Subject: Environmental Science and Sustainability

Class: FY BBA (SEM-I)

Unit 1: Understanding Environment, Natural Resources, Ecosystems and Sustainability

Course Content:

- Fundamental environmental concepts, Concept of sustainability;
- Natural resources Non-renewable Resources, Renewable Resources – (A) Forest resources, (B) Water resources, (C) Mineral resources, (D) Food resources, (E) Energy resources, (F) Land resources, Role of an individual in conservation of natural resources.
- Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. (A) The water cycle, (B) The Carbon cycle, (C) The Oxygen cycle,
- Food chains

❖ FUNDAMENTAL ENVIRONMENTAL CONCEPTS

1. Meaning of Environment

The term environment refers to the total surroundings in which living organisms exist and interact. It includes both living and non-living components that influence the growth, development, survival and activities of organisms.

Environment is not limited to forests, rivers and animals. It also includes human-made surroundings such as buildings, roads, industries, transport systems and social institutions.

Definition

Environment is the sum total of all living and non-living factors surrounding an organism and influencing its life.

Main Components

Environment = Biotic Components + Abiotic Components

Example

A student requires air for breathing, water for drinking, food for nutrition, sunlight and a suitable temperature. These environmental factors directly or indirectly influence the student's life.

2. Components of Environment

The environment has two major components:

A. Biotic Components

The word biotic refers to all living components of the environment.

Examples:

- Human beings
- Plants
- Animals
- Birds
- Insects
- Bacteria
- Fungi
- Microorganisms

Biotic components depend on one another for food, shelter, reproduction and survival.

Example:

Plants provide food to herbivores, herbivores provide food to carnivores, and decomposers break down dead organisms.

B. Abiotic Components

Abiotic components are the non-living physical and chemical factors of the environment.
Examples:

- Air
- Water
- Soil
- Sunlight
- Temperature
- Humidity
- Minerals
- Rocks

Abiotic factors influence the distribution and survival of living organisms.
Example:
Plants need sunlight, water, suitable temperature and soil nutrients to grow.

3. Interaction Between Biotic and Abiotic Components

Biotic and abiotic components are interdependent.
For example:

Sunlight + Water + Soil
↓
Plants
↓
Herbivores
↓
Carnivores
↓
Decomposers
↓
Nutrients return to soil

This shows that environmental components do not work independently. They form an interconnected system.

3. Natural Environment

The natural environment consists of components and processes that occur naturally without being created by humans.
Examples:

- Forests
- Mountains
- Rivers
- Oceans
- Lakes
- Soil
- Wildlife
- Climate

Natural ecosystems provide resources and services essential for human survival.
Example Forests provide:

- Oxygen
- Timber
- Food
- Medicines

- Wildlife habitat
- Climate regulation
- Soil protection

❖ CONCEPT OF SUSTAINABILITY

○ Meaning of Sustainability

Sustainability means maintaining a balance between environmental protection, social well-being and economic development so that resources and opportunities remain available over the long term.
In simple words:
Sustainability means meeting our present needs without destroying the ability of future generations to meet their needs.
The concept became particularly influential through the Brundtland Report, "Our Common Future" (1987).

Why is Sustainability Important?
Modern economic development depends heavily on natural resources.
If resources are used excessively:

Overuse of resources
↓
Resource depletion
↓
Environmental degradation
↓
Problems for future generations

Therefore, sustainability is necessary to maintain a balance between development and environmental protection.

○ Sustainable Development

Meaning
Sustainable development is development that seeks to improve human well-being and economic conditions while protecting the environment and ensuring that resources remain available for future generations.
Three Major Objectives

Economic Development
↓
Social Development
↓
Environmental Protection

These three objectives should be considered together.

Three Pillars of Sustainability

1. Environmental Sustainability
It focuses on protecting natural ecosystems and resources.
Examples:

- Conservation of forests
- Water conservation
- Pollution control
- Biodiversity protection
- Renewable energy

- Waste reduction

2. Social Sustainability 👥
It focuses on human well-being and social development.
Examples:
- Education
- Healthcare
- Equality
- Social justice
- Safe working conditions
- Community development

3. Economic Sustainability 💰
It means maintaining economic activities and business growth over the long term without exhausting resources or creating unacceptable environmental and social costs.
Examples:
- Efficient resource use
- Sustainable production
- Green technology
- Long-term investment
- Reducing unnecessary waste

❖ NATURAL RESOURCES

1. Meaning of Natural Resources

Natural resources are materials, substances and forms of energy that are obtained from nature and used by human beings for survival, economic activities and development.

In simple words:

Anything useful that we obtain from nature is called a natural resource.

Examples: 🌳 Forests
💧 Water
⛏️ Minerals
🌾 Food
☀️ Sunlight
🌬️ Wind
🌱 Land
🪨 Rocks
🐟 Fish

Natural resources provide the basic inputs required for **agriculture, industries, businesses, transportation and human life**.

2. Importance of Natural Resources

Natural resources are important because they:

1. Provide food and drinking water.
2. Provide raw materials to industries.
3. Provide energy for economic activities.
4. Provide land for agriculture and settlements.
5. Support biodiversity and ecosystems.
6. Generate employment and income.
7. Support economic development.
8. Maintain ecological balance.

