal growth and reproduction, which are important for successful survival of a species. Vitality of plant is determined by studying several factors such as stem height, root length, leaf size, quantity of leaf, quantity and weight of flower, fruits, seeds etc.

vi) Life Forms: Sum of adaptations of plants to environment is known as life form. Christen Raunkiaer (1934) considered following five major types of life forms of plants:

1) Phanerophytes
2) Chamaephytes
3) Hemicryptophytes
4) Cryptophytes
5) Therophytes.

1) Phanerophytes: These are those plants whose buds are visible. In those plants, buds are either naked or covered with scales and are situated high up on the plant on the top of the shoots. These life forms include trees, shrubs and climbers and are very common in tropical climates.

2) Chamaephytes: These are those plants whose buds are situated close to ground surface. These life forms are common in colder regions at high altitudes or latitudes. e.g. Temperate America. Sometimes buds of chamaephytes are covered by aerial parts of plants and snow cover.

3) Hemicryptophytes: These plants are found in the cold temperate regions where buds remain covered below surface soil and are protected by soil itself. Hemicryptophytes comprise annual or biennial herbs.

4) Cryptophytes (Geophytes): These are those plants whose buds remain completely buried under soil such as bulbs and rhizomes. These plants are generally found in the dry area of the world. In these forms buds are also found below the water surface (e.g. hydrophytes).

5) Therophytes: Therophytes are seasonal plants those complete their life cycle quickly under favourable conditions and remain resting throughout the rest of the unfavourable period of year in the form of seeds. They are common in deserts.

B) Synthetic Characters

The synthetic characters are determined from the quantitative and qualitative characters data of community. These characters are determined in terms of presence and constance, fidelity (species restrictedness in distribution), dominance etc.

Methods of Studying Plant Communities

To study the plant community area is divided into smaller units known as sampling units. Three types of sampling units

are generally considered for studying various plant communities. These are: a) area, b) line, and c) point. Plant communities can be studied by using following phyto-social methods:

1) Quadrat Method
2) Transect Method
3) Point Method

1) Quadrat Method

In this phyto-social method, community is studied by making quadrats. A **quadrat** is a small plot used in ecology to isolate a standard unit of area for study of biotic community. The quadrat is suitable for sampling plants. In quadrat method, sampling unit is definite area. In shape quadrat is usually square but it can also be rectangular, circular or irregular. Depending upon the purpose of study a quadrat may be: **list quadrat** (where the plant species encountered in the sample plot are listed by their names), **list- count quadrat** (where the species names are listed as well as individuals of each species numbers counted), **chart quadrat** (where distribution of species, their number etc. are recorded on a graph paper at irregular intervals using an instrument pantograph) and **experimental permanent quadrat** (where vegetation is recorded for a longtime to study periodic ecological changes in community).

2) Transect Method

In this method sampling unit is line or strip or belt. Transect may be a **line or belt** depending upon the study area. In a line transect, sampling is done across a thin line. Line transect is used in grassland community. In belt transect, an area (belt) of suitable size is selected where the sampling is done. Belt transects are mainly used in forests community.

3) Point Method

In point method, sampling unit is a point. In this method, observations are taken on the point in the study area where a nail (pin) or set of nail (pin) tough the ground on the grid lines or at random places. There are two important point methods:

A) Point Frame Method and
B) Point Centre Method.

A) Point Frame Method: In point frame method, point frame is used. Pont frame is scale like wooden frame bearing ten movable pins. In this method, point frame is laid randomly in an area, plants species hit by the pins are recorded, and their frequency determined. This method is used to study the grassland community and low herbaceous plant community.

B) Point Centre Method: In point centre method, brass needle or nail fitted with rubber cork and compass on the top is used. In this method, at each sampling point needle is fixed in the ground, which is known as central point. Sampling area is separated into four quarters by visualizing the two grid lines predetermined by the compass. In each of the four quarters plants nearest to the central point is spotted and species recorded.

Ecotones and Edge Effect

An **ecotone** is transitional area between two adjacent communities or biomes containing the characteristic species of each. In other words, ecotone is region where, two adjacent communities meet and integrate. It may be narrow or broad. It has some of the characteristics of each adjoining community and usually comprises species not found in the overlapping communities. The influence of the two adjoining communities is known as the **edge effect**.

Summary

- ✓ A community is collection of populations of diverse species occupying a particular area.
- ✓ Each community has species diversity and its own trophic structure.
- ✓ In biological communities, dominant species are presents.
- ✓ Each community has its own structure and composition.
- ✓ In community, keystone species are present.
- ✓ Each community undergoes succession.
- ✓ In each community there are diverse species.
- ✓ Various species are distributed irregularly throughout the community resulting in stratification.

- ✓ The stratification in community may be horizontal or vertical.
- ✓ Horizontal stratification comprises the zonation in the community. It is present in aquatic community.
- ✓ In typical forest and grassland community, marked vertical stratification is present.
- ✓ Communities may be identified and recognized by two types of characters: analytical characters and synthetic characters
- ✓ Analytical characters are of two types: quantitative and qualitative
- ✓ Frequency, density, abundance, cover area and basal area are quantitative characters used in analysis of plant community.
- ✓ Frequency expresses distribution of individual plant species in an area.
- ✓ Density is the numerical strength of plant species in a given plant community.
- ✓ Abundance represents number of individuals of any species occurring per sampling unit.
- ✓ Cover area is the percent area occupied by the above ground parts of plant species per unit area.
- ✓ Basal area expresses the area occupied by plant stem bases.
- ✓ Physiognomy, phenology, stratification, sociability, vitality and life forms are qualitative characters used in analysis of plant community.
- ✓ Physiognomy is study of external appearance of a community.
- ✓ Phenology is represents the periodic occurrence of different events (like seed germination, vegetative growth, flowering, fruiting, seed formation etc.) in the life history of a plant species.
- ✓ Sociability is degree of organization between plant species.
- ✓ Vitality expresses the ability of normal growth and reproduction, which are important for successful survival of a species.
- ✓ Life forms are sum of adaptations of plants to environment. According to Christen Raunkiaer (1934) there are five major types of life forms of plants: Phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes.
- ✓ Phanerophytes are those plants whose buds are visible.

- ✓ Chamaephytes are those plants whose buds are situated close to ground surface.
- ✓ Hemicryptophytes plants are found in the cold temperate regions where buds remain covered below surface soil and are protected by soil itself.
- ✓ Cryptophytes are those plants whose buds remain completely buried under soil such as bulbs and rhizomes.
- ✓ Therophytes are commonly deserts plants.
- ✓ The synthetic characters are determined in terms of presence and constance, fidelity, dominance etc.
- ✓ Plant communities can be studied by using quadrat method, transect method and point method.
- ✓ An ecotone is intermediary area between two adjacent communities or biomes containing the characteristic species of each.
- ✓ The influence of the two adjacent communities is known as the edge effect.

Question Bank

Q.1. **Define community and discuss in detail characteristics of community.**

Q.2. **Explain structure and composition of community.**

Q.3. **Describe in detail analytical and synthetic characters of the biotic community.**

Q.4. **Explain various methods of study of plant community.**

Q.5. **Write a short notes on**

a) **Physiognomy**

b) **Phenology**

c) **Stratification**

d) **Sociability**

e) **Vitality**

f) **Life forms**

g) **Ecotones and Edge Effect**

MCQ (Multiple Choice Questions)

1. **Assemblage of populations of diverse species occupying a particular area is known as _____.**
   a) Ecosystem b) Community
   c) Population ecology d) None of the above
2. **Horizontal stratification is _____.**
   a) Vertical distribution of organisms in community
   b) Zonation in the community
   c) Both a and b d) None of the above
3. **Vertical stratification is present in _____.**
   a) Forest community b) Grassland community
   c) Both a and b d) None of the above
4. **Vertical stratification refers to _____.**
   a) Vertical distribution of organisms in community
   b) Zonation in the community
   c) Both a and b d) None of the above
5. **In lakes and ponds _____.**
   a) Horizontal stratification present
   b) Vertical stratification present
   c) Both a and b d) None of the above
6. **Vertical stratification is present in _____.**
   a) Typical forest community b) Pond
   c) Lake d) None of the above
7. **Frequency, density, abundance, cover area and basal area are _____.**
   a) Quantitative characters used in plant communities
   b) Qualitative characters used in plant communities
   c) Both a and b d) None of the above
8. **Degree of distribution of individual plant species in an area is called its _____.**
   a) Density b) Frequency
   c) Abundance d) Cover area
9. **Numerical strength of plant species in a given plant community represents its _____.**
   a) Density b) Frequency
   c) Abundance d) Cover area

10. **Number of individuals of any species occurring per sampling unit is called its _____.**
    a) Density b) Frequency
    c) Abundance d) Cover area
11. **Percent area occupied by the above ground parts of plant sp. per unit area is called its _____.**
    a) Density b) Frequency
    c) Abundance d) Cover area
12. **Area occupied by plant stem base is called its _____.**
    a) Basal area b) Frequency
    c) Cover area d) None of the above
13. **Area occupied by plant stem base is called its _____.**
    a) Density b) Frequency
    c) Abundance d) None of the above
14. **Physiognomy, phenology, stratification, sociability, vitality and life forms are _____.**
    a) Quantitative characters used in plant communities
    b) Qualitative characters used in plant communities
    c) Both a and b d) None of the above
15. **Physiognomy represents _____.**
    a) Degree of organization between plant species
    b) External appearance of a community
    c) Both a and b d) None of the above
16. **Sociability expresses _____.**
    a) Degree of organization between plant species
    b) External appearance of a community
    c) Both a and b d) None of the above
17. **Vertical layering of plants corresponds to _____.**
    a) Phenology b) Sociability
    c) Vitality d) Stratification
18. **Plants whose buds are visible are grouped as _____.**
    a) Phanerophytes b) Chamaephytes
    c) Hemicryptophytes d) Cryptophytes
19. **Plants whose buds remain completely buried under soil such as bulbs and rhizomes _____.**
    a) Phanerophytes b) Chamaephytes
    c) Hemicryptophytes d) Cryptophytes

20. Chamaephytes are those plants whose buds are _____.
a) Visible b) Buried under soil
c) Situated close to ground surface d) None of the above

21. Phanerophytes are those plants whose buds are _____.
a) Visible b) Buried under soil
c) Situated close to ground surface d) None of the above

22. Cryptophytes are those plants whose buds are _____.
a) Visible b) Buried under soil
c) Situated close to ground surface d) None of the above

23. Sum of adaptations of plants to environment is known as _____.
a) Phenology b) Life forms
c) Vitality d) Stratification

24. Region where, two adjacent communities meet and integrate is known as _____.
a) Ecotone b) Edge effect
c) Both a & b d) None of the above

25. The influence of the two adjoining communities is known as _____.
a) Ecotone b) Edge effect
c) Both a & b d) None of the above

5. Community Ecology

Answers of Multiple Choice Questions (MCQ)

1.	(b)	2.	(b)	3.	(c)
4.	(a)	5.	(a)	6.	(a)
7.	(a)	8.	(b)	9.	(a)
10.	(c)	11.	(d)	12.	(a)
13.	(d)	14.	(b)	15.	(b)
16.	(a)	17.	(d)	18.	(a)
19.	(d)	20.	(c)	21.	(a)
22.	(b)	23.	(b)	24.	(a)
25.	(b)				

6
Ecological Succession

Natural change in community structure and species composition is known as ecological succession.

Types of Ecological Succession

Primary and Secondary Succession: Succession taking place in unoccupied habitat (bare ground) where no community existed before is termed as **primary succession.** Secondary succession is succession occurring in stable community which is disturbed by fire or flood or human activity. Secondary succession is comparatively rapid as compared to primary succession.

Autogenic and Allogenic Succession: Replacement of one community by other due to effects of organisms themselves is known as **autogenic succession.** Replacement of one community by the other due to external environmental factors is known as **allogenic succession.**

Autotrophic and Heterotrophic Succession: A succession where autotrophs (green plants) are dominated is known as **autotrophic succession.** A succession where hetrotrophs (bacteria, fungi, actinomycetes or animals) are dominated is known as **heterotrophic succession.** Autotrophic succession takes place in a medium rich in organic substances where as heterotrophic succession take place in substratum having excess organic substances.

General Process of Ecological Succession (Mechanisms of Ecological Succession)

The process of autotrophic succession involves the occurrence of following sequential stages:

I) Nudation
II) Migration
III) Ecesis
IV) Aggregations
V) Competition
VI) Coaction
VII) Reaction
VIII) Stabilization

I) Nudation: It is first step of succession. In this step, bare land is formed. It is produced due to several natural calamities such as soil erosion, deposition of sand, landslide, slipping of glaciers, fire, hails and storms, destruction of forest, diseases etc.

II) Migration: After nudation, the seeds and spores are introduced into barren land. This process is known as **migration**. The first group of species introducing in a bare area are called **pioneers**.

III) Ecesis: After migration, seeds, spores and other vegetative bodies of plant species germinate, grow, reproduce and establish themselves. This phenomenon is known as **ecesis**.

IV) Aggregations: After successful establishment of a species as a result of reproduction, the individuals of species increase in number and they come close to each other. This process is known as **aggregation**. Phenomenon of migration, ecesis and aggregation are collectively known as invasion.

V) Competition: Aggregation of large numbers of individuals of species in a limited area leads to **competition** for space, water, food, light or other physical factors. Competition may be interspecific or intraspecific.

VI) Coaction: Individuals of species influence each other's life in different ways and this is known as **coactions**.

VII) Reaction: Mechanism of alteration of environment, through the influence of living organisms on it known as **reaction**. As a result of reaction, environment get customized, and become unsuitable for the existing community and is

ultimately replaced by another community. The series of communities appearing one after the other is known as **sere** and communities are termed as **seral communities or seral stages.**

VIII) Stabilization: Stabilization is last stage of community succession, which is not replaced by other groups of organisms known as **climax stage** and community is known as **climax community.**

Concept of Climax

The final stage of community which is not replaced by other groups of organisms known as climax stage and community is known as climax community. Following three important theories were proposed to define, identify and interpret the concept of climax:

a) Monoclimax Theory
b) Polyclimax Theory
c) Climax Pattern Hypothesis

a) Monoclimax Theory: This theory was proposed by **Clements** in 1916. According to this theory, arrival one climax stage is controlled solely by climate and therefore Clements called it climatic climax.

b) Polyclimax Theory: This theory was proposed by **Tansley** (1935). According to him, climax stage is controlled not only by climate but also by other several factors such as soil moistures, soil nutrients, topography, slope exposure, fire and biotic factors.

c) Climax Pattern Hypothesis: This theory was put forth by **Whittaker** in 1953. According to this theory the climax community of an area is controlled by whole environmental factors of the region in which it exist.

Examples of Ecological Succession

1) Hydrarch (Hydrosere)

Ecological succession starts from a water body like pond, lake or pool or stream or bog it is known as hydrosere or hydrarch. A hydrarch, starts from a water body that is gradually converted into a forest through an orderly process. Succession in a lake or pond takes place through following stages:

a) Phytoplankton Stage
b) Rooted submerged Stage
c) Rooted floating Stage
d) Reed Swamp Stage
e) Sedge-Meadow Stage
f) Wood Land Stage
g) Forest Stage (Climax Stage)

a) Phytoplankton Stage: In the initial stage, pond is free of nutrients and organic matter and is devoid of life. The first organisms to inhibit primitive medium of the ponds are phytoplankton. They include free-floating blue green algae (cyanobacteria) or the green algae, diatoms and bacteria. These represent the pioneers of the hydrarch. Phytoplanktons grow and multiply for some time and complete their life cycle. Phytoplanktons are consumed by certain zooplanktons and fishes. Very soon zooplanktons are colonies the water surface. Then blue gill fish, sun fish etc. are start appearing. All phytoplanktons, zooplanktons, fishes are die. After death they settle at bottom. At bottom, dead organic matter of these organisms is decomposed by bacteria and fungi. After decomposition thin stratum of humus is formed at the bottom of the pond.

b) Rooted Submerged Stage: Due to formation of thin stratum of humus at the bottom, pond a bit shallower and this new habitat becomes favourable for rooted submerged hydrophytes (aquatic plants with roots but remain under water) like *Hydrilla, Ceratophyllum, Utricularia, Vallisenaria* etc. This stage is also invaded by animals like dragon flies, may flies, *Cyclops* etc. These organisms grow for some time and after their death and decay, further build up the substratum and gradually the water level of the pond decreases and it becomes shallower. With this change in environment, the conditions become favourable for some other community.

c) Rooted Floating Stage: After rooted submerged stage, due to build up of new substratum, gradually the water level of the pond decreases and it becomes shallower. With this change in environment, several plants rooted in the bottom soil with large floating leaves invade the pond. These rooted floating plants

include *Nelumbo, Nymphaea, Trapa, Monochoria* etc. Besides these, free-floating plants like *Lemna, Pistia, Salvinia, Azolla* and *Wolffia* are also appear. In this stage animals like hydra sp., gill breathing snails, frogs, salamanders, diving beetles, snakes etc. are also appear. Due to growth, and death and decay of these organisms, pond becomes rich in salts and organic matter. Consequently, water level decreases and pond become much shallower.

d) Reed Swamp Stage: In this stage, rooted floating plants, free-floating plants and other organisms of free floating stage are replaced by reed swamp species or amphibious plants such as *Typha, Phragmites, Sagittaria, Scirpus* etc. Animals such as mayflies, dragonflies etc also appeared. This stage is also known as amphibious stage because plants are found in the semi-aquatic environment. Swamp species form dense patches of growth.

e) Sedge-Meadow Stage: In this stage, pond becomes very shallow with reduced water and accumulated soil rich in salts and organic matter. Species of grasses and sedges such as *Carex, Juncus, Cyperus* etc. appear. They also form a dense growth. Due to increase in transpiration, the water level of the pond decreases a lot.

f) Wood Land Stage: This stage is dominated by rhizomatous woody plants. These plants can tolerate waterlogged soil. Due to the growth of rhizomatous woody plants, the area becomes rich in humus and flora of microbes.

g) Forest Stage (Climax Stage): This is climax stage i.e. final stage. This stage dominated by trees and terrestrial animals.