Business Example

A textile company requires:

Cotton → Water → Energy → Land → Machinery → Labour

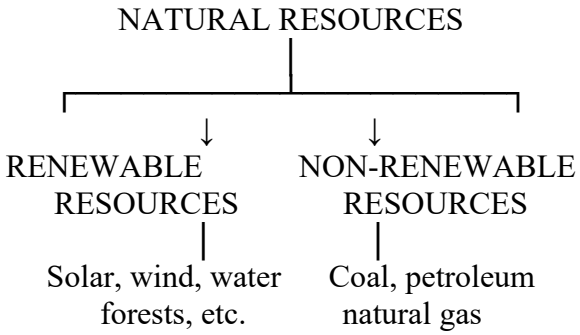
Several of these inputs ultimately depend on natural resources.

Therefore:

Natural resources are an important foundation of economic and business activity.

3. Classification of Natural Resources

Natural resources can broadly be classified into:



A. Renewable Resources

Meaning

Renewable resources are resources that can naturally regenerate or replenish over time.

Examples

- Solar energy
- Wind energy
- Water
- Forest resources
- Biomass
- Some agricultural resources

Important Point

Renewable does not mean unlimited.

If renewable resources are used faster than their natural rate of regeneration, they can become depleted or degraded.

Example

A forest can regenerate naturally.

But if:

Trees cut > Trees regenerated

then:

❌ Forest cover decreases.

Therefore, even renewable resources require proper management.

B. Non-Renewable Resources

Meaning

Non-renewable resources are resources available in finite quantities or resources that take extremely long periods to form compared with the rate at which humans consume them.

Examples

- Coal
- Petroleum
- Natural gas
- Iron ore
- Copper
- Bauxite
- Other mineral deposits

Example

Petroleum is formed through geological processes over millions of years.
Therefore:
Petroleum consumed today cannot be replaced within a human lifetime.
Problems
Excessive use may lead to:

- Resource depletion
- Environmental pollution
- Greenhouse gas emissions
- Higher extraction costs
- Energy security concerns

4. Renewable vs Non-Renewable Resources

Basis	Renewable	Non-Renewable
Availability	Can regenerate naturally	Finite or very slow to regenerate
Time	Relatively shorter	Usually geological time
Examples	Solar, wind, forests	Coal, petroleum, natural gas
Risk	Can be depleted if overused	Depletion is a major concern
Conservation	Sustainable management required	Careful and efficient use essential

1. FOREST RESOURCES

o Meaning of Forest Resources

Forest resources are the products, materials, services and ecological benefits obtained from forests.
Forests are much more than sources of timber.
Products obtained from forests

- Timber
- Bamboo
- Fruits
- Nuts
- Medicinal plants
- Honey
- Gum

- Resin
- Fibres

Ecological services

- Carbon storage
- Soil protection
- Water-cycle regulation
- Wildlife habitat
- Climate regulation
- Biodiversity conservation

o Importance of Forest Resources

1. Maintain biodiversity

Forests provide habitat for numerous species.

2. Prevent soil erosion

Tree roots hold soil together.

3. Support the water cycle

Forests influence rainfall, infiltration and groundwater recharge.

4. Store carbon

Trees and forest ecosystems store carbon and therefore contribute to climate regulation.

5. Provide livelihood

Many communities depend on forests for food, fuel, materials and income.

6. Provide raw materials

Timber, paper, furniture and several other industries depend directly or indirectly on forest resources.

o Problems Related to Forest Resources

Deforestation

Deforestation means the permanent or long-term removal of forest cover for conversion to other land uses.

Causes

- Agriculture expansion
- Urbanization
- Infrastructure development
- Mining
- Excessive logging

- Forest fires
- Certain development activities

- **Effects**

❌ Loss of biodiversity
❌ Soil erosion
❌ Habitat destruction
❌ Disturbance of water cycles
❌ Increased carbon emissions

- **Conservation of Forest Resources**

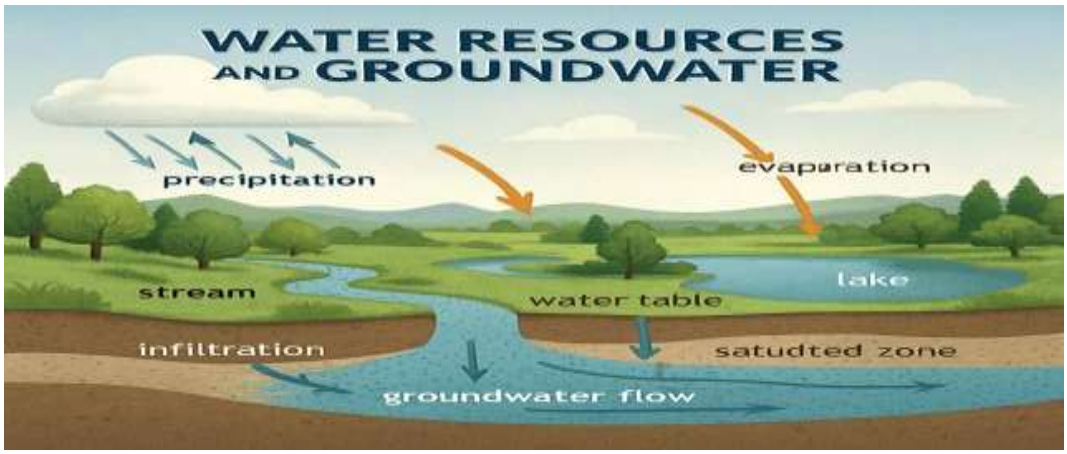
Ways to conserve forests:
🌱 Afforestation and reforestation
🌳 Sustainable Forest management
🔥 Forest-fire prevention
🚫 Control illegal logging
♻️ Reduce paper waste
🌿 Protect wildlife habitats
👥 Involve local communities

2. WATER RESOURCES 💧

- **Meaning of Water Resources**

Water resources include water available for human use and ecosystem functioning.
Major sources

- Rivers
- Lakes
- Ponds
- Groundwater
- Rainwater
- Glaciers
- Reservoirs
- Wetlands



○ Importance of Water Resources

Water is essential for:
Human life
Drinking, sanitation and hygiene.
Agriculture
Irrigation and livestock.
Industry
Manufacturing, cooling, cleaning and processing.
Energy
Hydropower generation and cooling in some energy systems.
Ecosystems
Aquatic plants and animals depend on water.