2) Xerosere or Xerarch

Succession taking place in dry area such as desert area, sandy areas, rocks etc. is called as xerosere. Succession taking place in bare rocky area is known as lithosere. Succession taking place in sand dune is known as psammosere. The plant succession on bare rocks (lithosere) takes place through following stages:

a) Crustose Lichen Stage
b) Foliose Lichen Stage
c) Moss Stage

d) Herb Stage
e) Shrub Stage
f) Forest Stage (Climax Stage)

a) Crustose Lichen Stage: The first organisms to colonies primitive medium of bare rock is crustose lichens. These comprise the pioneers of the lithosere. The substratum colonized by crustose lichen is hard, very poor in organic matter and moisture content. These lichens produce carbonic acid in the substratum that brings about weathering of rock. After the death of these lichens, organic content is added to the rock substratum that enriches it. Consequently, thin layer of soil formed.

b) Foliose Lichen Stage: Crustose lichens are replaced by foliose lichens. These types of lichens have large-sized leaf like thalli and these are also able to absorb more water in their body. These lichens absorb water and accumulate dust particles and also cause further weathering of rocks. This results into accumulation of more and more of humus. Due to their death and decay further organic content is added to the rock substratum that enriches it. Consequently, thin layer of soil formed.

c) Moss Stage: The building of a thin layer of soil on the rock surface invites xerophytic mosses. Due to death of mosses more biomass and moisture added to the substratum and thus the soil layer becomes thick and able to support herbaceous species.

d) Herb Stage: Due to development of thick soil layer, mosses are replaced by herbs. Herbs cause break down of rock into smaller pieces. Due to this soil layer becomes thick retaining more moisture, minerals or organic matter. Due to their growth and death more humus is added in substratum.

e) Shrub Stage: In this stage, herbs are replaced by shrubs due to development of suitable soil substratum.

f) Forest Stage (Climax Stage): This is final stage or climax stage. When rock completely converts into land, many tree species are appears. Further increase in humus content of the soil favors the appearance of more trees. Finally this results into development of forest community.

Summary

- ✓ Ecological succession refers to natural change in community structure and species composition.
- ✓ Primary succession is taking place in unoccupied habitat (bare ground) where no community existed before where as secondary succession is succession occurring in stable community, which is disturbed by fire or flood or human activity.
- ✓ Replacement of one community by other due to effects of organisms themselves is known as autogenic succession while replacement of one community by the other due to external environmental factors is known as allogenic succession.
- ✓ Autotrophic succession is dominated by green plants whereas heterotrophic succession is dominated by heterotrophs.
- ✓ Nudation is first step of succession.
- ✓ The final stage of community is not replaced by other groups of organisms. It is known as climax stage and community is known as climax community.
- ✓ Monoclimax theory states that climax stage is controlled solely by climate.
- ✓ According to polyclimax theory climax stage is controlled not only by climate but also by other several factors such as soil moistures, soil nutrients, topography, slope exposure, fire and biotic factors.
- ✓ According to climax pattern, hypothesis climax community of an area is controlled by whole environmental factors of the region in which it exist.
- ✓ Ecological succession starts from a water body is known as hydrosere or hydrarch.
- ✓ Phytoplankton stage is first stage of hydrosere.
- ✓ Succession occurring in dry area such as desert area is called as xerosere.
- ✓ Crustose lichen stage is first stage of xerosere.

Question Bank

Q.1. What is ecological succession? Discuss types of ecological succession.
Q.2. Discuss mechanism of ecological succession.
Q.3. Describe sequential stages of hydrosere and xerosere.
Q.4. Write a short notes on
a) Types of ecological succession
b) Concept of climax
c) Hydrosere
d) Xerosere

MCQ (Multiple Choice Questions)

1. Succession taking place in unoccupied habitat (bare ground) where no community existed before is termed as _____.
a) Primary succession b) Secondary succession
c) Autogenic Succession d) Allogenic Succession

2. Succession occurring in stable community is known as _____.
a) Primary succession b) Secondary succession
c) Autogenic Succession d) Allogenic Succession

3. Replacement of one community by other due to effects of organisms themselves is known as _____.
a) Primary succession b) Secondary succession
c) Autogenic Succession d) Allogenic Succession

4. Replacement of one community by the other due to external environmental factors is known as _____.
a) Primary succession b) Secondary succession
c) Autogenic Succession d) Allogenic Succession

5. A succession where autotrophs are dominated is known as _____.
a) Autotrophic Succession b) Heterotrophic Succession
c) Autogenic Succession d) Allogenic Succession

6. A succession where heterotrophs are dominated is known as _____.
a) Autotrophic Succession b) Heterotrophic Succession
c) Autogenic Succession d) Allogenic Succession

7. The final stage of community which is not replaced by other groups of organisms known as _____.
a) Pioneer stage b) climax stage
c) Both a & b d) None of the above

8. Succession taking place in dry area such as desert area, rocks etc. is known as _____.
a) Hydrosere b) Xerosere
c) Both a & b d) None of the above

9. Climax stage in hydrosere is _____.
a) Phytoplankton stage b) Forest stage
c) Rooted Floating stage d) Reed Swamp stage

10. Pioneer stage in hydrosere is _____.
a) Rooted Submerged stage b) Phytoplankton stage
c) Rooted Floating stage d) Forest stage

11. First stage in Xerosere is _____.
a) Crustose lichen stage b) Foliose lichen stage
c) Moss stage d) Herb stage

12. Final stage in Xerosere is _____.
a) Forest stage b) Foliose lichen stage
c) Moss stage d) Herb stage

6. Ecological Succession

Answers of Multiple Choice Questions (MCQ)

1.	(a)	2.	(b)	3.	(c)
4.	(d)	5.	(a)	6.	(b)
7.	(b)	8.	(b)	9.	(b)
10.	(b)	11.	(a)	12.	(a)

7
ECOSYSTEM

Introduction

Ecosystem is any small or large area of nature where living and nonliving factors interact and exchange materials (energy and nutrients) between them. Sir **Arthur Tansley** in 1935 coined the term ecosystem. The term ecosystem is derived from two words namely eco and system. Eco= environment and system= complex coordination unit. According to Tansley (1935) ecosystem defined as "the system resulting from the integration of the all the biotic and abiotic factors of the environment. An ecosystem may be as small as drop of pond water or as large as an ocean. Ecosystem may be natural or artificial. It may be temporary or permanent. Ecosystem is basic unit in ecology.

Structure of Ecosystem

Ecosystem comprises following two components:

A) Non-Living Factors
B) Living Factors

A) Non-Living Factors

It is also known as **abiotic factors**. Abiotic factors include the non-living substances of the environment (Fig.7.1). Abiotic factors include following three components

I) Inorganic Substances
II) Organic Substances
III) Ecological Factors

I) Inorganic Substances

Inorganic substances include water, carbon, hydrogen, nitrogen, phosphorous, calcium etc. Those substances are involved in the material cycles of the ecosystem.

II) Organic Substances

Organic substances like carbohydrates, proteins, lipids, humic substances etc. are present in ecosystem.

III) Ecological Factors

Ecological factors consist of light, temperature, precipitation, humidity of air, atmosphere, topographic factors and soil that delimits the conditions of existence.

B) Living Factors

It is also known as **biotic components**. The biotic components include all living organisms (Fig.7.1). From nutrition point of view, the living factors are divided into following two basic types

I) Autotrophic Components
II) Heterotrophic Components

I) Autotrophic Components

Autotrophic components are also known as **producers**. Producers prepare their food by using light energy and chemical energy and they also provide food to heterotrophic organisms. Autotrophic components are further divided into following two sub types:

a) Photoautotrophs
b) Chemoautotrophs

a) Photoautotrophs

Photoautotrophs prepare their food by photosynthesis. All green plants, algae, cyanobacteria, photosynthetic bacteria are examples of photoautotrophs.

b) Chemoautotrophs

Chemoautotrophs use energy produced in oxidation-reduction chemical reaction. Sulpher bacteria are the best example of chemoautotrophs.

II) Helerotrophic Components

Heterotrophic components are also known as **consumers** because they consume the food material synthesized built up by the autotrophs. On the basis of their size consumers are mainly divided into following two basic types:

a) Macroconsumers
b) Microconsumers

a) Macroconsumers

Macroconsumers are further divided into following three types:

i) Primary Consumers
ii) Secondary Consumers
iii) Tertiary Consumers

i) Primary Consumers

They are also known as **herbivores** because they live directly upon green plants. Consumers eat the producers. Rabbit, grasshopper, cattle, goat, deer etc. are examples of herbivores.

ii) Secondary Consumers

Secondary consumers are also known as **primary carnivores**. They kill and eat the herbivores. For examples frog, fox, wolf etc.

iii) Tertiary Consumers

Tertiary consumers are also known as **secondary carnivores**. They kill and eat the secondary consumers. Lion, snake, tiger etc. are examples of tertiary consumers.

b) Microconsumers

They are also known as **decomposers, reducers or saprophytes**. Decomposers are microorganisms mainly fungi and bacteria. They take food material from dead organic matter. Decomposers or microconsumers decompose the dead bodies of plants, animals and their waste products. They secrete hydrolytic enzymes which decompose the dead organism and debris into smaller molecules. These molecules are absorbed by the reducers. Finally reducers take the energy and release these molecules in to the ecosystem as biochemicals to be used again by autotrophs.

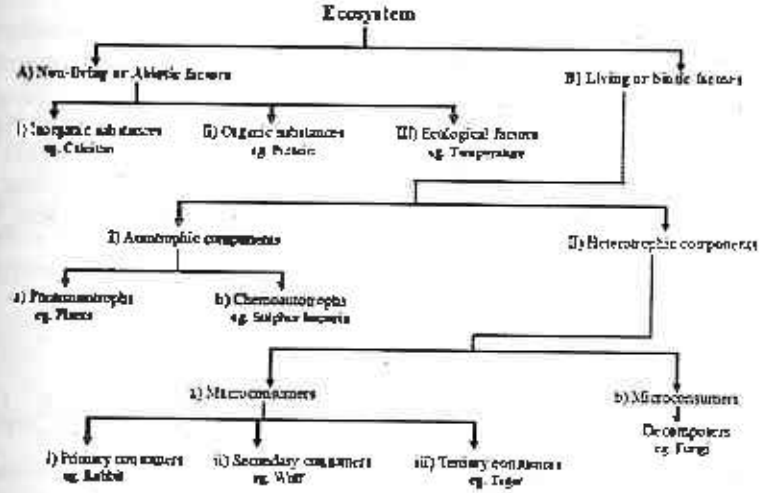

Fig.7.1: Structure of Ecosystem

Types of Ecosystem

Ecosystems are of different types (Fig.7.2). These can be artificially divided as follows:

A) Natural ecosystem
B) Artificial ecosystem

A) Natural Ecosystem

Natural ecosystem develops and operates by themselves under natural conditions. On the basis of habitat, natural ecosystems are further classified into following two types:

a) Terrestrial ecosystem
b) Aquatic ecosystem

a) Terrestrial Ecosystem

Terrestrial ecosystems are operating on land. Forest, grassland, desert ecosystem etc. are examples of terrestrial ecosystem.

b) Aquatic Ecosystem

Aquatic ecosystems are operating on water. Aquatic ecosystems are of following two types:

i) Fresh water ecosystem
ii) Marine water ecosystem

i) Fresh Water Ecosystem

Fresh water ecosystem may be lotic or lentic. Ecosystem of running water is known as lotic ecosystem. Spring, stream, rivers etc. are examples of lotic ecosystem. Ecosystem of is standing water system is known as lentic ecosystem. For example: lake, pond, pools, puddles, swamp etc.

ii) Marine Water Ecosystem

Marine water ecosystem comprises sea, ocean, estuaries etc.

B) Artificial Ecosystem

Man made ecosystem is known as artificial ecosystem. Crop land ecosystem is an example of artificial ecosystem.

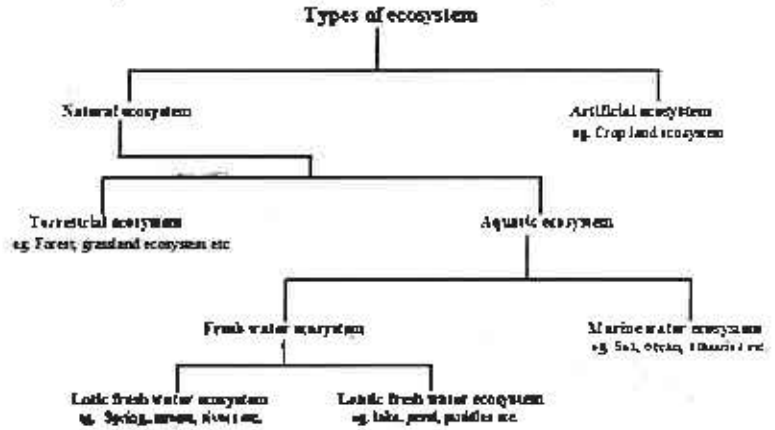

Fig.7.2: Types of Ecosystem

Grassland Ecosystem

Grassland ecosystem is kind of terrestrial ecosystem. This ecosystem is dominated by grasses. Grassland ecosystem comprises follows two main components:

A) Non-Living Factors
B) Living Factors

A) Non-Living Factors

In grassland ecosystem, inorganic and organic substances like water, carbon, hydrogen, nitrogen, phosphorous, calcium, carbohydrates, proteins, lipids, humic substances etc. are present. Ecological factors like light, temperature, precipitation, humidity of air, and soil are also present.

B) Living Factors

It is also known as **biotic components**. The biotic components include all living organisms. From nutrition point of view, the living factors are divided into following two basic types:

I) Autotrophic Components
II) Heterotrophic Components

I) Autotrophic Components or Producers

Autotrophic components are also known as **producers**. They are mainly grasses like *Cenchrus, Cynodon, Digitaria* etc. Some shrubs also present in this ecosystem.

II) Heterotrophic Components

Heterotrophic components are also known as **consumers**. Consumers are mainly divided in following two types

a) Macro Consumers
b) Micro Consumers

a) Macro Consumers

Macro consumers are further divided into following three types

i) Primary Consumers
ii) Secondary Consumers
iii) Tertiary Consumers

i) Primary Consumers

They are also known as **herbivores**. Primary consumers eat grasses. Grazing animals like goat, cow, buffalos, rabbit, deer, mouse, grasshopper etc. are herbivores in grassland ecosystem.

ii) Secondary Consumers

Secondary consumers are also known as **primary carnivores**. They kill and eat the herbivores. Fox, jackals, snakes, frogs,

lizards, birds etc. are secondary consumers in grassland ecosystem.

iii) Tertiary Consumers

Tertiary consumers are also known as **secondary carnivores.** They feed on secondary consumers. Hawk, vulture etc. are tertiary consumers in grassland ecosystem.

b) Micro Consumers

They are also known as **decomposers, reducers** or **saprophytes.** Decomposers comprises fungi, bacteria etc. They decompose the dead organic matter.

Pond Ecosystem

Pond ecosystem is type of aquatic ecosystem. A pond ecosystem is a living ecosystem- a balance of fish, plant and beneficial microorganisms that compliment and support each other. Pond ecosystem consists of following two main components:

A) Non-Living Factors
B) Living Factors

A) Non-Living Factors or Abiotic Factors

In pond ecosystem, inorganic and organic substances like water, carbon, hydrogen, nitrogen, phosphorous, calcium, carbohydrates, proteins, lipids, humic substances etc. are present. Ecological factors like dissolved oxygen and carbon dioxide, light, temperature and soil are also present.

B) Living Factors

It is also known as **biotic components.** The biotic components include all living organisms. From nutrition point of view, the living factors are divided into following two basic types

I) Autotrophic Components
II) Heterotrophic Components

I) Autotrophic Components or Producers

Autotrophic components are also known as **producers.** In pond ecosystem, producers are plants and phytoplanktons. Aquatic plants in pond ecosystems are rooted partly submerged, rooted completely submerged, rooted floating and free floating. Aquatic plants like *Typha, Sagittaria, Nyphea, Chara, Hydrilla, Vallisneria, Utricularia, Marselia, Azolla, Salvinia, wolffia, Lemna* etc. are present in pond ecosystem. Phytoplanktons are minute, floating or suspended lower plants. Phytoplanktons mainly comprise *Oedogonium, Spirogyra, Zygnema, Ulothrix, Cladospora,* diatoms, *Volvox* etc.

II) Heterotrophic Components

Heterotrophic components are also known as consumers. Consumers are mainly divided in following two types

a) Macro consumers
b) Micro consumers

a) Macro Consumers

Macro consumers are further divided into following three types

i) Primary Consumers
ii) Secondary Consumers
iii) Tertiary Consumers

i) Primary Consumers

They are also known as **herbivores.** Primary consumers live on aquatic plants and phytoplanktons. Animals like fish, insect larvae, mites, and molluscs eat plants and zooplanktons like rotifers, protozoan, and crustaceans live on phytoplanktons.

ii) Secondary Consumers

Secondary consumers are also known as **primary carnivores.** They kill and eat the herbivores. Water beetles, medium fishes, frog etc. are secondary consumers in pond ecosystem.

iii) Tertiary Consumers

Tertiary consumers are also known as **secondary carnivores.** They kill and eat the secondary consumers. Larger fish, water snake etc. are tertiary consumers in pond ecosystem.

b) Micro Consumers

They are also known as **decomposers, reducers** or **saprophytes.** Decomposers comprises mainly fungi, bacteria etc. which live on dead organic matter.

Ecological Pyramids

Graphical representation of relationship between producers and consumers at successive trophic level in terms of their number or biomass or energy is known as **ecological pyramids.**

Since the pyramids were first devised by Charles Elton (1927), they are also known as Eltonian pyramids. There are following three types of ecological pyramids:

A) Pyramid of Number
B) Pyramid of Biomass
C) Pyramid of Energy

A) Pyramid of Number

Pyramids of number represent the relationship between producers and consumers at successive trophic levels in terms of their numbers. The pyramid of number may be upright or inverted. Pyramid of number are not very functional because they do not give idea about biomass and energy in food chain. The pyramids of number in different types of ecosystem are discussed as fallows.

In grassland ecosystem, producers *i.e.* grasses are always more in number. Primary consumers like grasshopper, rabbits, mice etc. are minimum in number than grasses. Secondary consumers like snakes and lizards are minimum in number than the rabbits and mice and tertiary consumers like hawk, eagle etc. are minimum in number than secondary consumers. Consequently a pyramid becomes upright (Fig.7.3).

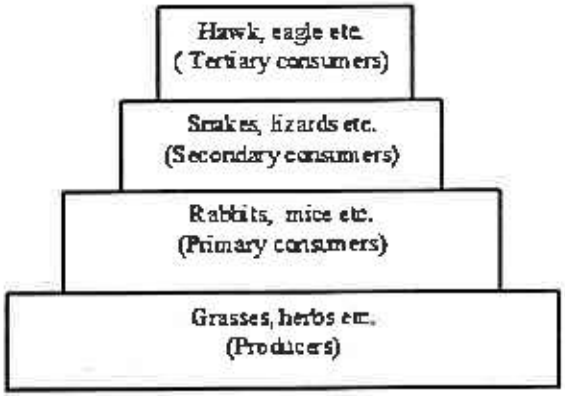

Fig.7.3: Pyramid of Number in Grassland Ecosystem

In pond ecosystem, the pyramid of number is also upright (Fig.7.4).

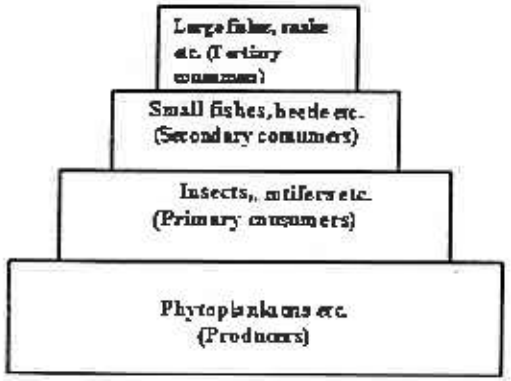

Fig.7.4: Pyramid of Number in Pond Ecosystem

In forest ecosystem, the pyramid of number is rhomboidal (Fig.7.5). In forest ecosystem, producer that is trees are less in number. While primary consumers like birds, deers, elephants etc. are more in number than trees (producers). Primary carnivores like wolf, snake etc. are less in number as compare to herbivores and secondary carnivores like tigers, lions etc. are less in number than primary carnivores.

Fig.7.5: Pyramid of Number in Forest Ecosystem

Pyramid of number in a parasitic food chain is always inverted because single plant (producer) may provide food to many herbivores like fruit eating birds and each herbivores (fruit eating birds) in turn may provide food to parasites like bugs, lices etc. and each parasite may bear several hyperparasites like fungi, bacteria , consequently pyramid become inverted (Fig.7.6).

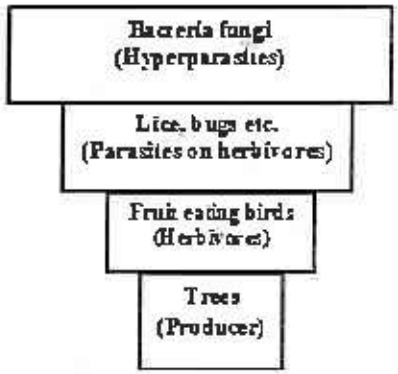

Fig.7.6: Pyramid of Number in Parasitic Food Chain

B) Pyramid of Biomass

Pyramid of biomass represents the relationship between producers and consumers at successive trophic levels in terms of their biomass. The pyramid of biomass may be upright or inverted. Pyramid of biomass do not give idea about number and energy in food chain. The pyramids of biomass in different types of ecosystem are discussed as fallows.

In grassland ecosystem and forest ecosystem, pyramid of biomass is upright (Fig.7.7 & Fig.7.8). Biomass of organism is gradually decreased from producers to secondary carnivores and consequently a pyramid becomes upright.

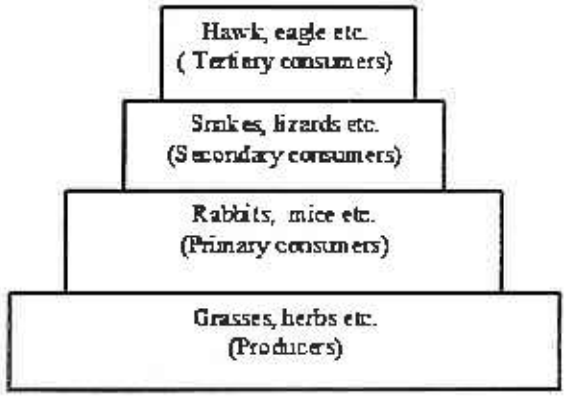

Fig.7.7: Pyramid of Biomass in Grassland Ecosystem

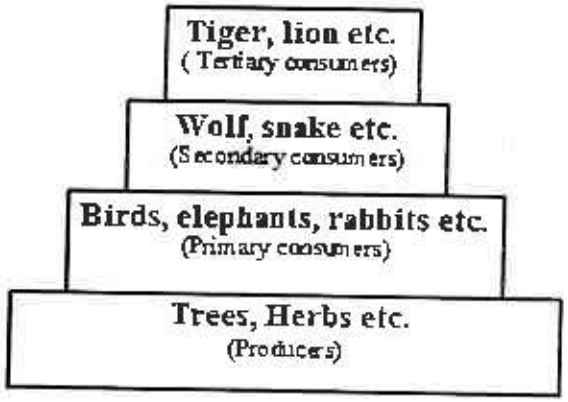

Fig.7.8: Pyramid of Biomass in Forest Ecosystem

In pond ecosystem, the pyramid of biomass is inverted because producers in pond ecosystem (phytoplanktons) have less biomass than primary consumers. Further biomass is increases at secondary consumers and tertiary consumers leve (Fig.7.9).

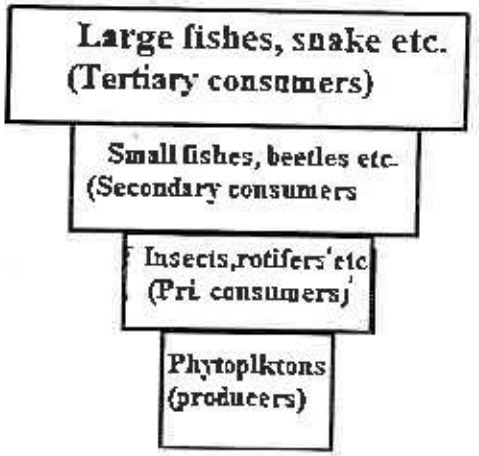

Fig.7.9: Pyramid of Biomass in Pond Ecosystem

In a parasitic food chain, the pyramid of biomass is upright because plants (producer) have maximum biomass than herbivores and herbivores have maximum biomass as compared to parasite and hyperparasites (Fig.7.10).

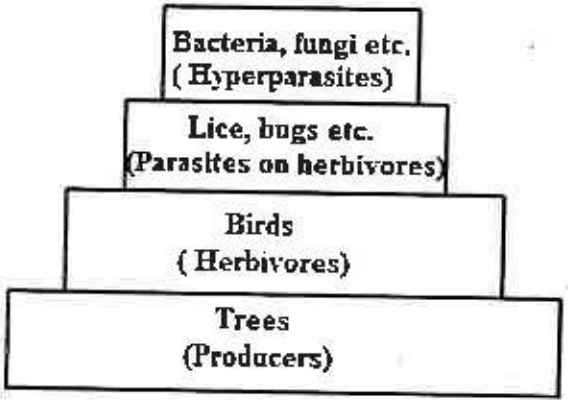

Fig.7.10: Pyramid of Biomass in Parasitic Food Chain

C) Pyramid of Energy

Pyramid of energy represents the rate of energy flow at successive trophic levels. The pyramid of energy is always upright because some energy is always lost as heat is going from one trophic level to the next. The pyramids of energy more accurately reflect the law of thermodynamics. Hence, in all ecosystems (grassland ecosystem, forest ecosystem pyramid, pond ecosystem pyramid and other ecosystems etc.) pyramid of energy is upright (Fig.7.11, Fig.7.12, Fig.7.13 and Fig.7.14).

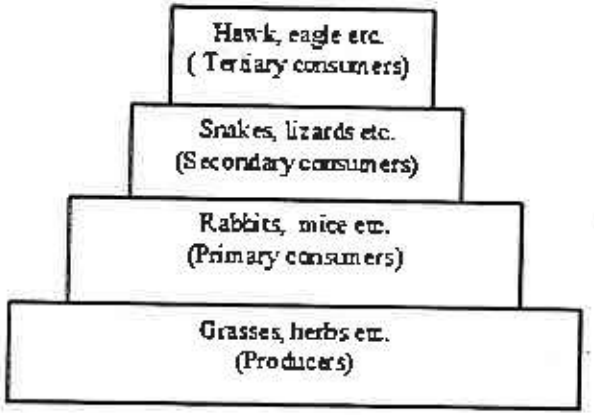

Fig.7.11: Pyramid of Energy in Grass Land Ecosystem

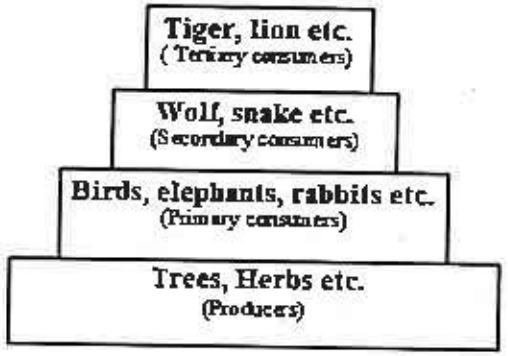

Fig.7.12: Pyramid of Energy in Forest Ecosystem

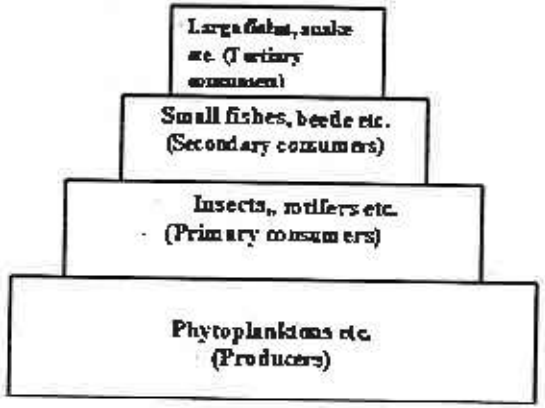

Fig.7.13: Pyramid of Energy in Pond Ecosystem

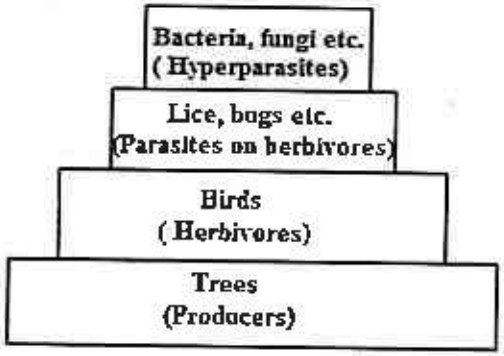

Fig.7.14: Pyramid of Energy in Parasitic Food Chain

Food Chain

The producers synthesize organic food by photosynthesis. Herbivores take food energy from producers. From herbivores, the organic food energy is passed in to primary consumers from which it transfers to secondary consumers and from secondary consumers it is transfers to tertiary consumers. Such sequence of kind of organisms through which energy is flow in an ecosystem is known as food chain. In simple words, the series of the eaters being eaten is called as **food chain.** Each step of food chain is called as **trophic level or energy level.** There are usually four to five trophic levels. First trophic level is occupied by autotrophic organisms. The second trophic level is occupied by herbivores while that third level is known as secondary consumer and fourth level is called as tertiary consumers. In food chain, energy is transferred from one trophic level to another trophic level.

For example: A typical food chain can be seen in grassland ecosystem (Fig. 7.15). A food chain in grassland initiates with grasses. Grass is eaten by grasshopper which is eaten by lizard and finally lizard is the eaten by hawk.

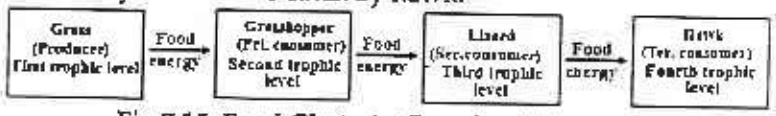

Fig.7.15: Food Chain in Grassland Ecosystem

Types of Food Chain

In different ecosystem following three types of food chains are present

A) Grazing Food Chain
B) Parasitic Food Chain
C) Detritus Food Chain

A) Grazing Food Chain: Grazing food chain begins from green plants or producer like trees, herbs, phytoplanktons etc. In this food chain, producers like trees, herbs, phytoplanktons etc. are eaten by herbivores like deer, mouse, rabbit, grasshopper, zooplanktons, birds etc. From primary consumers, food energy is transfer to secondary consumers like wolf, fox, snake, small fishes, lizard etc. Tertiary consumers like tiger, lion, hawk, vulture, large fishes etc. live on secondary consumers. On the basis of habitats this food chain may be i.e. terrestrial or aquatic. Producers and consumers of this food chain are different in terrestrial and aquatic ecosystem (Fig. 7.16 & 7.17).

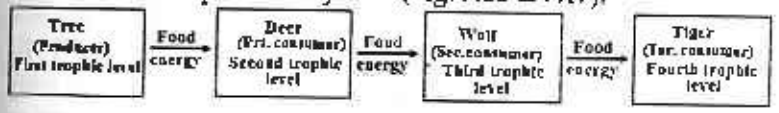

Fig.7.16: Food Chain in Terrestrial (Forest) Ecosystem

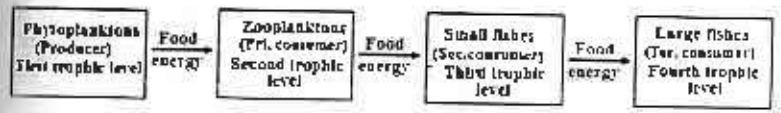

Fig.7.17. Food Chain in Aquatic (Pond) Ecosystem

B) Parasitic Food Chain: Parasitic food chain is also begins from green plants (Fig.7.18). In this type of food chain, producers like trees eaten by herbivores like fruit eating birds and herbivores transfer food energy to secondary consumers (parasites) like bugs, lice etc. and parasite provide food energy to tertiary consumers (hyperparasites) like fungi, bacteria etc. In other words, this food chain goes from larger to smaller organisms.

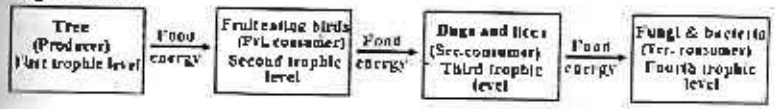

Fig.7.18. Parasitic Food Chain

C) Detritus Food Chain: Detritus food chain starts from **detritus** (dead organic matter of plants or animals). Detritivores (Algae, fungi, bacteria, moulds, nematodes, actinomycetes, protozoa insects, rotifers etc.) take food energy from detritus. They decompose the detritus. Carnivores live on detritivores and from carnivores food energy transfer to top carnivores (Fig.7.19).

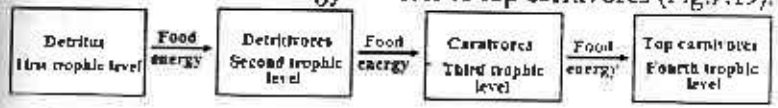

Fig.7.19. Detritus Food Chain

Food Web

In ecosystem, food chains are never found in isolated form or very rarely linear but they are very much linked with each other forming a complex network known as food web. For example: In grassland ecosystem, grass may be eaten by grasshopper, rabbit, mouse, deer and cow. A grasshopper may be eaten by lizard which may be eaten by hawk or vulture or eagle. Rabbit may be eaten by hawk, man, wolf or fox. Mouse may be eaten by snake which may be eaten by hawk or eagle. In addition, hawk may be also directly eats grasshopper and mouse. Thus there are several linear food chains which are interconnected to form a food web (Fig.7.20).