○ Major Water Problems

1. Water scarcity
Insufficient water availability to meet demand.
2. Water pollution
Discharge of sewage, chemicals and other pollutants can reduce water quality.
3. Groundwater depletion
Excessive withdrawal can reduce groundwater levels.
4. Unequal distribution
Some regions receive abundant rainfall while others face water scarcity.

○ Water Conservation

Simple methods
🚰 Repair leaking taps
🌧️ Rainwater harvesting
💧 Reuse suitable wastewater
🌱 Use efficient irrigation
🏠 Avoid unnecessary water wastage
🌊 Protect rivers, lakes and wetlands
Real-Life Example
If a college installs rainwater harvesting, rainwater can be collected and directed to storage or groundwater recharge systems.

3. MINERAL RESOURCES ⛏️

○ Meaning of Mineral Resources

Mineral resources are naturally occurring inorganic substances found in the Earth's crust that have economic value.
Examples

- Iron
- Copper
- Aluminium
- Gold
- Silver
- Limestone
- Manganese

- Bauxite

Types of Mineral Resources

Metallic Minerals
Contain economically useful metals.
Examples:

- Iron
- Copper
- Gold
- Aluminium

Non-Metallic Minerals
Do not primarily yield metals.
Examples:

- Limestone
- Mica
- Gypsum
- Clay

Importance of Minerals

Minerals are essential for:
🏗️ Construction
🚗 Automobile industry
📱 Electronics
🏭 Manufacturing
⚡ Energy infrastructure
💻 Technology
Example
A smartphone requires various mineral-based materials for components such as wiring, batteries and electronic parts.

Problems of Mineral Extraction

Mining can cause:

- Deforestation
- Soil degradation
- Water pollution
- Dust and air pollution
- Habitat destruction
- Waste generation
- Landscape alteration

Conservation

- Efficient mining
- Recycling metals
- Reuse of materials
- Reducing unnecessary consumption
- Mine-site restoration
- Cleaner mining technologies

4. FOOD RESOURCES

Meaning of Food Resources

Food resources are resources from which humans obtain food and nutrition.

Major sources

Agriculture

Livestock

Fisheries

Forest products

Poultry

○ Agriculture as a Food Resource

Agriculture provides:

- Cereals
- Pulses
- Vegetables
- Fruits
- Oilseeds
- Sugar crops
- Fibre crops

Problems in Agriculture

- Soil degradation
- Excessive chemical use
- Water scarcity
- Loss of biodiversity
- Food waste
- Climate-related risks

○ Food Security

Meaning

Food security exists when people have reliable access to sufficient, safe and nutritious food to meet their dietary needs and preferences for an active and healthy life.

Four commonly discussed dimensions:

1. Availability
2. Access
3. Utilization
4. Stability

Example

Producing enough food is not sufficient if people cannot afford or physically access it.

○ Sustainable Food Resources

We can protect food resources by:

🌱 Sustainable agriculture

💧 Efficient irrigation

🌾 Crop diversification

🐝 Protecting pollinators

🍱 Reducing food waste

🌍 Protecting soil fertility

♻️ Composting organic waste

Real-Life Example

A restaurant can reduce food-resource pressure by:

Buying according to demand → Proper storage → Portion control → Food waste reduction → Composting suitable waste

5. ENERGY RESOURCES ⚡

Meaning of Energy Resources

Energy resources are natural sources from which useful energy can be obtained.
Energy is required for:

- Transportation
- Manufacturing

- Agriculture
- Communication
- Household activities
- Business operations

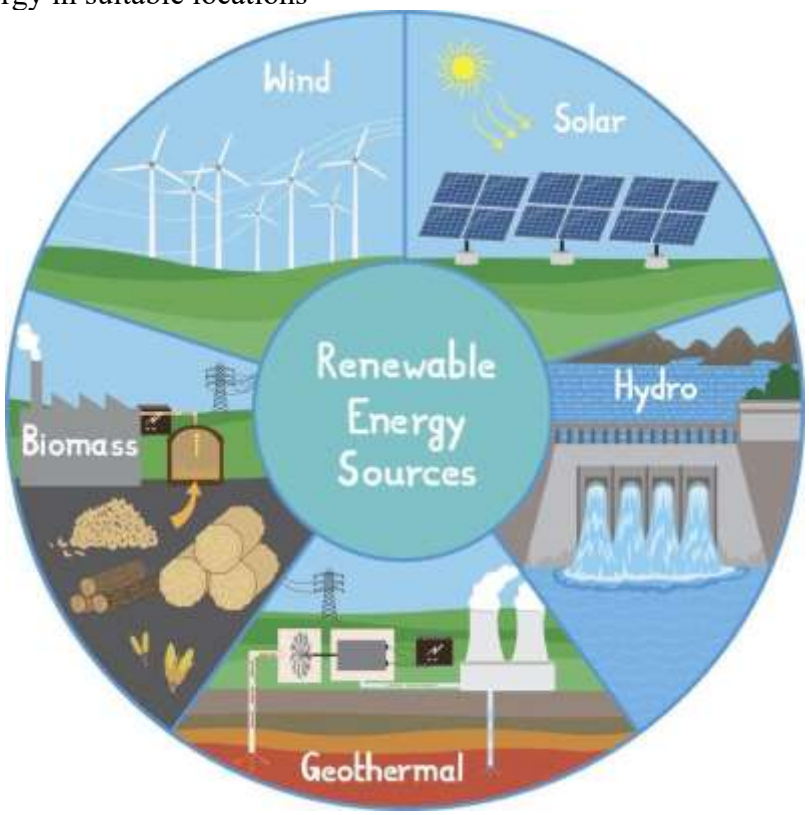
Types of Energy Resources

Conventional / Fossil Fuel Resources

- Coal
- Petroleum
- Natural gas

Renewable Energy Resources

- Solar
- Wind
- Hydropower
- Biomass
- Geothermal
- Tidal/wave energy in suitable locations