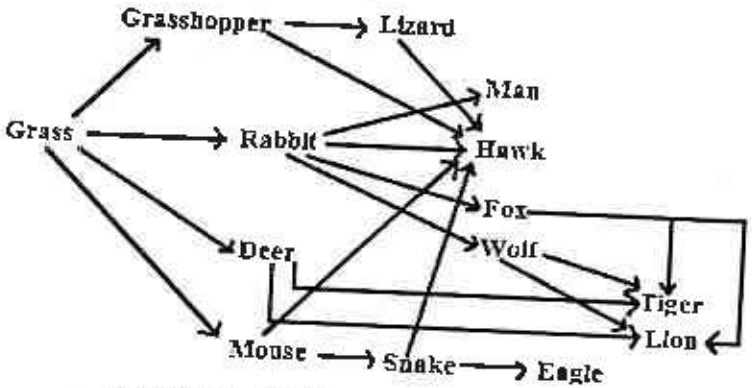

Fig.7.20: Food Web in Grassland Ecosystem

Significance of food web: Food web maintains the stability of an ecosystem.

Productivity of Ecosystems

Productivity of an ecosystem refers to the amount of organic matter produced or acquired or accumulated by a particular trophic level per unit of area, in a unit time. Productivity of an ecosystem is divided into following three types:

A) Primary Productivity
B) Secondary Productivity (S.P.)
C) Net Productivity (N.P.)

A) Primary Productivity

Productivity at autotrophs or producers or autotrophs level is known as primary productivity. In simple words, photosynthetic organic matter produced at producer level is known as primary productivity. It is divided into following two sub-types:

a) Gross Primary Productivity (GPP)
b) Net Primary Productivity (NPP)

a) Gross Primary Productivity (GPP): Total amount of photosynthetic organic matter synthesized by producer per unit area, in a unit time is known as gross primary productivity (GPP.)

b) Net Primary Productivity (NPP): It refers to the gross productivity minus the rate of plant respiration.

B) Secondary Productivity (S.P.)

Amount of organic matter or food energy available or storage at consumer level is known as secondary productivity.

C) Net Productivity (N.P.)

Amount of photosynthetic organic matter or food energy not utilized by the consumers is known as net productivity. In simple words, net productivity is net primary productivity minus consumption of photosynthetic organic matter by hetrotrophs or consumers.

Tropical rain forests have maximum net productivity. Open oceans, deserts and temperate forest have very low net productivity.

Energy Flow in Ecosystem

- Energy flow in ecosystem is the transfer of energy form one trophic level to another trophic level. In another words energy flow is the amount of energy that moves through a food chain.
- The energy flow in the ecosystem is calculated in Joules or calories. Hence, the energy flow is known calorific flow.
- Energy flow is the key function in the ecosystem.
- Energy flow in ecosystem fallows the two basic laws of thermodynamics.

- The flow of energy in an ecosystem is unidirectional. That is it flows from the producer level to the top consumer level and never in the reverse direction. Hence energy can be used only once in the ecosystem. But the minerals circulate and recirculate many times in the ecosystem.
- The conversion of solar radiation to chemical energy by photosynthesis is the initial point of energy flow within ecosystem.
- The main source of energy for an ecosystem is the sun.
- Maximum amount of energy is lost at each trophic level.
- It is estimated that when energy is transfer from one trophic level to another trophic level, 80- 90% of the energy is lost.
- Energy that is not used in an ecosystem is eventually lost as heat.
- Energy and nutrients are passed around through the food chain, when one organism eats another organism. Any energy remaining in a dead organism is consumed by decomposers.
- The top consumer of a food chain is the organism that receives the least amount of energy.

Summary

- ✓ Ecosystem is any small or large region of nature where abiotic and biotic factors interact and exchange materials (energy and nutrients) between them.
- ✓ The term ecosystem coined by Sir Arthur Tansley.
- ✓ Ecosystem consists of abiotic and biotic factors.
- ✓ Abiotic factors include inorganic substances, organic substances and ecological factors.
- ✓ The biotic factors include all living things.
- ✓ Biotic factors are of two types: autotrophic components and heterotrophic components.
- ✓ Autotrophic components are also known as producers.
- ✓ Autotrophs produce food by photosynthesis or chemical reactions.
- ✓ Autotrophic components are of two types :
  a) photoautotrophs and b) chemoautotrophs
- ✓ Heterotrophic components are also known as consumers.
- ✓ All consumers depend on producers for food energy.

- ✓ On the basis of size, consumers are of mainly divided into two types:
  a) macroconsumers and b) microconsumers.
- ✓ Macroconsumers are three types: i) primary consumers, ii) secondary consumers and iii) tertiary consumers.
- ✓ Primary consumers are also known as herbivores.
- ✓ Herbivores consume the green plants i.e. producers.
- ✓ Secondary consumers are also known as primary carnivores and they feed on herbivores.
- ✓ Tertiary consumers are also known as secondary carnivores or top carnivores and they live on secondary consumers.
- ✓ Microconsumers are also known as decomposers, reducers or saprophytes. Fungi, bacteria etc. are well known examples of decomposers.
- ✓ Microconsumers live on dead organic matter.
- ✓ Ecosystems are broadly divided into two types: natural ecosystem and artificial ecosystem..
- ✓ Natural ecosystems are of two types: terrestrial and aquatic ecosystem.
- ✓ Forest, grassland ecosystem etc. are examples of terrestrial ecosystem.
- ✓ Aquatic ecosystems are of two types: freshwater or marine water ecosystem.
- ✓ Crop land ecosystem is best example of artificial ecosystem.
- ✓ Ecological pyramids represent the relationship between producers and consumers at successive trophic level in terms of their number or biomass or energy.
- ✓ Ecological pyramids are of three types: pyramid of number, pyramid of biomass and pyramid of energy
- ✓ Pyramid of number, biomass and energy represent the relationship between producers and consumers at successive trophic levels in terms of their numbers, biomass and energy respectively.
- ✓ The pyramid of number and biomass may be upright or inverted.
- ✓ In grassland and pond ecosystem, pyramid of number and biomass is upright.
- ✓ In forest ecosystem, the pyramid of number is rhomboidal.

- ✓ Pyramid of number in a parasitic food chain is always inverted.
- ✓ In grassland ecosystem, forest ecosystem and parasitic food chain, pyramid of biomass is upright while in pond ecosystem, it is inverted.
- ✓ The pyramid of energy is always upright.
- ✓ Series of the eaters being eaten is known as food chain.
- ✓ Food chains are of three types: grazing food chain, parasitic food chain and detritus food chain
- ✓ Grazing food chain and parasitic food chain initiates from green plants.
- ✓ Detritus food chain begins from detritus (dead organic matter of plants or animals).
- ✓ Network of different food chains is known as food web.
- ✓ Amount of organic matter produced or acquired or accumulated by a particular trophic level per unit of area, in a unit time is known as productivity of ecosystem.
- ✓ Productivity of an ecosystem is divided into three types: primary productivity, secondary productivity (S.P.) and net productivity (N.P.).
- ✓ Primary productivity is productivity at producer's level.
- ✓ Primary productivity is of two sub-types: gross primary productivity (GPP) and net primary productivity (NPP).
- ✓ Gross primary productivity (GPP.) refers to total amount of organic food synthesized by producer.
- ✓ Net primary productivity (NPP) is gross productivity minus the rate of plant respiration.
- ✓ Secondary productivity refers to the amount of organic matter or food energy available or storage at consumer level.
- ✓ Net productivity refers to amount of photosynthetic organic matter or food energy not utilized by the consumers.
- ✓ The flow of energy in an ecosystem is always unidirectional.

Question Bank

Q.1. Give an account of structure of typical ecosystem.
Q.2. Discuss types of ecosystem.
Q.3. Discuss structure of pond ecosystem.
Q.4. Explain grassland ecosystem.
Q.5. Explain in detail ecological pyramids.
Q.6. What is food chain? Explain different types of food chain.
Q.7. Give in detail account of food web.
Q.8. Explain energy flow in ecosystem.
Q.9. Write a short notes on
a) Pond ecosystem
b) Grassland ecosystem
c) Pyramid of number
d) Pyramid of biomass
e) Pyramid of energy
f) Food chain
g) Food web
h) Energy flow in ecosystem

Question Bank

1) Abiotic factors of ecosystem include _____.
a) Inorganic substances b) Organic substances
c) Ecological factors d) All of the above

2) Abiotic factors of ecosystem include _____.
a) Primary consumers b) Secondary consumers
c) Tertiary consumers d) None of the above

3) Biotic factors of ecosystem includes _____.
a) Photoautotroph b) Secondary consumers
c) Tertiary consumers d) All of the above

4) Biotic factors of ecosystem includes _____.
a) Inorganic substances b) Organic substances
c) Ecological factors d) None of the above

5) The term ecosystem was coined by _____.
   a) Ernst Haeckel b) Charels Elton
   c) Sir Arthur Tansley d) None of the above

6) The system resulting from the integration of the all the living and non living factors of the environment _____.
   a) Ecology b) Ecosystem
   c) Food chain d) Food web

7) Light, temperature, precipitation, humidity of air, atmosphere and soil are _____.
   a) Biotic factor of ecosystem b) Abiotic factor of ecosystem
   c) Non-living component of ecosystem d) Both b and c

8) The biotic factor/s is/ are of ecosystem _____.
   a) Producer b) Consumer
   c) Decomposer d) All of the above

9) Autotrophic components are also known as _____.
   a) Producers b) Consumers
   c) Decomposers d) All of the above

10) Heterotrophic components are also known as _____.
   a) Producers b) Consumers
   c) Both a and b d) All of the above

11) Primary consumers are also called as _____.
   a) Herbivores b) Primary carnivores
   c) Secondary carnivores d) Producers

12) Secondary consumers are also called as _____.
   a) Herbivores b) Primary carnivores
   c) Secondary carnivores d) Producers

13) Tertiary consumers are also called as _____.
   a) Herbivores b) Primary carnivores
   c) Secondary carnivores d) Producers

14) Micro consumers are also termed as _____.
   a) Decomposers b) Primary carnivores
   c) Secondary carnivores d) Producers

15) Micro consumers are also known as _____.
   a) Decomposers b) Reducers
   c) Saprophytes d) All of the above

16) The organisms live on dead organic matter are called as _____.
   a) Decomposers b) Primary carnivores
   c) Secondary carnivores d) Producers

17) Grassland ecosystem, pond ecosystem and terrestrial ecosystem are examples of _____.
   a) Natural ecosystem b) Artificial ecosystem
   c) Both a and b d) None of the above

18) Crop land ecosystem is examples of _____.
   a) Natural ecosystem b) Artificial ecosystem
   c) Both a and b d) None of the above

19) The ecosystems operating on land are known as _____.
   a) Terrestrial ecosystem b) Aquatic ecosystem
   c) Both a and b d) None of the above

20) The ecosystems operating on water are known as
   a) Terrestrial ecosystem b) Aquatic ecosystem
   c) Both a and b d) None of the above

21) A Lake is a _____.
   a) Fresh water ecosystem b) Marine water ecosystem
   c) Both a and b d) None of the above

22) A pond is a _____.
   a) Fresh water ecosystem b) Marine water ecosystem
   c) Both a and b d) None of the above

23) A puddle is a _____.
   a) Fresh water ecosystem b) Marine water ecosystem
   c) Both a and b d) None of the above

24) A swamp is a _____.
   a) Fresh water ecosystem b) Marine water ecosystem
   c) Both a and b d) None of the above

25) A pond is a _____.
a) Aquatic ecosystem b) Terrestrial ecosystem
c) Both a and b d) None of the above

26) The sea, ocean, estuaries are _____.
a) Fresh water ecosystem b) Marine water ecosystem
c) Both a and b d) None of the above

27) The sea, ocean, estuaries are _____.
a) Aquatic ecosystem b) Terrestrial ecosystem
c) Both a and b d) None of the above

28) A Lake is a _____.
a) Lotic water ecosystem b) Lentic water ecosystem
c) Both a and b d) None of the above

29) A pond is a _____.
a) Lotic water ecosystem b) Lentic water ecosystem
c) Both a and b d) None of the above

30) A puddle is a _____.
a) Lotic water ecosystem b) Lentic water ecosystem
c) Both a and b d) None of the above

31) A swamp is a _____.
a) Lotic water ecosystem b) Lentic water ecosystem
c) Both a and b d) None of the above

32) A spring is a _____.
a) Lotic water ecosystem b) Lentic water ecosystem
c) Both a and b d) None of the above

33) A stream is a _____.
a) Lotic water ecosystem b) Lentic water ecosystem
c) Both a and b d) None of the above

34) A river is a _____.
a) Lotic water ecosystem b) Lentic water ecosystem
c) Both a and b d) None of the above

35) The graphical representation of the number, biomass and energy of the successive trophic level of an ecosystem is known as _____.
a) Ecological pyramid b) Food web
c) Food chain d) None of the above

36) Ecological pyramids are of _____.
a) Three types b) Four types
c) Two types d) Five types

37) The first pyramid diagrams were prepared by _____.
a) Ernst Haeckel b) Charels Elton
c) Sir Arthur Tansley d) None of the above

38) The ecological pyramids which shows the relationship between producers and consumers at successive trophic levels in terms of their numbers are known as _____.
a) Pyramid of number b) Pyramid of biomass
c) Pyramid of energy d) None of the above

39) The ecological pyramids which shows the relationship between producers and consumers at successive trophic levels in terms of their biomass are known as _____.
a) Pyramid of number b) Pyramid of biomass
c) Pyramid of energy d) None of the above

40) The ecological pyramids which shows the relationship between producers and consumers at successive trophic levels in terms of their energy are known as _____.
a) Pyramid of number b) Pyramid of biomass
c) Pyramid of energy d) None of the above

41) The pyramid of number may be _____.
a) Inverted b) Upright
c) Both a and b d) None of the above

42) The pyramid of biomass may be _____.
a) Inverted b) Upright
c) Both a and b d) None of the above

43) **Pyramid of number and biomass in parasitic food chain _____.**
a) Inverted b) Upright
c) Both a and b d) None of the above

44) **Pyramid of number in grassland, forest and pond ecosystem is _____.**
a) Inverted b) Upright
c) Both a and b d) None of the above

45) **Pyramid of biomass in grassland and forest ecosystem is _____.**
a) Inverted b) Upright
c) Both a and b d) None of the above

46) **Pyramid of biomass in pond ecosystem is _____.**
a) Inverted b) Upright
c) Both a and b d) None of the above

47) **The pyramid of energy is always _____.**
a) Inverted b) Upright
c) Both a and b d) None of the above

48) **The sequence of the eaters being eaten is called as _____.**
a) Food web b) Food chain
c) Ecological pyramid d) None of the above

49) **When various food chains are interconnected with each other to form a network is called as _____.**
a) Food web b) Food chain
c) Ecological pyramid d) None of the above

50) **Grazing food chain begins with _____.**
a) Green plants b) Dead organic material
c) Both a and b d) None of the above

7. Ecosystem

Answers of Multiple Choice Questions (MCQ)

1.	(d)	**2.**	(d)	**3.**	(d)
4.	(d)	**5.**	(c)	**6.**	(b)
7.	(d)	**8.**	(d)	**9.**	(a)
10.	(b)	**11.**	(a)	**12.**	(b)
13.	(c)	**14.**	(a)	**15.**	(d)
16.	(a)	**17.**	(a)	**18.**	(b)
19.	(a)	**20.**	(b)	**21.**	(a)
22.	(a)	**23.**	(a)	**24.**	(a)
25.	(a)	**26.**	(b)	**27.**	(a)
28.	(b)	**29.**	(b)	**30.**	(b)
31.	(b)	**32.**	(a)	**33.**	(a)
34.	(a)	**35.**	(a)	**36.**	(a)
37.	(b)	**38.**	(a)	**39.**	(b)
40.	(c)	**41.**	(c)	**42.**	(c)
43.	(a)	**44.**	(b)	**45.**	(b)
46.	(a)	**47.**	(b)	**48.**	(b)
49.	(a)	**50.**	(b)		

8

HYDROLOGICAL AND BIOGEOCHEMICAL CYCLES

I) Hydrological Cycles

It is also known as water cycle. In water cycle, water transport between atmosphere and land and oceans. During water cycle, water that falls as precipitation (e.g. snow rain, hail) some amount of water is percolate into the ground and remaining water passes into springs, rivers, ponds etc which ultimately transport into the ocean. Then water evaporates from oceans, transpiration and respiration as vapour, forms clouds in the atmosphere and falls again as precipitation (Fig.8.1).