Renewable Energy

Solar Energy
Energy obtained from sunlight.
Example: Solar panels on college buildings.

Wind Energy
Electricity generated using wind turbines.
Hydropower
Energy generated using flowing or falling water.
Biomass
Energy obtained from organic materials such as agricultural residues and other suitable biomass.

- **Problems of Conventional Energy**

Excessive dependence on fossil fuels can cause:

- Air pollution
- Greenhouse gas emissions
- Climate change
- Resource depletion
- Environmental damage from extraction

Conservation

- Energy-efficient appliances
- Public transport
- Renewable energy
- Energy-efficient buildings
- Switching off unnecessary equipment
- Reducing energy waste

6. LAND RESOURCES

- **Meaning of Land Resources**

Land resources refer to the Earth's land surface and its soil and associated natural features that support human activities and ecosystems.
Land is required for:

- Agriculture
- Housing
- Industries
- Roads
- Forests
- Wildlife habitats
- Recreation

Importance of Land Resources

Agriculture
Provides land for growing food.
Human settlements
Provides space for homes and cities.
Industry
Industrial facilities require land.
Ecosystems
Forests, grasslands and wetlands occupy land and support biodiversity.
Economic Development
Infrastructure and business activities depend on land.

Land Degradation

Meaning
Land degradation means a decline in the quality, productivity or ecological condition of land.
Causes

- Deforestation
- Soil erosion
- Overgrazing
- Improper agricultural practices
- Mining
- Urbanization
- Improper irrigation
- Pollution

Effects

❌ Loss of soil fertility
❌ Reduced agricultural productivity
❌ Desertification in vulnerable areas
❌ Biodiversity loss
❌ Water problems

Conservation of Land Resources

Methods

🌱 Afforestation
🌾 Sustainable agriculture
🚜 Proper soil management
💧 Efficient irrigation
🌿 Contour farming where appropriate
♻️ Proper waste disposal
🏗️ Planned urban development

❖ ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES

This is an important exam topic.
Conservation does not depend only on government and industries.
Every individual uses natural resources every day.
Therefore:
Individual behaviour plays an important role in reducing resource consumption and protecting the environment.

1. Save Water 💧

- Close taps when not needed.
- Repair leaks.
- Use water efficiently.
- Avoid unnecessary wastage.
- Support rainwater harvesting.

Example
Do not leave the tap running while brushing your teeth.

2. Save Electricity ⚡

- Switch off lights when leaving a room.
- Turn off fans and air conditioners when not required.
- Use energy-efficient appliances.
- Make maximum use of natural light.

Example
Switching off classroom lights during sufficient daylight reduces unnecessary electricity consumption.

3. Reduce Paper Consumption 🌳

- Use digital documents where appropriate.
- Print only when necessary.
- Use both sides of paper.
- Recycle used paper.

Business Example
Companies can reduce paper consumption by using digital invoices, online forms and electronic records.

4. Reduce Plastic Waste ♻️

- Carry reusable bags.
- Avoid unnecessary single-use plastics.
- Reuse suitable containers.
- Segregate recyclable materials.

5. Use Public Transport 🚌

Using public transport, walking or cycling where practical can reduce:

- Fuel consumption
- Traffic congestion
- Air pollution
- Carbon emissions

6. Protect Forests 🌳

Individuals can:

- Plant and care for trees.

- Avoid unnecessary paper waste.
- Support responsible forest products.
- Prevent littering in forest areas.
- Participate in local conservation activities.

7. Reduce Food Waste
Food production requires:
Land + Water + Energy + Labour
Therefore, wasting food also wastes these resources.
Individual Actions
- Take only the amount you can eat.
- Store food properly.
- Use leftovers safely.
- Compost suitable organic waste.

Important Exam Questions

Short Answer Questions
1. Define natural resources.
2. What are renewable resources?
3. What are non-renewable resources?
4. Give four examples of forest resources.
5. What is water conservation?
6. Define mineral resources.
7. What is food security?
8. What are energy resources?
9. Define land degradation.
10. Explain the 5R principle.

Long Answer Questions
1. Explain renewable and non-renewable resources with examples.
2. Explain different types of natural resources and their importance.
3. Discuss forest, water and mineral resources and their conservation.
4. Explain food and energy resources with problems and conservation methods.
5. Explain land resources, land degradation and conservation.
6. Discuss the role of an individual in the conservation of natural resources.

❖ CONCEPT OF AN ECOSYSTEM

Introduction

The environment around us is made up of living organisms such as plants, animals, birds, insects, and microorganisms, as well as non-living things like air, water, soil, sunlight, and temperature. All these components work together to support life on Earth. This natural system is known as an ecosystem.

The ecosystem is one of the most important concepts in Environmental Studies because it explains how living and non-living things depend on each other. Every organism in nature has a specific role to play. Plants produce food, animals consume food, and microorganisms break down dead organisms and return nutrients to the soil. This continuous interaction helps maintain the balance of nature.

An ecosystem can be as small as a pond or as large as an ocean. Every ecosystem has its own plants, animals, climate, and natural resources, but all ecosystems function in a similar way by exchanging energy and recycling nutrients.

❖ Meaning of an Ecosystem

The word ecosystem is made up of two words:

- Eco means *environment* or *home*.
- System means *a group of parts working together*.

Therefore, an ecosystem means a natural system in which living organisms interact with one another and with their physical environment.

In simple words, an ecosystem is a place where plants, animals, humans, microorganisms, air, water, soil, and sunlight work together to support life.

❖ Definition of an Ecosystem

The term ecosystem was introduced by the British ecologist A.G. Tansley in 1935. Definition

"An ecosystem is a system formed by the interaction of all living organisms with each other and with the physical environment."

This definition shows that an ecosystem is not only about living organisms but also about the non-living factors that influence life.

❖ Components of an Ecosystem

Every ecosystem has two major components:

1. Biotic Components (Living Components)

Biotic components include all living organisms present in an ecosystem. These are divided into three groups.

A. Producers

Producers are organisms that prepare their own food using sunlight through the process of photosynthesis. They are also called autotrophs.

Examples:

- Trees
- Grass
- Shrubs
- Algae
- Phytoplankton

Importance of Producers

- Produce food for themselves and other organisms, Absorb carbon dioxide.
- Release oxygen into the atmosphere, Support all other living organisms.

B. CONSUMER

Consumers cannot prepare their own food. They depend on plants or other animals for nutrition. Consumers are also called heterotrophs.

Consumers are classified into different types.

Primary Consumers (Herbivores)

These animals eat only plants. Examples:

- Cow
- Goat
- Rabbit
- Deer

Secondary Consumers

These animals feed on herbivores.

Examples:

- Frog
- Snake
- Fox

Tertiary Consumers

These animals feed on secondary consumers. Examples:

- Tiger
- Lion
- Eagle

Omnivores

These animals eat both plants and animals. Examples:

- Human beings
- Bear

Importance of Consumers

- Transfer energy through the food chain.
- Help maintain ecological balance.
- Control the population of other organisms.
- Support nutrient cycling.

C. Decomposers

Decomposers break down dead plants, animals, and organic waste into simpler substances. They return nutrients to the soil, making them available for plants.

Examples:

- Bacteria
- Fungi
- Mushrooms

Importance of Decomposers

- Keep the environment clean.
- Recycle nutrients.
- Improve soil fertility.
- Complete the nutrient cycle.

Without decomposers, dead plants and animals would accumulate, and nutrients would not return to the soil.

❖ Characteristics of an Ecosystem

An ecosystem has several important characteristics.

- It consists of both living and non-living components.
- Living organisms depend on one another for survival.
- Energy enters the ecosystem mainly through sunlight.
- Nutrients are continuously recycled.
- Every organism has a specific role.
- Ecosystems maintain ecological balance.
- They may be natural or human-made.
- They can be small or large.

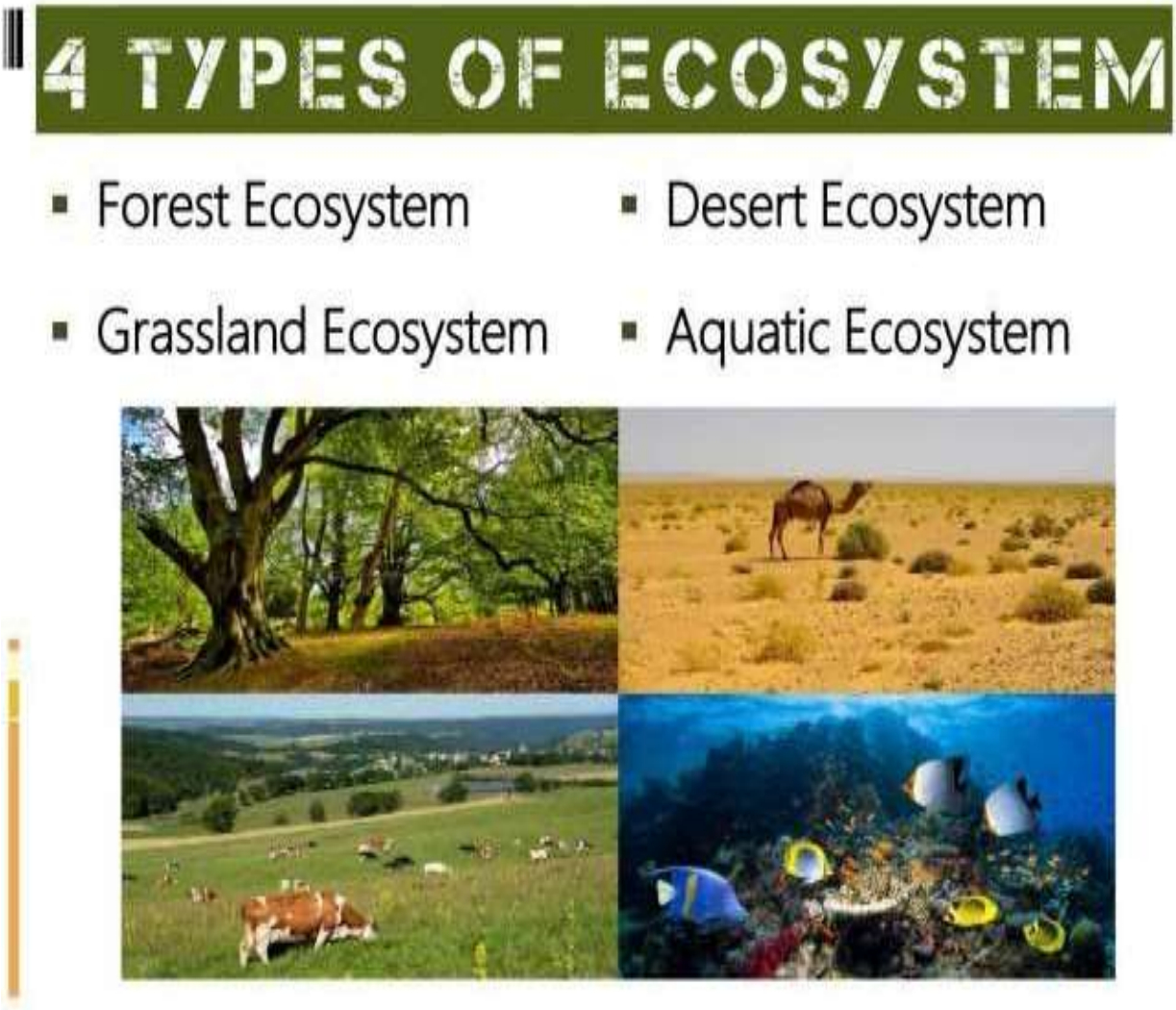
These characteristics make ecosystems stable and capable of supporting life.