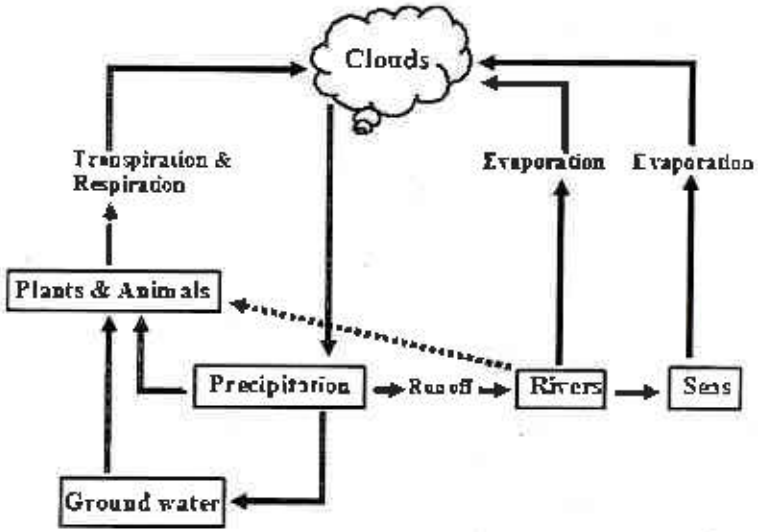

Fig.8.1: Water Cycle

II) Biogeochemical Cycles

Biogeochemical cycle refers to flow of essential chemical elements between biotic and non biotic components of the environment in cyclic manner. During these cycles biological, geological and chemical processes are involved; hence the name biogeochemical cycles derives. Biogeochemical cycles are sometimes also known as nutrient cycles. Biogeochemical cycles are mainly of following two types:

A) Gaseous Cycles
B) Sedimentary Cycles

A) Gaseous Cycles

In a gaseous cycle, chemical elements transport through the atmosphere. In these cycles, chief reservoirs are the atmosphere and the ocean. Gaseous cycles have a tendency to move more rapidly than the sedimentary cycles. Common examples of gaseous cycles are:

a) Carbon Cycle
b) Nitrogen Cycle

a) Carbon Cycle

Carbon is one of the most vital elements that sustain life on earth. It is basic component of all organic compounds. In atmosphere, carbon is present in the form of CO_2 and in water; it is present in the form of dissolved CO_2. During photosynthesis plants take CO_2 from atmosphere. In photosynthesis CO_2 is reduced into carbohydrates. Then these carbohydrates are consumed by herbivores animals and from it transfer to carnivores animals. Some of the CO_2 is returned to atmosphere by respiration of both animals plants. After the death of animals and plants, dead organic matter of these organisms is decomposed by bacteria and fungi. Decomposition releases CO_2 in atmosphere. Fire of plants also returns CO_2 in atmosphere. Fraction of carbon becomes incorporate into the earth crust as sedimentary rocks, coal, fossil fuel which release CO_2 after combustion. Atmospheric CO_2 may get dissolved in water and form the carbonic acid. Sedimentary gives rise to carbonated

rocks like lime stones. Volcanoes can return CO_2 to atmosphere and water by their eruptions (Fig.8.2).

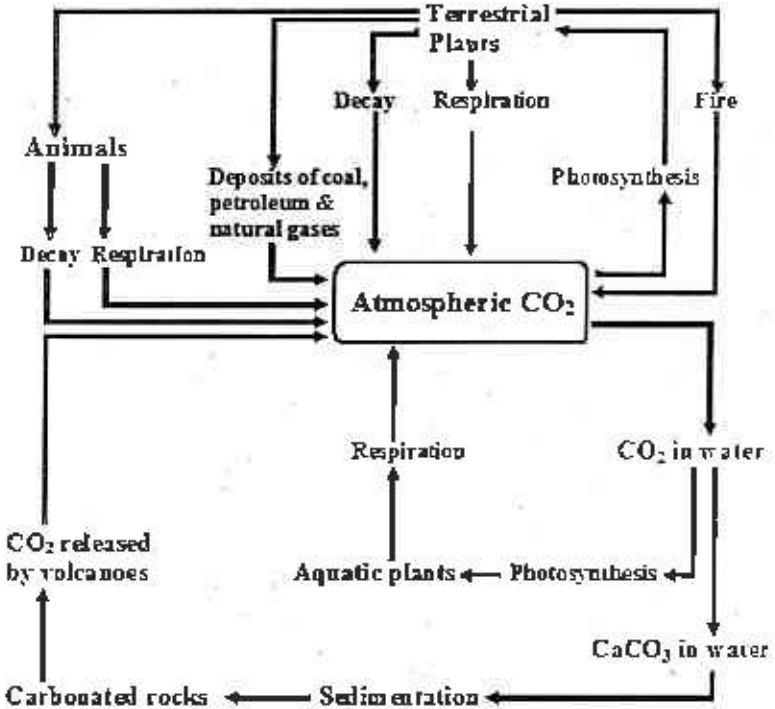

Fig. 8.2: Carbon Cycle

b) Nitrogen cycle

Nitrogen cycle can be conveniently discussed under the following six heads:

I) Nitrogen Fixation
II) Nitrogen Assimilation
III) Ammonification
IV) Nitrification
V) Denitrification
VI) Sedimentation

I) Nitrogen Fixation: In atmosphere, about 78% nitrogen is present but very few microorganisms can directly take the atmospheric nitrogen. Plants cannot utilize the atmospheric nitrogen. Plant can take nitrogen in form of ammonia, nitrates and nitrites.

Reduction of molecular or atmospheric nitrogen into organic form (ammonia) is called as nitrogen fixation. Nitrogen fixation is of two types: i) Physical nitrogen fixation ii) Biological nitrogen fixation. Reduction of molecular or atmospheric nitrogen into organic form (ammonia or nitrate or nitrite) by physical processes is called as physical nitrogen fixation. In fertilizer industries nitrogen is converted into ammonia at very high temperature and pressure over an iron catalyst. Nitrogen is converted into nitrates and nitrites during lightning.

Reduction of molecular or atmospheric nitrogen into ammonia by microorganisms is called as biological nitrogen fixation. Biological nitrogen fixation is catalyzed by nitrogenase enzyme. Biological nitrogen fixation may be symbiotic or non-symbiotic.

II) Nitrogen Assimilation: Plant absorbs nitrogen from soil in form of ammonia, nitrates and nitrites and transformed into amino acids, proteins and nitrogenous organic compounds. From plant, nitrogen in form of amino acids, proteins and nitrogenous organic compounds is transfer to herbivores and from it transfer to carnivores. When plants and animals die, it releases organic nitrogen in soil.

III) Ammonification: Animal excreta and decaying plants and animals remains release the organic nitrogen (proteins and amino acids) into the soil. This organic nitrogen in the soil is decomposed by some saprophytic bacteria to ammonia and the phenomenon is called as ammonification. The bacteria which are responsible for ammonification are known as ammonifying bacteria.

IV) Nitrification: Ammonia produced by ammonification is oxidized into nitrates by bacteria. This metabolic process is known as nitrification. The bacteria which cause nitrification are known as nitrifying bacteria.

V) Denitrification: Nitrates formed from nitrification are taken by plants in some amount and it is also reduced into molecular nitrogen by denitrifying bacteria through a process called as denitrification.

VI) Sedimentation: Nitrates of soil are washed down to the sea or leached deep in to the earth along with percolating water. Nitrates thus lost from soil surface are locked up in the rock. This is sedimentation of nitrogen. Nitrogen is released from rocks due to erosion and chemical weathering and volcanic eruptions (Fig.8.3).

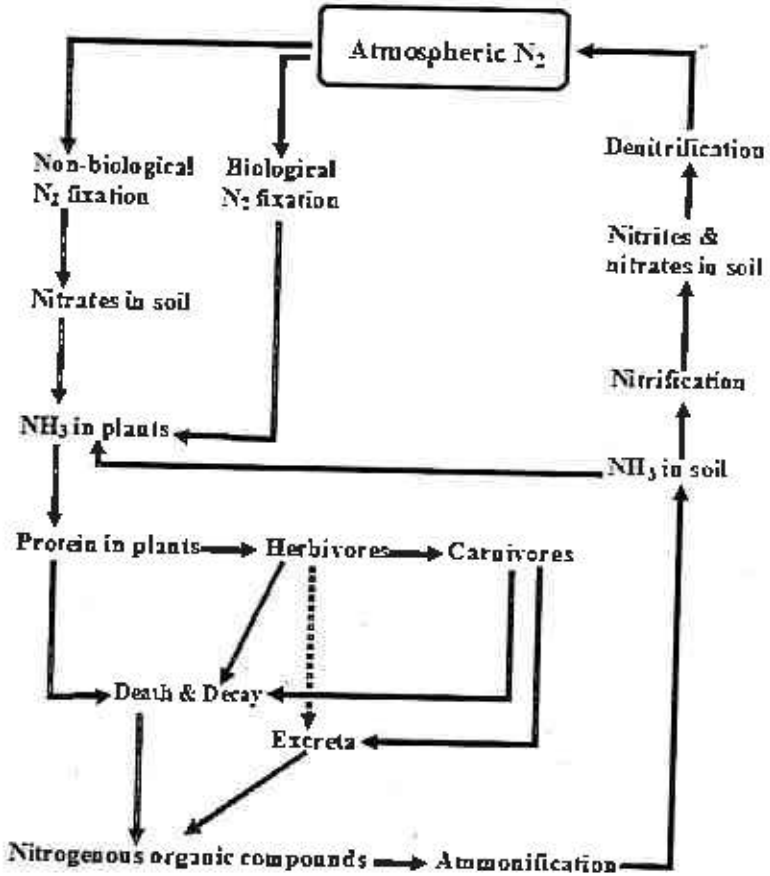

Fig.8.3: Nitrogen Cycle

B) Sedimentary Cycles

In a sedimentary cycle, chemical elements transport from land to sediment via water. In these cycles, chief reservoirs are the soil and sedimentary rocks. The sedimentary cycles are generally very slow because chemical elements may get locked up in rocks and go out of circulation for long times. Common examples of gaseous cycles are:

a) Phosphorus Cycle
b) Sulphur Cycle

a) Phosphorus Cycle

Phosphorus is usually occurs in water, soil and sediments. Phosphorus cannot be found in air in the gaseous state (Fig.8.4). Phosphorus is mainly cycled through water, soil and sediments. Hence phosphorous cycle is sedimentary cycle. Phosphorus transfers slowly from deposits on land and in sediments, to living organisms, and much more gradually back into the soil and water sediment. The chief source of phosphate is rock or sediment. Phosphorous is released from rocks due to erosion and chemical weathering and is made available in the soil. Plant absorb the phosphorous (in the form of $H_2PO^-_4$ or $H_2PO^{2-}_4$) form soil. From plant it move to herbivores and from it move to carnivores. After the death of animals and plants, dead organic matter of these organisms is decomposed by bacteria and fungi. Decomposition liberated phosphorous in soil as inorganic phosphate. Excess of phosphate in animals is excreted and returned to soil through faeces. Phosphate is also returned to soil by combustion of trees and grasses. Phosphorous reaches the water bodies and settles down as sediments.

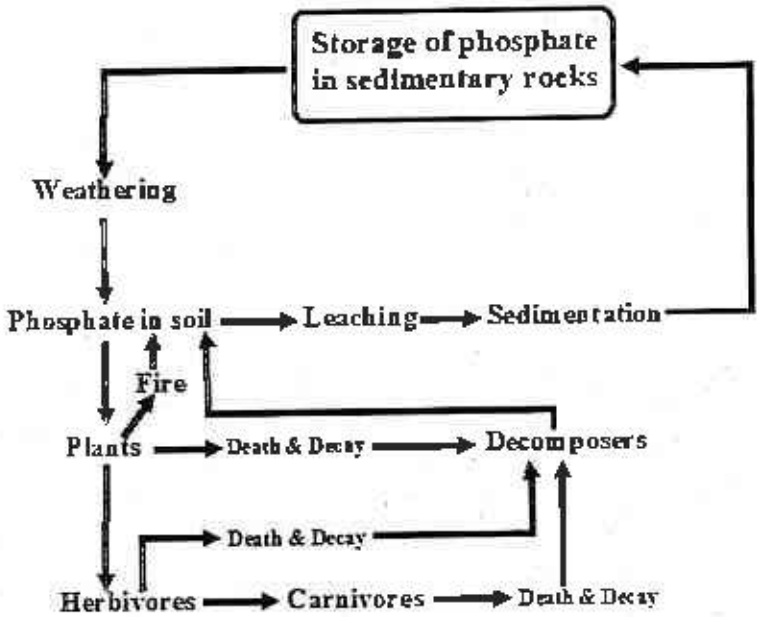

Fig. 8.4: Phosphorous Cycle

b) Sulphur Cycle

Sulphur is usually found in water, soil and sediments. Sulphur is found in solid state and air in the gaseous state. Sulpher is mainly cycled through water, air, soil and sediments (Fig.8.5). The sulphur cycle includes both sedimentary phase and gaseous phase. But sedimentary phase is long termed; hence phosphorous cycle is sedimentary cycle. The main source of sulphur is rock. Sulphur is released from rocks due to erosion and chemical weathering and is made available in the soil. Plant absorb the sulphur (in the form of SO_4^-) form soil. From plant it transfer to herbivores and from it transfer to carnivores. After the death of animals and plants, dead organic matter of these organisms is decomposed by bacteria and fungi. Decomposition liberated sulphur in soil as inorganic phosphate. Excess of sulphur in animals is excreted and returned to soil in organic form through faeces. By mineralization, organic sulphate is transformed into inorganic form. Late combustion of fossil fuels

releases sulphur as sulphur dioxide into atmosphere which may return to soil as acid rain. Some amount of sulphur reaches the water bodies and settles down as sediments. Certain amounts of sulphur as dimethyl sulfide release to atmosphere by plankton. Some amount of sulphur is also released to atmosphere by anaerobic respiration of sulphate – reducing bacteria and volcanic activity.

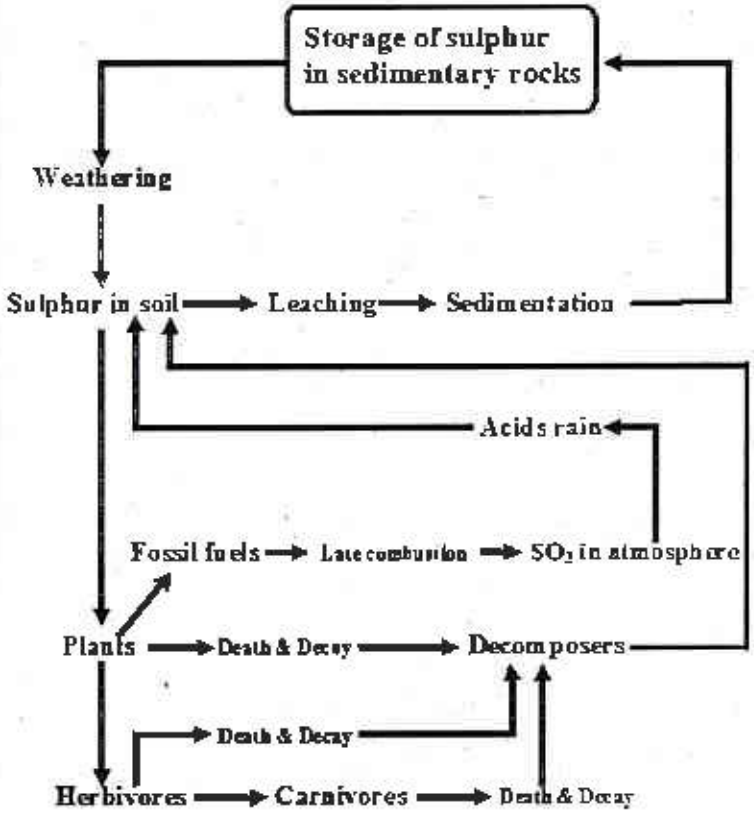

Fig. 8.5: Sulphur Cycle

Summary

- ✓ In each ecosystem, hydrological and biogeochemical cycles operate simultaneously.
- ✓ Water cycle is also known as hydrological cycles.
- ✓ In water cycle, water transport between atmosphere and the land and oceans.
- ✓ The flow of essential chemical elements between biotic and non biotic components of the environment in cyclic manner is known as biogeochemical cycle.
- ✓ Gaseous cycle and sedimentary cycle are two main types of biogeochemical cycles.
- ✓ Chief reservoirs of gaseous cycles are the atmosphere and the ocean.
- ✓ Carbon cycle and nitrogen cycle are gaseous cycles.
- ✓ Chief reservoirs of sedimentary cycles are soil and sedimentary rocks.

Question Bank

Q.1. Give in brief an account of hydrobiological cycle.

Q.2. Discuss in detail carbon cycle.

Q.3. Describe in detail nitrogen cycle.

Q.4. Explain in brief phosphorus cycle.

Q.5. Discuss in brief sulphur cycle.