❖ Types of Ecosystems

Different Types of Ecosystems – Detailed Notes in Simple Language

An ecosystem is a natural system in which living organisms interact with one another and with non-living things such as air, water, soil, sunlight and temperature.

For example, in a pond, fish, algae, insects, plants and microorganisms interact with water, sunlight, oxygen and nutrients. Together they form a pond ecosystem.



A. TERRESTRIAL ECOSYSTEM

1. Terrestrial means land.

A terrestrial ecosystem is an ecosystem that exists mainly on land. Examples include:

1. Forest ecosystem
2. Grassland ecosystem
3. Desert ecosystem
4. Tundra ecosystem

The type of terrestrial ecosystem depends greatly on factors such as temperature, rainfall and vegetation.

2. Forest Ecosystem

❖ Meaning

A forest ecosystem is an ecosystem where trees and other vegetation are the major producers and many different animals, birds, insects and microorganisms live together.
Forests generally have a large variety of living organisms and complex food webs.
Examples

- Tropical rainforest
- Tropical deciduous forest
- Temperate forest
- Coniferous forest
- Mangrove forest

Main Components Abiotic components:

- Sunlight
- Rainfall
- Air
- Soil
- Water
- Temperature
- Minerals Biotic components: Producers

- Trees
- Shrubs
- Grass
- Ferns
- Other green plants

Consumers

- Deer
- Elephant
- Monkey
- Rabbit
- Birds
- Tiger
- Fox
- Insects

Decomposers

- Bacteria
- Fungi
- Earthworms

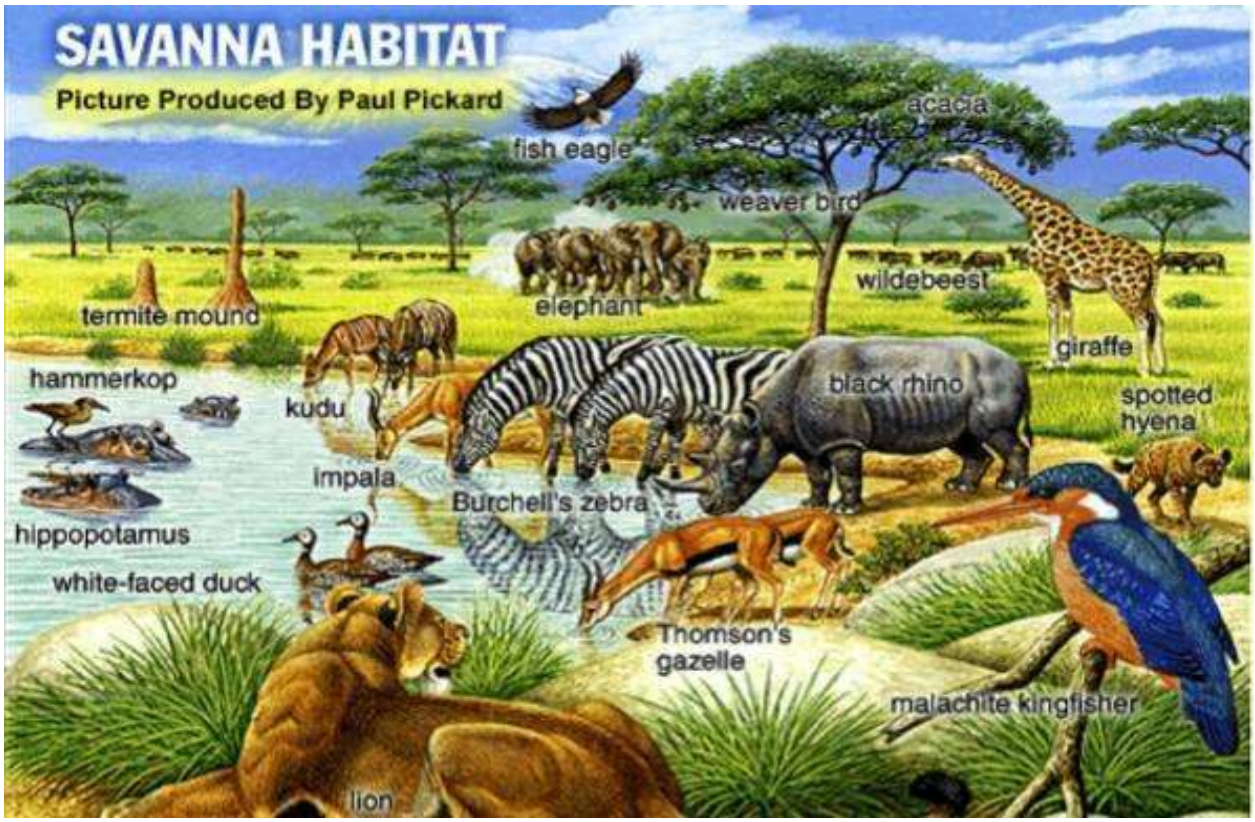
Simple Food Chain Grass → Deer → Tiger Another example:

Leaves → Caterpillar → Bird → Hawk
When plants and animals die:
Dead plants/animals → Fungi & bacteria → Nutrients → Soil → Plants Importance of Forest Ecosystem
Forests:

- Provide oxygen.
- Absorb carbon dioxide.
- Provide habitat for wildlife.
- Help control temperature.
- Help maintain the water cycle.
- Reduce soil erosion.
- Provide timber, fruits, medicines and other resources.
- Support biodiversity. Easy

Example for Students Ask students:
"Imagine a forest where all trees disappear. What will happen?" They can identify:
Trees decrease → herbivores lose food → carnivores lose prey → food chain is disturbed → ecosystem becomes unstable.

3. Grassland Ecosystem



❖ Meaning

A grassland ecosystem is an ecosystem where grasses and herbs are the main vegetation, while trees are relatively few or widely scattered.

Examples include:

- Savanna
- Prairies
- Steppes
- Pampas
- Indian grasslands

Why are there fewer trees?

Grasslands generally have conditions such as:

- Seasonal rainfall
- Periods of dryness
- Grazing by animals
- Fires in some grassland systems

These conditions can limit the growth of large numbers of trees.

Producers

- Grasses
- Herbs
- Small plants Primary

Consumers These animals eat plants:

- Deer
- Rabbit
- Zebra
- Antelope
- Grasshopper
- Cattle Secondary

Consumers They eat herbivores:

- Snake
- Fox
- Wild cat
- Some birds

Top Consumers

Examples include:

- Lion
- Tiger
- Eagle

Decomposers

- Bacteria
- Fungi
- Earthworms

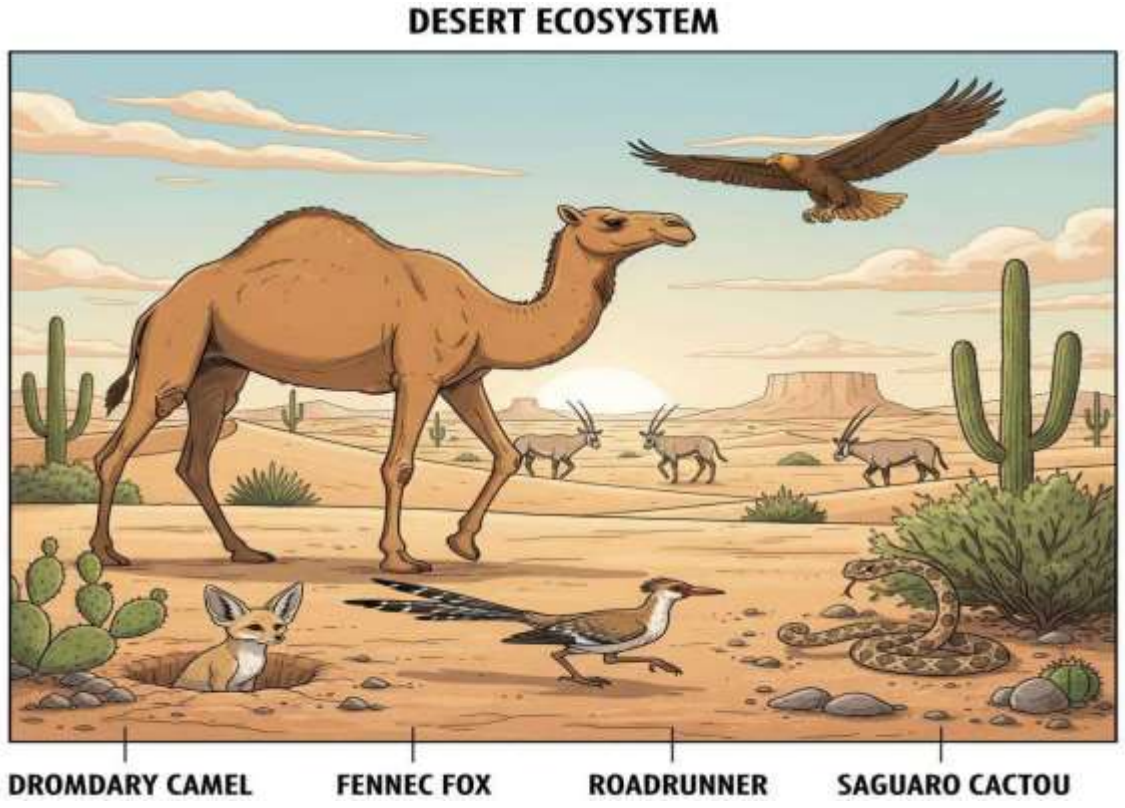
Example Food Chain

Grass → Grasshopper → Frog → Snake → Eagle

Another:
Grass → Deer → Lion
Importance Grasslands:

- Provide food for grazing animals.
- Support wildlife.
- Store carbon in vegetation and soil.
- Provide fertile soils in many regions.
- Support agriculture and livestock.
- Provide habitats for many birds and insects.