Q.6. Write a short notes on
- a) Hydrobiological Cycle
- b) Carbon Cycle
- c) Nitrogen Cycle
- d) Phosphorus Cycle
- e) Sulphur Cycle

MCQ (Multiple Choice Questions)

1. Carbon cycle is _____.
   a) Gaseous cycle b) Sedimentary cycle
   c) Both a & b d) None of the above

2. Nitrogen cycle is _____.
   a) Gaseous cycle b) Sedimentary cycle
   c) Both a & b d) None of the above
3. Phosphorous cycle is _____.
   a) Gaseous cycle b) Sedimentary cycle
   c) Both a & b d) None of the above
4. Sulphur cycle is _____.
   a) Gaseous cycle b) Sedimentary cycle
   c) Both a & b d) None of the above
5. Which of the following cycle/s is/are gaseous cycle/s _____.
   a) Carbon cycle b) Nitrogen cycle
   c) Both a and b d) Hydrological cycle
6. Which of the following cycle/s is/are not gaseous cycle/s _____.
   a) Phosphorous cycle b) Nitrogen cycle
   c) Carbon cycle d) None of the above
7. Which of the following cycle/s is/are not gaseous cycle/s _____.
   a) Carbon cycle b) Nitrogen cycle
   c) Both a and b d) None of the above
8. Which of the following cycle/s is/are not sedimentary cycle/s _____.
   a) Carbon cycle b) Nitrogen cycle
   c) Both a and b d) None of the above
9. Which of the following cycle/s is/are not sedimentary cycle/s _____.
   a) Phosphorous cycle b) Sulphur cycle
   c) Both a and b d) None of the above
10. Which of the following cycle/s is/are sedimentary cycle/s _____.
    a) Sulphur cycle b) Nitrogen cycle
    c) Carbon cycle d) None of the above
11. Which of the following cycle/s is/are sedimentary cycle/s _____.
    a) Phosphorous cycle b) Nitrogen cycle
    c) Water cycle d) None of the above
12. Which of the following cycle/s is/are sedimentary cycle/s _____.
    a) Sulphur cycle b) Phosphorous cycle
    c) Both a and b d) None of the above

13. In biogeochemical cycle, _____.
    a) Biological process involved b) Geological involved
    c) Chemical process involved d) All of the above
14. In sedimentary cycle, chief reservoir/s is/are _____.
    a) Atmosphere and the ocean b) Soil and sedimentary rocks
    c) Water d) None of the above
15. In gaseous cycle, chief reservoir/s is/are _____.
    a) Atmosphere b) Ocean
    c) Both a and b d) None of the above
16. In gaseous cycle, chief reservoir/s is/are _____.
    a) Atmosphere and the ocean b) Soil and sedimentary rocks
    c) Water d) None of the above
17. Chief reservoir/s of sulphur cycle is/are _____.
    a) Atmosphere b) Sedimentary rocks
    c) Water d) None of the above
18. Chief reservoir/s of nitrogen cycle is/are _____.
    a) Water b) Sedimentary rocks
    c) Atmosphere d) None of the above
19. Chief reservoir/s of carbon cycle is/are _____.
    a) Atmosphere b) Sedimentary rocks
    c) Water d) None of the above
20. In water cycle, water transport between _____.
    a) Atmosphere and land b) Land and ocean
    c) Atmosphere and land and ocean d) None of the above

8. Hydrological and Biogeochemical Cycles

Answers of Multiple Choice Questions (MCQ)

1.	(a)	2.	(a)	3.	(b)
4.	(b)	5.	(c)	6.	(a)
7.	(d)	8.	(c)	9.	(d)
10.	(a)	11.	(a)	12.	(c)
13.	(d)	14.	(b)	15.	(c)
16.	(a)	17.	(b)	18.	(c)
19.	(a)	20.	(c)		

9

Ecological Adaptations in Plants and Animals

Morphological and Anatomical Adaptations of Plants to Water Stress Conditions

Morphological and Anatomical Adaptations in Hydrophytes

Plants, which are, grow near or in water are known as hydrophytes. *Hydrilla*, Nymphea etc. are examples of hydrophytes.

Morphological and anatomical adaptations of *Hydrilla* stem to the water stress

A) **Morphological adaptations**
- Stem is long.
- It is slender.
- Another morphological adaptation of *Hydrilla* stem is that it is spongy and flexible.

B) **Anatomical adaptations**
- Cuticle is either absent or poorly developed and thin.
- Epidermis is single layered and it is made up of thin walled parenchymatous cells
- Hypodermis is completely absent.
- Many air chambers or air cavities are present in the cortex.
- Vascular elements are thin walled.
- Mechanical tissues are usually absent.

Morphological and anatomical adaptations of *Nymphea* petiole to the water stress

A) Morphological adaptations

- Petiole is long.
- It is flexible.
- It is usually covered with mucilage.

B) Anatomical adaptations

- Cuticle is either absent or poorly developed and thin.
- Epidermis is made up of thin walled parenchymatous cells
- Mechanical tissues are very less.
- Many air chambers or air cavities are present in the ground tissues.
- Vascular bundles very much reduced.
- Internal hairs are present.

Morphological and Anatomical Adaptations in Xerophytes

Plants, which are, grow in desert places are known as xerophytes. *Nerium*, *Casuarina* etc. are the examples of xerophytes.

Morphological and Anatomical Adaptations of *Nerium* Leaf to the Water Stress

A) Morphological adaptations

- Leaves are much reduced and small.
- Leaves are scale like appearing.
- Leaf surface is shiny and glazed to reflect light and heat.

B) Anatomical adaptations

- Cuticle is thick and well developed.
- Several layered epidermis is present.
- Mechanical tissues are well developed.
- Mesophyll cells are well differentiated into palisade and spongy parenchyma.
- Vascular bundles are well developed.
- Sunken stomata are present.

Morphological and Anatomical Adaptations of *Casuarina* Stem to the Water Stress

A) Morphological adaptations

- Stem is stunted, woody and dry.
- It is hard, ridged and covered with thick bark.
- On stem hairs and waxy coating is present.

B) Anatomical adaptations

- Cuticle is thick and well developed.
- Epidermis is well developed.
- Hypodermis is several layered and sclerenchymatous.
- Mechanical tissues are well developed.
- Vascular tissues are well developed.
- Sunken stomata are present.
- Oils and resins are usually present.

General Characteristics of Halophytes

- Plants growing in saline soils are known as halophytes.
- In other words, they inhabit salty soils.
- They are tolerant to high concentration of salts like sodium chloride, magnesium chloride and magnesium sulphate.
- They have remarkable capability to enhance osmotic concentration of their cell sap.
- Leaves of these plants are succulent and evergreen.
- Leaves have thick cuticle, well developed palisade tissues and water storage tissues.
- Many halophytes produce special type branched and negatively geotropic roots with breathing pores for the exchange of gases. These specialized roots are known as pneumatophores.
- Some halophytes exhibit vivipary i.e. seed germinate before the fruit drop from parent plants.

Adaptation in Aquatic Animals or Hydrocoles

The adaptational features of aquatic animals are given as follows:

- Body is stream-lined in shape which helps to reduces friction when the animal travels through the water.

- Body of aquatic animals is soft and slippery which helps to escape from the enemies and it also helps to move through the water with little friction.
- Some aquatic animals like ducks, penguins, and alligators have webbed feets which help the animal swim faster to catch prey or escape a predator.
- In many aquatic animals eyes are situated on top of the head which permit animals to hide almost fully submerged in water and still detect predators or prey above the water.
- Waterproof feathers are present in aquatic bird which prevent wetting of the feathers.
- Swimming organ like fins, flippers and paddles are present to swim in water easily.
- In aquatic animals like fishes respiration in water is possible due to presence special respiratory organ- gill.
- In some fishes air bladders are present which functions as hydrostatic organ.
- Bones in aquatic animals are light in weight which helps to swim in water easily.

Adaptation in Desert Animals or Xerocoles

Desert animal are adapted to preserve moisture and escape heat of shining sun. They show following important adaptations:

- For several months to years, the eggs of insects and other invertebrates and insect pupae lie quiescent.
- Some desert animals like camel have water-sacs in their stomach walls.
- On the body of desert animals protective covering is present to prevent water loss by evaporation.
- A desert animal like lizard can take up water through its hygroscopic skin.
- Body of desert insect is covered by wax to prevent water loss by evaporation.
- To preserve the water, desert rats and snakes dig holes and burrows in the sand and live inside them during daytime.

Summary

- ✓ Hydrophytes grow near or in water. For example: Hydrilla, *Nymphea* etc.
- ✓ Presence of long, slender, absence of cuticle, absence of hypodermis and mechanical tissues and presence of air chambers are important morphological and anatomical adaptations of *Hydrilla* stem and *Nymphea* petiole to the water stress.
- ✓ Xerophytes grow in desert places. For example: *Nerium*, *Casuarina* etc.
- ✓ Presence of scaly and small leaves, well developed cuticle, vascular tissues, mechanical tissues, sunken stomata are important morphological and anatomical adaptations of *Nerium* leaf to the water stress.
- ✓ Presence of stunted, woody and dry stem, well developed cuticle, vascular tissues, mechanical tissues, sunken stomata are important morphological and anatomical adaptations of *Casuarina* stem to the water stress
- ✓ Presence of stream-lined and soft body, waterproof feathers, gills light bones etc. are important adaptations of aquatic animals.
- ✓ In desert animals, water sac, hygroscopic skin and wax covered body is present.

Question Bank

Q.1. Describe morphological and anatomical adaptations in hydrophytic plants (*Hydrilla* and *Nymphea*).

Q.2. Discuss in detail morphological and anatomical adaptations of *Nerium* leaf to the water stress.

Q.3. Describe in brief morphological and anatomical adaptations of *Casuarina* stem to the water stress.

Q.4. Explain in brief adaptation in aquatic animals or hydrocoles.

Q.5. Describe adaptation in desert animals or xerocoles.

Q.6. Write a short notes on
a) Adaptation in aquatic animals
b) Adaptation in desert animals

MCQ (Multiple Choice Questions)

1) Plants, which are, grow near or in water are known as _____.
a) Hydrophytes b) Xerophytes
c) Mesophytes d) None of the above

2) *Hydrilla* and *Nymphea* are _____.
a) Hydrophytes b) Xerophytes
c) Mesophytes d) None of the above

3) Cuticle is either absent or poorly developed in _____.
a) Hydrophytes b) Xerophytes
c) Mesophytes d) None of the above

4) Plants, which are, grow in desert places are known as _____.
a) Hydrophytes b) Xerophytes
c) Mesophytes d) None of the above

5) *Nerium* and *Casuarina* are _____.
a) Hydrophytes b) Xerophytes
c) Mesophytes d) None of the above

9. Ecological Adaptations in Plants and Animals

Answers of Multiple Choice Questions (MCQ)

1.	(a)	2.	(a)	3.	(a)
4.	(b)	5.	(b)		

10

Environmental Pollution

Pollution refers to unwanted changes in physical, chemical or biological characteristics of air, water, land etc. that may cause harmful effect on environment, human being and other living organism. Pollution causing substances are known as pollutants. There are following main types of environmental pollution:

I) Water Pollution
II) Air Pollution
III) Soil Pollution
IV) Noise Pollution

I) Air Pollution

Air pollution refers to undesirable changes in physical, chemical or biological characteristics of air that may cause harmful effect on environment human being and other living organism. The common air pollutants are carbon dioxide, carbon monoxide, nitrogen oxides, ozone, sulphur dioxide, fluorocarbons, hydrocarbons, metals etc.

Sources and Pollutants of Air Pollution (Causes of Air Pollution)

A) Sources of Air Pollution

Air pollution is caused by following sources:

1. Natural pollutant
2. Industries
3. Automobiles
4. Thermal power station

1. **Natural Pollutant**

Natural pollutants such as pollen grains and hydrocarbons released by vegetation, dusts from deserts, storms and volcanic eruptions are responsible for air pollution.

2. **Industries**

There are number of industries which are responsible for air pollution. Industries such as petroleum refineries, chemical manufacturing plants, paper mills, cement factories, hot mixers etc. release air pollutants like CO (carbon monoxide), CO_2 (carbon dioxide), SO_2 (sulphur dioxide), NO_x (oxides of nitrogen), hydrocarbons etc.

3. **Automobiles**

Exhaust of automobiles (such as railroads, ships, aircrafts, trucks, buses, tractors, two wheelers, three wheelers etc.) causes more than 50% atmospheric air pollution. Automobiles release air pollutants such as carbon monoxide, nitrogen oxides, hydrocarbons, sulphur doixides and lead oxides.

4. **Thermal Power Stations**

Thermal power stations also cause air pollution. Thermal power stations release air pollutants such as sulphur dioxide, carbon monoxide, nitrogen dioxides, aldehyde, hydrocarbons, fly ash etc

B) Air Pollutants

Important air pollutants are given as follows:

I) CO (carbon monoxide)
II) CO_2 (carbon dioxide)
III) NOx (oxides of nitrogen)
IV) SO_2 (sulphur dioxide)
V) Fluorocarbons
VI) Hydrocarbons
VII) Suspended particulate matter
VIII) Photochemical smog

I) CO (carbon monoxide): Carbon monoxide is mostly released in the atmosphere from incomplete fuel (petrol, diesel) combustion in motor vehicles. It is also emitted in the atmosphere from incomplete fuel combustion in industries, oil refineries and thermal power stations.

II) CO_2 (carbon dioxide): Carbon dioxide is emitted in the atmosphere from combustions of fossil fuels (coal, petrol and diesel) and burning of wood for domestic cooking, heating etc. It is also added to the atmosphere by combustion of fuel in power stations and factories.

III) NO_x (oxides of nitrogen): Nitrogen oxides such as nitric acids (NO) and nitrogen dioxides (NO_2) are added to the atmosphere from industrial plants, atmospheric exhausts, burning of organic wastes etc.

IV) SO_2 (sulphur dioxide): Sulphur dioxides artificially added to atmosphere by human activities such combustion of coal, petrol and diesel. It is also released by petroleum refining, thermal power stations, smelting of sulphur containing metal ores and sulphuric acid and fertilizers manufacturing industries.

V) Fluorocarbons: Fluorocarbons released in the atmosphere from phosphate fertilizers manufacturing industries, air conditioning plants and refrigerators plants.

VI) Hydrocarbons: Hydrocarbons such as benzene, benzpyrene and methane are responsible for air pollution. They are artificially added to the atmosphere from exhausts of automobiles and industries.

VII) Suspended particulate matter: These air pollutants include fly ash, smoke, dust, burnt soot, pollen grains, fungal spores, metal dust etc.

VIII) Photochemical smog: It is secondary air pollutants. Photochemical smog is mixture of ozone, oxides of nitrogen, hydrocarbons and peroxyacetyl nitrate (PAN). Photochemical smog is product of photochemical reaction between oxides of nitrogen, hydrocarbons and oxygen in presence of U.V. light.

$$NO_2 \xrightarrow{U.V.\ light} NO + O$$
$$O + O_2 \longrightarrow O_3$$
$$O_3 + NO \longrightarrow NO_2 + O_2$$
$$\text{Hydrocarbons} + O_2 + No \longrightarrow NO_2 + \text{Peroxy acetyl nitrate (PAN)}$$

Fig.10.1: Photochemical Smog Reaction

Effects of Air Pollutants

I) In human, carbon monoxide cause headache, dizziness, nausea, difficulty in breathing.
II) Carbon monoxide combines with hemoglobin, which reduces oxygen carrying capacity of blood.
III) Carbon monoxide reduces the growth of plants.
IV) As like carbon monoxide, nitrogen oxide attaches to hemoglobin and reduce the oxygen carrying capacity of blood.
V) Nitrogen oxide causes respiratory disorders.
VI) Nitrogen oxides damages the leaves of plants, retard the photosynthetic activity and cause chlorosis.
VII) Sulphur dioxides cause respiratory disorders, cough, eye irritation and headache in human. VIII) Sulphur dioxides damage crops and affect the growth of plants.
IX) Sulphur dioxide also causes bad effects on lime stones, roofing, textiles and buildings.
X) Oxides of nitrogen and sulphur cause **acid rain.** When oxides of sulphur and nitrogen dissolved in moisture, it produces droplets of sulphuric acid and nitric acids. When these come, called as acid rain. Acid rain increase soil acidity, thus affecting on ecosystems. Besides these acid rain gives bad effect on buildings, strait, brides, fences, railing, metals, fabric etc. Acid rain also causes bad effect on plant and nitrogen fixing bacteria.
XI) Hydrocarbons cause lung diseases, irritation of eyes; respiratory disorders etc. It also causes chlorosis in plants.
XII) Hydrocarbons also cause adverse effect on textiles, paper, rubber and polythene.
XIII) At high concentration ozone causes irritation of eyes. It also damages leafy vegetables and fruit trees.
XIV) PAN damages leaf and block Hill's reaction. It also causes irritation of eyes in human.
XV) CO_2, CH_4, NO_2 and chlorofluorocarbons are known as green house gases because these air pollutants cause green house effects. Green house effect increases the temperature of earth hence it is responsible for global warming. It causes melting of glaciers and polar ice caps consequently coastal areas are getting submerged due to rise in sea water.

Control Measures of Air Pollution

I) Particulate matter released from industrial chimney can be removed with the help of cyclone separators, wet scrubber, fabric filter and electrostatic preceptors.
II) Gaseous pollutants released from industrial exhausts can be reduced or removed by combustion and by using absorbent material such as dolomite, lime and lime stone.
III) Vehicular pollution can be reduced by using new types of engines (steam, gas), lead free petrol, alternative fuels such as alcohol and multi point fuel injection engine.
IV) Air pollution can also be controlled trough law.

II) Water Pollution

Water pollution refers to undesirable changes in water causing harmful effect on environment, human being and other living organism.

Sources and Pollutants of Water Pollution (Causes of Water Pollution)

Water pollution is caused by following factors or pollutants:

1. Sewage
2. Industrial effluents
3. Agricultural discharges
4. Thermal pollutants
5. Radioactive wastes
6. Oil pollutants
7. Ground water pollution

1. Sewage

Sewage is waterborne domestic waste which contains kitchen waste, urine, human faecal matter, animal waste, paper, detergents, soap etc. Sewage is dumped into water bodies such as rivers, ponds, lakes and streams. Sewage polluted the water of these water bodies. In metropolitan cities, domestic sewage cause maximum water pollution.

2. Industrial effluents

Industries like petrochemical factories, plastic factories, tanneries, fertilizers factories, oil refineries, breweries, paper mills, textile mills, pulp mills, steel mills etc. produce chemical pollutants. These pollutants are dumped in the water of rivers,

lakes, ponds etc. Industrial pollutants include dyes, aldehyde, ketone, oils, greases, plastics, metallic wastes, phenols, toxins, acids, salts, alkalis, cyanides, heavy metals etc.

3. **Agricultural practices**

Agricultural discharge mainly contains the fertilizers, insecticides, herbicides, pesticides etc. It is added to the water bodies due to drainage and irrigation which cause pollution of water.

4. **Thermal pollutants**

Various industries and thermal power plants use water for cooling and resultant warmed water is released in to water bodies. The temperature of this water may rises even upto 40° C which cause bad effect on aquatic life.

5. **Radioactive wastes**

Radioactive pollutants are released form explosion of nuclear devices and nuclear test. These pollutants added to the water bodies and polluted the water.

6. **Oil pollutants**

Oil is the most apparent pollutant of the sea which is discharged into the sea either deliberately when oil tankers are washed out prior to reloading or in ship accident.

7. **Ground water pollution**

Underground water is polluted due to percolation of sewage water, agriculture discharges, industrial effluents and chemical such as silica, fluoride, nitrates, arsenic etc.

Effects of Water Pollution

I) Domestic sewage adds large quantity of nutrients to the fresh water ecosystem due to this phytoplankton like blue green, green algae etc. grow abundantly. This stimulates productivity of phytoplankton in fresh water ecosystem is known as **eutrophication.** As algae use oxygen of the water for respiration, the oxygen is depleted from the water. The rapid growth also consumes all the nutrients the water. The depletion of oxygen and nutrients lead to the algae and other phytoplanktons. As other organism such as zooplanktons and fishes of the water depends on the phytoplanktons for their food, they also die. Thus, eutrophication leads to the complete depletion of the fauna from ecosystem.

II) Sewage water pollution increase biological oxygen demand (BOD) and chemical oxygen demand (COD) of water.

III) Diseases like black foot disease, jaundice, hepatitis, cholera, typhoid, diarrhoea etc. are transported through water contaminated with sewage.

IV) Fluoride pollution in drinking water causes fluorosis.

V) Domestic sewage pollution decrease oxygen level in water bodies.

VI) Industrial effluents contain many heavy metals such as lead, zinc and mercury. Lead causes anaemia. Lead also damages the kidney, liver, mental retardation and fertility abnormalities.

VII) Mercury pollution causes **minamata disease** which is characterized by crippling and death.

VIII) Arsenic pollution causes **black foot disease.**

IX) Cadmium pollution cause **itai-itai or ouch-ouch disease.**

X) Nitrates used in fertilizers dissolved in drinking water. Nitrate enters into intestine of man through drinking water where nitrate is converted into nitrites. Then nitrites combine with the hemoglobin of blood to form methaemoglobin this causes **methaemoglobinemia** or **blue –baby syndrome.** This disease reduces oxygen carrying capacity of blood.

XI) Water contaminated with agricultural discharge is unfit for the drinking and also causes diseases.

XII) DDT is entered into the human body through food chain and causes damage to the vital organs. Concentration of DDT is gradually increases when it is transfer from one trophic level to the other in food chain. This phenomenon is known as **biological magnification.**

XIII) Thermal and radioactive pollutant affects the aquatic life in the water bodies.

XIV) Oil present on the surface of water prevents water oxygenation. Flight of birds is impossible when oil spread on water surface because oil clogs the feathers of birds. Oil pollution reduces respiration and metabolism in aquatic life.

Control Measures of Water Pollution

I) Sewage pollution can be controlled by sewage treatments like sedimentation and dilution of sewage. This pollution can also be controlled by effluent treatment plant.
II) Water pollution can be controlled by recycling and treatment of the polluted water.
III) Pollutants from industrial effluents can be removed by filtration and selective absorption.
IV) Excessive use of fertilizers, fungicides and pesticides should be avoided.
V) Water pollution can also be controlled trough law.

IV) Soil Pollution

Soil pollution refers to undesirable changes in soil causing harmful effect on environment, human being and other living organism.

Sources and Pollutants of Soil Pollution (Causes of Soil Pollution)

Soil pollution is caused by following factor

1. Industrial wastes
2. Urban wastes
3. Radioactive pollutants
4. Agricultural practices
5. Mining
6. Resistant objects

1. Industrial Wastes

Industrial waste is mainly responsible for soil pollution. Industries those manufacturing sugar, fertilizers, pesticides, pulp, cement, petroleum, textiles, paper mills etc. releases harmful chemicals wastes and cause soil pollution. Industrial waste mainly includes carbonates, bicarbonates, sulphites, chlorides, fluorides, cyanides, phenols and nickel, copper, molybdenum, arsenic, mercury etc. in trace amount.

2. Urban Wastes

Urban wastes include solid domestic wastes. Urban wastes are commonly referred as refuse. Refuse or urban wastes contains garbage, rubbish material such as domestic waste, plastics, glasses, metallic cans, containers, waste cloths, papers,

street sweeping etc. These pollutants cause soil pollution and cause adverse effects.

3. Radioactive Pollutants

Radioactive pollutants are released form explosion of nuclear devices and nuclear test. These pollutants are penetrating in to the soil and cause soil pollution.

4. Agricultural Practices

Agricultural practices release the fertilizers, pesticides, farm waste and fumigants in to the soil and cause soil pollution.

5. Mining

In surface and strip mining man removes the top soil and sub soil. This leaves deep silts in the earth. The uncontrolled mine fire may also destroy the productivity of soil.

6. Resistant Objects

Large resistant objects such as tyres, cans, glass, plastic, refrigerators, washing machines etc. when dumped into nature cause soil pollution.

Effects of Soil Pollution

I) An industrial pollutant, radioactive pollutants, fertilizers and pesticides in soil enters the food chain and causes the serious effects on living organisms.
II) Urban waste causes obstruction in daily life. Solid waste cause odour and it is also excellent medium for the growth of pathogenic bacteria, viruses, protozoa which causes diseases like plague, typhoid, tetanus, anthrax, dysentery etc.
III) Agricultural practices and nuclear waste change the chemical nature of soil.
IV) Mining leads to loss of grazing and fertile land, soil erosion.
V) Resistant objects such as can, plastics, tyres etc. destroy the beauty of landscape.

Control Measures of Soil Pollution

I) Soil pollution due to sewage can be controlled by chemical treatments.
II) It can be controlled by disposing the soil pollutants by proper method.

III) It can also be controlled by recycling the resistant objects like plastics, paper, glass etc..
IV) This pollution can be controlled by open dumping.
V) Sanitary landfills control the soil pollution in better way.
VII) Soil pollution due to pesticides and fungicides can be controlled by using biodegradable chemicals instead of synthetic pesticides and fungicides.
VIII) Soil pollution due to fertilizers can be controlled by using organic manure in agriculture instead of chemical fertilizers.

IV) Noise Pollution

Unwanted sound is known as noise. Intensity of sound is measured by unit known as decibel or dB.

Sources of Noise Pollution (Causes of Noise Pollution)

Noise pollution is caused by industrial machines, vehicles, T.V., radio, music systems, domestic appliances like grinding mixtures, coolers, washing machines etc.

Effects of Noise Pollution

I) Noise pollution may cause permanent deafness.
II) It also cause head ache, axiety, fatigue, tension, nausea, dialation of eye pupils, change in heart beats, diastolic blood pressure etc.

Control Measures of Noise Pollution

I) Vehicular noise pollution can be reduced by providing good traffic control.
II) Industrial noise pollution can be controlled by using noise free machines or instruments.
III) It can also be controlled by banning the unwanted public use of loud speakers.
IV) It can also be controlled by applying laws.

Summary

- ✓ Pollution is unwanted changes in physical, chemical or biological characteristics of air, water, land etc. that may cause harmful effect on environment, human being and other living organism.
- ✓ Pollutants are pollution causing substances.
- ✓ Water pollution, air pollution, soil pollution and noise pollution are main kinds of pollution in environment
- ✓ Carbon dioxide, carbon monoxide, nitrogen oxides, ozone, sulphur dioxide, fluorocarbons, hydrocarbons, metals etc. are major air pollutants.
- ✓ Air pollution is caused due to natural pollutant, industrial effluents, automobiles exhaust and thermal power station waste.
- ✓ Photochemical smog is secondary air pollutant. It contains ozone, oxides of nitrogen, hydrocarbons and peroxyacetyl nitrate (PAN).
- ✓ Water pollution is caused due to sewage, industrial effluents, agricultural discharges, thermal pollutants, radioactive wastes and oil pollutants.
- ✓ Soil pollution is caused due to industrial wastes, urban wastes, radioactive pollutants, agricultural practices, mining and resistant objects.
- ✓ Noise pollution is caused by industrial machines, vehicles, T.V., radio, music systems, domestic appliances like grinding mixtures, coolers, washing machines etc.

Question Bank

Q.1. Define air pollution and explain causes, effects and control measures of air pollution.

Q.2. What is water pollution? Discuss causes, effects and control measures of water pollution.

Q.3. Explain causes, effects and control measures of soil pollution.

Q.4. Write a short notes on
a) Air pollutants
b) Causes of air pollution
c) Effects of air pollution
d) Control measures of air pollution
e) Causes of water pollution
f) Effects of water pollution
g) Control measures of water pollution
h) Causes of soil pollution
i) Effects of soil pollution
j) Control measures of soil pollution
k) Photochemical smog
l) Acid rain
m) Methaemoglobinemia
n) Biological magnification
o) Minamata disease
p) Oil pollution
q) Noise pollution

MCQ (Multiple Choice Questions)

1) Air pollution is caused by _____.
a) Industries effluents b) Automobiles exhaust
c) Thermal power station waste d) All of the above

2) Nitrogen dioxides (NO_2) are added to the atmosphere from _____.
a) Industrial plants b) Automobiles exhaust
c) Both a and b d) All of the above

3) Photochemical smog contains _____.
a) Ozone
b) Oxides of nitrogen
c) Hydrocarbons and peroxyacetyl nitrate (PAN)
d) All of the above

4) Acid rain is caused by _____.
a) Oxides of nitrogen b) Oxides of sulphur
c) Both a and b d) All of the above

5) Which of the following are green house gases?
a) CO, SO_2, NO_2 and chlorofluorocarbons
b) Oxides of sulphur, ozone and CO
c) CO_2, CH4, NO_2 and chlorofluorocarbons
d) All of the above

6) Green house effect is caused by _____.
a) CO and SO_2
b) Oxides of sulphur, ozone and CO
c) CO_2, CH4, NO_2 and chlorofluorocarbons
d) All of the above

7) Photochemical smog is _____.
a) Primary air pollutant b) Secondary air pollutant
c) Water pollutant d) All of the above

8) Water pollution is caused by _____.
a) Industries effluents b) Automobiles exhaust
c) Sewage d) All of the above

9) Sewage water pollution
a) Increases the BOD b) Decreases the BOD
c) Both a and b d) All of the above

10) Eutrophication is caused by _____.
a) Sewage pollution b) Thermal pollutants
c) Radioactive pollutants d) All of the above

11) Minamata disease is caused by _____.
a) Mercury pollution b) Arsenic pollution
c) Cadmium pollution d) All of the above

12) Black foot disease is caused by _____.
a) Mercury pollution b) Arsenic pollution
c) Cadmium pollution d) All of the above

13) Itai-itai disease is caused by _____.
a) Mercury pollution b) Arsenic pollution
c) Cadmium pollution d) All of the above

14) Increase in carbon dioxides concentration in atmosphere cause ____.
a) Acid rain b) Green house effect
c) PAN d) Eutrophication

15) Oxides of sulphur and nitrogen cause _____.
a) Acid rain b) Green house effect
c) PAN d) Eutrophication

10. Environmental Pollution

Answers of Multiple Choice Questions (MCQ)

1.	(d)	2.	(c)	3.	(d)
4.	(c)	5.	(c)	6.	(c)
7.	(b)	8.	(d)	9.	(a)
10.	(a)	11.	(a)	12.	(b)
13.	(c)	14.	(b)	15.	(a)

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11
Biomes

Biomes are large communities units on the earth with vegetation and animals adapting to their environment. Major biomes on earth are classified into fallowing two basic types:

A) Aquatic Biomes
B) Terrestrial Biomes

A) Aquatic Biomes

Aquatic bodies cover the 75% area of the earth. Aquatic biomes are grouped into following two basic types:

a) Fresh Water Biomes
b) Marine Water Biome.

a) Fresh Water Biomes

Ponds and lakes, streams and rivers, and wetlands are different kinds of freshwater areas. Flora and fauna of freshwater includes aquatic plants, phytoplanktons, zooplanktons, protozoan, aquatic insects, fishes etc.

b) Marine Water Biomes

Oceans, coral reefs, and estuaries are different kinds of marine water regions. Flora and fauna of marine water bodies mainly comprises phytoplanktons, zooplanktons, sea weeds, worms, clams, predatory crustaceans, crabs, oysters, shells, corals, shorebirds, seaweeds, fish, whales, dolphins, sponges, sea anemones, sea urchins, octopuses, worms, sea stars etc.

B) Terrestrial Biomes

Terrestrial biomes are grouped into following four basic types:

a) Desert Biome
b) Forest Biome
c) Grassland Biome
d) Tundra Biome

a) Desert Biome

Desert covers about 20% of the earth surface. It is characterized by very low rain fall or no rain fall, extreme heat, and low atmospheric moisture. Desert biomes are present in North America (Sahara desert), South Africa, China, India etc. Desserts are generally of four types- hot and dry desert, semiarid desert, coastal desert and cold desert. Desert has very few vegetation and animals. Vegetation generally comprises short shrubs, cacti and succulent plants. Desert animals consist of birds, insects, lizards, snakes, mouse etc.

b) Forest Biome

There are following main six types of forests:

I) Tropical rain forest
II) Temperate evergreen forest
III) Temperate deciduous forest
IV) Temperate rain forest
V) Boreal coniferous forest

I) Tropical Rain Forest: Tropical forests locate near the equator. They occur in many parts of south and Central America, central Africa, north, Australia etc. In these forests rainfall is plentiful. There is no winter. Soil of these forests is poor in nutrients. These forests are characterized by highest diversity of animals and plants. These forests are richest biomes on earth. Vegetation includes different tall tree species having broad and evergreen leaves. Vegetation also includes small trees species, epiphytic plants, shrubs species, orchids, lianas, ferns, mosses, palms etc. Fauna comprise worms, snails, millipedes, centipedes, snakes, numerous birds, bats, small mammals, insects etc.

II) Temperate Evergreen Forest: Temperate evergreen forests are also known as chaparral. They are occur where winter is mild wet and summer is hot and dry. They are found in countries like Spain, Southern France, Israel, North Africa etc. Vegetation includes trees like oak, shrubby woody plants species, shrubs species. Fauna contains mammals, birds, insects etc.

III) Temperate Deciduous Forest: Temperate deciduous forests are found in America, Europe etc. These forests have very cold winter and hot summer. Rainfall is through the year. These forests are dominated by the broad leaved deciduous trees like oak, beech, maple etc.

IV) Temperate Rain Forest: Temperate rain forests occur in New Zealand, Pacific coast of America and Southern Chile where climate is cool and abundant rainfall in summer. Flora includes evergreen trees, mosses, liverworts and filmy ferns.

V) Boreal Coniferous Forest: These forests are also known as **taiga.** These forests are found in countries like Russia, Sweden, Canada, Alaska, Norway etc. These forests have short summer and long winter. Vegetation contains coniferous trees such as pines, firs, cedars, spruces etc. Vegetation also comprises mosses, ferns, twin flowers plants etc. Fauna includes moose, bear, lynx, fox, squirrel, voles, insect species etc.

c) Grassland Biome

Grassland biomes are grouped into following two basic types:

a) Tropical grassland
b) Temperate grassland

a) Tropical Grassland: Tropical grassland also known as **savannah.** These grasslands found in India, Australia, Africa and South America. These grasslands characterized by small rainy and dry season. Fire (caused due to lighting or human activities) frequently destroyed these grasslands. Flora includes grasses and few scattered trees. Fauna contains giraffe, zebra, black rhinoceros, kangaroo, tigers, lions etc.

b) Temperate Grassland: Temperate grasslands occur in Europe, Asia, Argentina and Central North America. These grasslands characterized by slow rainfall, cold winter and hot, dry summer season. Vegetation includes grasses. Fauna contains kangaroos, zebras, rhinoceroses, wild horses, lions, rabbits, deer, mice, foxes, snakes, grasshoppers etc.

d) Tundra Biome

Tundra is the coldest and treeless plain. This biome has low rain, extremely low temperatures and low biotic diversity. Flora consists of mosses, lichens and grasses. Fauna includes arctic hares and squirrels, arctic foxes, wolves, and polar bears, migratory birds, mosquitoes, flies, moths, grasshoppers, mountain goats, sheep etc. Tundra is divided into two types: arctic tundra and alpine tundra. Arctic tundra is found in the northern hemisphere, encircling the north pole. Alpine tundra is located on top of high mountains.

Summary

- ✓ Biomes are large communities units on the earth with flora and fauna adapting to their environment.
- ✓ Biomes on earth are of two main types: aquatic biomes and terrestrial biomes
- ✓ Aquatic bodies occupy the 75% area of the earth.
- ✓ Aquatic biomes are of two basic types: fresh water biomes and marine water biome.
- ✓ Ponds and lakes, streams and rivers, and wetlands are different kinds of freshwater areas.
- ✓ Terrestrial biomes are divided into four basic types: desert biome, forest biome, grassland biome and tundra biome
- ✓ Desert has very few vegetation and animals.
- ✓ Forest biomes include five major types of forests: tropical rain forest, temperate evergreen forest, temperate deciduous forest, temperate rain forest and boreal coniferous forest.
- ✓ Tropical rain forests are richest biomes on earth.
- ✓ Temperate evergreen forests also refer as chaparral.
- ✓ Temperate forests dominated by the broad leaved deciduous trees like oak, beech, maple etc.
- ✓ Temperate rain forests contain evergreen trees, mosses, liverworts and filmy ferns.
- ✓ Boreal coniferous forests also known as taiga.
- ✓ Grassland biomes are of two basic types: tropical grassland and temperate grassland.
- ✓ Tropical grassland also known as savannah.
- ✓ Tundra is treeless plain.

Question Bank

Q.1. Explain in detail major terrestrial biomes on earth.

Q.2. Write a short notes on

a) Aquatic Biomes
b) Desert Biome
c) Tropical Rain Forest
d) Temperate Evergreen Forest
e) Temperate Deciduous Forest
f) Temperate Rain Forest
g) Boreal Coniferous Forest
h) Grassland Biome
i) Tundra

MCQ (Multiple Choice Questions)

1) Temperate evergreen forests are also known as _____.
   a) Chaparral b) Taiga
   c) Savannah d) All of the above

2) Boreal coniferous forests are also known as _____.
   a) Chaparral b) Taiga
   c) Savannah d) All of the above

3) Tropical grassland is also known as _____.
   a) Chaparral b) Taiga
   c) Savannah d) All of the above

4) Which of the following is/are trees less biomes?
   a) Grassland biome b) Forest biome
   c) Tundra d) All of the above

11. Biomes

Answers of Mulliple Choice Questions (MCQ)

1.	(a)	2.	(b)
3.	(c)	4.	(c)

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12

BIOGEOGRAPHICAL ZONES OF INDIA

There are following ten biogeographical zones of India:

1) Trans-Himalayan
2) Himalayan
3) Gangetic Plain
4) Indian Desert
5) The Semi-Arid
6) Deccan Peninsula
7) Western Ghats
8) North-East India
9) Islands
10) Coasts

1) Trans-Himalayan: This zone comprises mainly the districts of Ladakh and Kargil in Jammu and Kashmir, and the Spiti valley, Lingti plains (Lahaul valley), and Pooh tehsil (district Kinnaur) in Himachal Pradesh. This region is very cold and arid, sparse alpine vegetation. This zone has wild sheep and goats.

2) Himalayan: It includes northwest Himalaya, west Himalaya, central Himalaya and east Himalaya. This region has alpine and sub-alpine forests, grassy meadows and moist deciduous forests. The forests are very dense with extensive growth of grass and evergreen tall trees. This zone is dominated by plants like oak, chestnut, conifer, ash, pine and deodar. There is no plant life over the snowline. This zone comprises animals like wild sheep, mountain goats, ibex, shrew, tapir, panda and snow leopard.

3) Gangetic Plain: This zone includes plains of UP, Bihar, West Bengal. This region characterized by moderate amount of rainfall and most fertile (alluvial) soils. This zone is generally

under cultivation. Flora consists of tropical moist and deciduous and dry deciduous forest type. Ganga is the main river of this zone. Sunderbans forests are situated in this region. The common flora of this zone comprises *Dalbergia sissoo, Acacia nilotica, Saccharum munja, Terminalia arjuna, Acacia catechu, Azadirachta indica, Ficus religiosa, Xanthium, Argemone, Amaranthus* etc. Common fauna of this zone includes one-horned rhinoceros, Asian elephant, wild water buffalo, swamp deer etc.

4) Indian Desert: It includes sally desert of Gujarat and the sandy desert of Rajasthan. This zone is characterized by very hot and summer. Thorny scrubs, grasses and some bamboos are present in some regions. In this region sparse thorn forests are present. Wild ass sauns birds, desert cat, hanshabar, jackals, leopards, eagles, snakes, fox; buffaloes are occurring in this region.

5) The Semi-Arid: It consists of plains of Punjab, Haryana, Gujarat, Eastern Rajasthan, west-central UP, western MP. Most land of this zone is under agriculture. Limited forested area is present in this zone.

6) Deccan Peninsula: This is the largest biogeographical zone of India. The zone consists of major portion of the states of Maharashtra, Madhya Pradesh, Uttar Pradesh, Karnataka, Tamil Nadu, Andhra Pradesh, Orissa and Bihar. It comprises mostly deciduous trees. This region is bound by Satpura, western ghats and eastern ghats. It comprises mostly deciduous trees. Deer, sambar, four-horned antelope, Asian elephants, wild water buffaloes etc. are found in this zone.

7) Western Ghats: The western ghats run from the tapti river in the north to kanyakumari in the south. This zone is one of the 25 biodiversity 'hotspots' in the world. This zone consists of major tropical evergreen forests having enormous plant diversity.

8) North-East India: This zone characterizes the transition region between the Indian, Indo-Malay and Indo-Chinese biogeographic regions. This zone comprises eight states i.e. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The zone acts as a biogeographical gateway for much of India's flora and fauna. In India, apart from the western ghats, it is richest flora region in

the country. Plants like orchids, bamboos, ferns, banana, mango, citrus, pepper etc. are found in this region.

9) Islands: In India, there are two groups of islands i.e. lakshadweep islands and the andaman islands. These islands have tropical evergreen moist forests.

10) Coasts: Indian coasts region consists of beaches, mangroves, mud flats, coral reefs and marine angiosperm pastures. This region is very poorly explored.

Summary

- ✓ Trans-himalayan, himalayan, gangetic plain, Indian desert, semi-arid, deccan peninsula, western ghats, north-east India, islands and coasts are ten biogeographical zones of India:
- ✓ Deccan peninsula is largest biogeographical zone of India
- ✓ Coast is very poorly explored biogeographical zone of India.

Question Bank

Q.1. **Explain in detail biogeographical zones of India.**

MCQ (Multiple Choice Questions)

1) **Largest biogeographical zone of India is _____.**
   a) The Semi-Arid b) Deccan Peninsula
   c) Western Ghats d) North-East India

2) **Very poorly explored biogeographical zone of India is _____.**
   a) Coasts b) Deccan Peninsula
   c) Western Ghats d) North-East India

12. Biogeographical Zones of India

Answers of Multiple Choice Questions (MCQ)

1.	(b)	2.	(a)

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13

Natural Resources Erosion and Their Conservation

Forest Resources Erosion and Their Conservation

Deforestation

Permanent removal or clear of a natural forest is known as deforestation. Conversions of forestland to farms, ranches, or urban use are examples of deforestation.

Causes of Deforestation

Deforestation is caused due to following factors:

- ➢ Deforestation is caused due to cutting of forest for agriculture and fuel for cooking food.
- ➢ Mining for metals also causes the deforestation.
- ➢ Constructions of roads and buildings are also responsible for deforestation.
- ➢ It is also caused due to cutting of wood for timber
- ➢ Development of industries and projects like large dams, hydrolytic projects etc. also cause deforestation.
- ➢ It is also caused by forest fire, overgrazing and natural calamities like storms, snow, earthquake, flood etc.

Impact of Deforestation

Deforestation causes following problems:

- ➢ Deforestation reduces biodiversity.
- ➢ It causes extinction of species.
- ➢ It accelerates rates of soil erosion.
- ➢ It decreases soil fertility.

- It disrupts water cycle which results in reduction of rainfall.
- It causes global warming.

Afforestation

- Establishment of a forest or stand of trees on non-forest land is known as afforestation.
- Afforestation is usually confused with reforestation.
- Reforestation is a tree-planting process undertaken to replenish already harvested trees in existing forest land but afforestation is concern with planting of plants in an area where there was no forest.
- Afforestation programs are undertaken by many governments and non-governmental organizations to build forests, increase carbon capture and help to anthropogenically develop biodiversity
- Afforestation programs are undertaken to save the environment and it is also undertaken for commercial purpose.
- The scope of afforestation should expand from simple planting of trees to planting the correct types of trees at the right spaces. Many nations have previously taken steps towards setting standards for planning, scheming and executing afforestation projects.
- Afforestation should be carried out in a prearranged way with thorough knowledge of local environment, vegetation, soil type and socio-economic issues; . not knowing or ignoring local conditions can prove extremely dangerous to the ecosystem.
- Afforestation projects undertaken without a complete understanding of the surroundings can cause extra environmental damages. For example, fast-growing trees commonly used in timber plantations consume enormous amounts of water, which causes depletion of water resources around the area. There are also concerns about permanent changes in edaphic factors caused by alien species. For instance, pine trees increase acidity of soil. The water from the acidic soil eventually trickles down to local streams and water bodies, which causes harmful effect to both the water and land ecosystems.

Chipko Movement

- Chipko movement was started to save the destruction of forests spread throughout India.
- "Chipko" is hindi word which means to embrace or to hug to stick.
- In this movement, villagers hugged the trees, and prevented the contractors' from cutting the trees.
- This movement was started in 1970 in the Garhwal, Uttarakhand, then in Uttar Pradesh with growing awareness towards fast deforestation.
- The Chipko movement of 1970 was one of the most famous movements which was initiated at Tehri Garhwal district of Uttar Pradesh. Bishnoi women in the Tehri- Garhwal district saved the marked trees by embracing them.
- The movement had spread throughout India by the 1980.
- Chipko movement achieved momentum under the leadership of famous environmentalist, Mr. Sunderlal Bahugauna., who spent his life educating the people to save the destruction of forest. Another main leader of chipko movement is Chandi Pasad Bhatta of Gopeshwar, Chamoli District.

Soil Erosion and Its Conservation

Soil Erosion (Soil Resource Degradation)

Soil erosion is the removal of soil particles by the action of wind or water. Erosion is mainly caused by two agents wind and water. Soil erosion is also caused by overgrazing.

Types of Soil Erosions (Causes of Soil Erosion)

Soil erosions are following three main types:

A) Water Erosion
B) Wind Erosion
C) Erosion due to overgrazing and deforestation.

A) Water Erosion: Soil erosion caused by water is called water erosion. Water erosion can be discussed under following categories:

I) Sheet Erosion: In this type of water erosion, the soil is eroded as layers from the hill slopes. Sheet erosion is more or less common on bare follow land, all uncultured land whose plant cover has been thinned out by over grazing, fire or other misuse and all sloping cultured fields and on sloping forest, scrub jungles where natural porosity of soil has been detached by heavy grazing, felling of trees or burning etc.

II) Rill Erosion: In this type, heavy rain water eroded the soil in the form of finger like grooves or small channels.

III) Gully Erosion: Several rills join towards the steep slopes and combine to form little wider channels called gullies.

IV) Slip Erosion. In this type, heavy rain caused more percolation of water which creates hydrolytic pressure and which ultimately causes land sliding.

V) Riparian Erosion: Rapid flowing water in river strikes the bank and causes the erosion of bank soil.

VI) Waterfall Erosion: When water falls from height it causes the erosion of soil.

B) Wind Erosion: Soil erosion caused by wind is called wind erosion. It occurs in dry climatic areas having a thin and low flora cover on mechanically weathered, loosened surficial material.

C) Erosion due to overgrazing and deforestation: Soil erosion is also caused by overgrazing and deforestation.

Methods of Soil Conservation

Ecologist classifieds the methods of soil conservation into following three types:

A) Biological methods
B) Mechanical methods
C) Other methods

A) Biological Methods

Biological methods include:

a) Agronomic practices and
b) Agrostological methods.

a) Agronomic Practices: In this method, soil is conserved by applying the agronomic practices like farming on the ridges (contour farming), maintaining of soil fertility, mulching (formation of a protective layer by basal parts of herbaceous plants), crop rotation, tillage (weed removal) and strip cropping (Planting crops in parallel rows).

b) Agrostological Methods: In this method, soil is conserved by growing the grasses.

B) Mechanical Methods

Mechanical methods comprises:

a) Basin Listing
b) Contour Terracing.

a) Basin Listing: In this method, soil is conserved by creating the small furrows or basin along the contours.

b) Contour Terracing: In this method, soil is conserved by constructing channel along the slope.

C) Other Methods

These includes:

a) construction of dams, bunds and drains
b) protection of bank of river from cutting and caving by growing the vegetation alongside the river bank
c) afforestation and re-forestation.

Summary

- ✓ Deforestation refers to permanent removal of a natural forest.
- ✓ Deforestation is caused due to cutting of forest for agriculture, mining for metals, constructions of roads and buildings etc.
- ✓ Afforestation is establishment of a forest on non-forest land.
- ✓ Chipko movement was started to save the destruction of forests spread throughout India.
- ✓ Soil erosion is mainly caused by two agents: wind and water.
- ✓ Soil can be conserved by using biological methods or mechanical methods.

Question Bank

Q.1. Discuss in brief deforestation.

Q.2. Explain in brief afforestation.

Q.3. Give in detail account of Chipko Movement.

Q.4. Explain types of soil erosion.

Q.5. Describe methods of soil conservation.

Q.6. Write a short notes on
- a) Deforestation
- b) Afforestation
- c) Chipko movement
- d) Types of soil erosion
- e) Methods of soil conservation

MCQ (Multiple Choice Questions)

1) Establishment of a forest or stand of trees on non-forest land is known as _____.

a) Defforestation b) Afforestation
c) Reforestation d) All of the above

2) Permanent removal or clear of a natural forest is known as _____.

a) Defforestation b) Afforestation
c) Reforestation d) All of the above

13. Natural Resources Erosion and Their Conservation

Answers of Multiple Choice Questions (MCQ)

1.	(b)	2.	(a)

❖ ❖ ❖

14

Biodiversity and Conservation

Biodiversity or biological diversity means the variety and variability of life such as plants, animals etc. within specific area.

Types of Biodiversity

Biodiversity is very broad term and is often divide into following three levels:

A) Genetic Diversity
B) Species Diversity
C) Ecosystem Diversity

A) Genetic Diversity: Genetic diversity refers to the variations within species at genetic level.

B) Species Diversity: Species diversity is number and abundance of different species within a region.

C) Ecosystem Diversity: Ecosystem diversity refers to variations in the ecosystem or biological communities.

Importance of Biodiversity

Biodiversity offers many advantages to the mankind the form of food, medicinal resources, pharmaceutical drugs, wood products, ornamental plants etc. It also provides a number of ecosystem services, such as protection of water resources, soils formation and protection, pollution breakdown and absorption, maintenance of ecosystems etc.

Loss of Biodiversity

There are following major causes for the rapid extinction of species:

I) Destruction of habitat of several species of plants and animals
II) Fragmentation of forest due to buildings and road construction, mining etc.
III) Climate change
V) Environmental pollution
VI) Over-exploitation of natural resources
VII) Introduction of exotic species and genetically modified species.

IUCN and Red Data Book

In order to enlist and conserve the extinct, rare and threaten species at a global level, an International Union for the Conservation of Nature (IUCN) came into existence. ICUN is also known as World Conservation Union (WCU). ICUN recognized the nine red list categories of species namely: Extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, lower risk, data deficient and not evaluated. Critically endangered, endangered, and vulnerable species are collectively known as threatened species. Threatened species are listed in red data book.

Biodiversity Conservation

Biodiversity can be conserved by following two methods:
A) In-situ conservation
B) Ex-situ conservation

A) In-situ conservation: Conservation of habitats, species and ecosystems in their natural surroundings is called in-situ conservation. They include **natural parks, nature reserves, sanctuaries, biosphere reserve, natural monuments** etc.

B) Ex- situ conservation: The conservation of elements of biodiversity away from their natural habitats is referred to as ex-situ conservation. They include **zoos, botanical gardens, seed banks, pollen bank, ova bank, cell bank, organ bank** etc.

Summary

- ✓ Biodiversity means the variety and variability of organisms within specific area.
- ✓ Biodiversity divide into three levels namely: genetic diversity, species diversity and ecosystem diversity
- ✓ Genetic diversity is variations within species at genetic level.
- ✓ Species diversity refers to number and abundance of different species within a region.
- ✓ Ecosystem diversity is variations in the ecosystem or biological communities.
- ✓ Biodiversity offers many advantages to human being.
- ✓ Destruction of habitat, fragmentation of forest, climate change, environmental pollution, over-exploitation of natural resources, introduction of exotic species are major causes of loss of biodiversity.
- ✓ International Union for the Conservation of Nature (IUCN) is also known as World Conservation Union (WCU).
- ✓ Threatened species are listed in red data book.
- ✓ Biodiversity can be conserved by two methods namely: in-situ conservation or ex-situ conservation
- ✓ Conservation of habitats, species and ecosystems in their natural surroundings is called in-situ conservation. For example: Natural parks, nature reserves, sanctuaries, biosphere reserve, natural monuments etc.
- ✓ The conservation of elements of biodiversity away from their natural area is known as ex-situ conservation. For example: Zoos, botanical gardens, seed banks, pollen bank, ova bank, cell bank, organ bank etc.

Question Bank

Q.1. What is biodiversity? Explain in brief types of biodiversity.

Q.2. Discuss in short importance of biodiversity.

Q.3. Describe causes of loss of biodiversity.

Q.4. Explain methods of biodiversity conservation.

Q.5. **Write a short notes on**

a) **IUCN**
b) **Types of Biodiversity**
c) **In-situ Conservation**
d) **Ex-situ Conservation**

MCQ (Multiple Choice Questions)

1) Variations within species at genetic level is known as ____.

a) Genetic biodiversity b) Ecosystem biodiversity
c) Species biodiversity d) All of the above

2) Biodiversity can be conserved by ____.

a) In-situ conservation methods b) Ex-situ conservation methods
c) Both a and b d) All of the above

3) Conservation of elements of biodiversity in their natural habitat is called as ____.

a) In-situ conservation b) Ex-situ conservation
c) Both a and b d) All of the above

4) The conservation of elements of biodiversity away from their natural habitats is called as ____.

a) In-situ conservation b) Ex-situ conservation
c) Both a and b d) All of the above

14. Biodiversity and Conservation

Answers of Multiple Choice Questions (MCQ)

1.	(c)	2.	(c)
3.	(a)	4.	(b)

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