4. Desert Ecosystem



❖ Meaning

A desert ecosystem is an ecosystem found in areas receiving very little rainfall.

Deserts may be:

- Hot deserts
- Cold deserts

Examples Hot deserts

- Sahara
- Thar Desert

Cold deserts

- Gobi
- Ladakh region

Main Characteristics

- Very low rainfall
- Limited water
- High evaporation in hot deserts
- Extreme temperatures
- Sparse vegetation

Plants in Desert

Plants need special adaptations to survive. Examples:

- Cactus
- Thorny shrubs
- Acacia
- Desert grasses

Adaptations of Plants

Many desert plants:

- Have small leaves or spines.
- Have thick stems.
- Store water.
- Have deep or widespread roots.
- Have protective surfaces that reduce water loss.

Animals

Examples:

- Camel
- Desert fox
- Snake
- Lizard
- Scorpion
- Rodents
- Insects Animal

Adaptations Many desert animals:

- Are active at night.
- Stay in burrows during the hottest part of the day.
- Need very little water.
- Have body features that help conserve water.

Simple Food Chain

Desert plant → Insect → Lizard → Snake → Eagle Importance

Even though deserts look empty, they contain organisms specially adapted to dry conditions. They are important for:

- Biodiversity
- Soil and nutrient cycles
- Specialized plants and animals
- Human livelihoods in desert regions

5. Tundra Ecosystem

❖ Meaning

The tundra ecosystem occurs in extremely cold regions where trees generally cannot grow because of severe climate and a short growing season.

Examples:

- Arctic tundra
- Alpine tundra in high mountains

Main Features

- Very cold climate
- Short growing season
- Low vegetation
- Snow and ice for much of the year
- In Arctic tundra, permanently frozen subsoil (permafrost) is common.

Plants

- Mosses
- Lichens
- Small grasses
- Small shrubs

Animals

- Arctic fox
- Reindeer/caribou
- Polar bear
- Arctic hare
- Snowy owl

Food Chain

Lichen → Reindeer → Arctic Wolf

Adaptations

Animals may have:

- Thick fur
- Fat layers
- Seasonal behaviour
- Compact body structures

Plants generally remain small and grow close to the ground.

B. AQUATIC ECOSYSTEM

An aquatic ecosystem is an ecosystem associated with water. It is broadly divided into:

AQUATIC ECOSYSTEM

FRESHWATER ECOSYSTEM

MARINE ECOSYSTEM

Seas & Oceans

LENTIC Pond/Lake

LOTIC River/Stream

Freshwater ecosystems include ponds, lakes, rivers, streams and wetlands, while marine

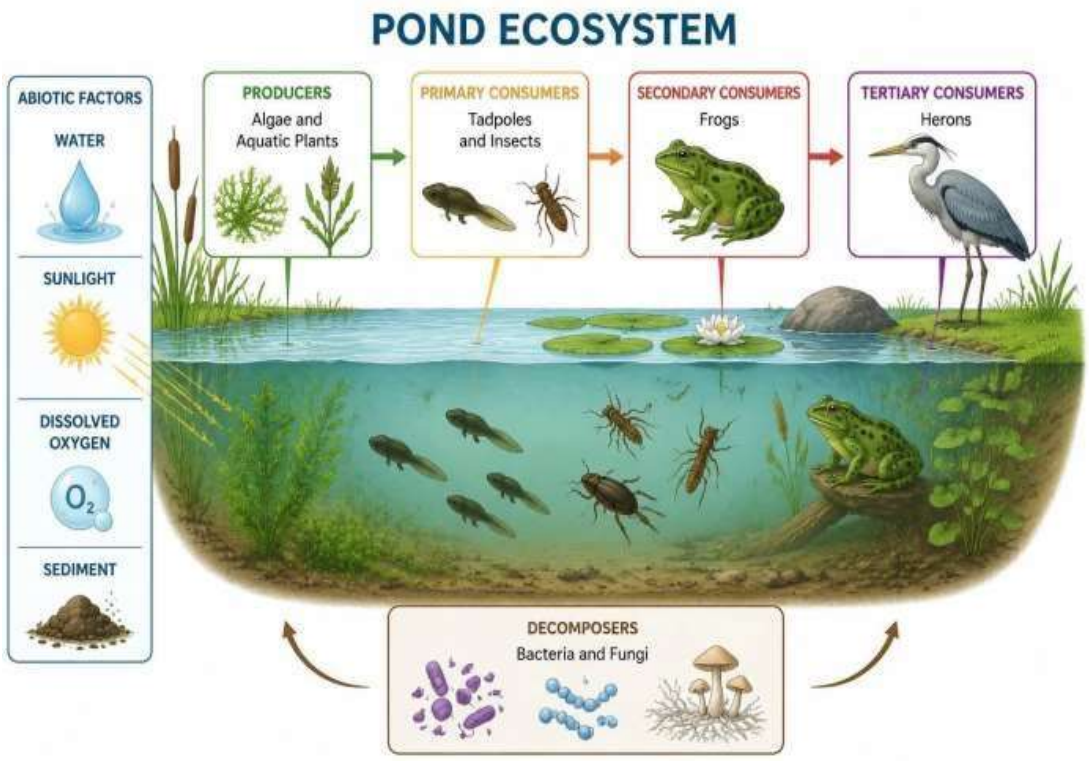
- ecosystems include seas and oceans.

6. Freshwater Ecosystem

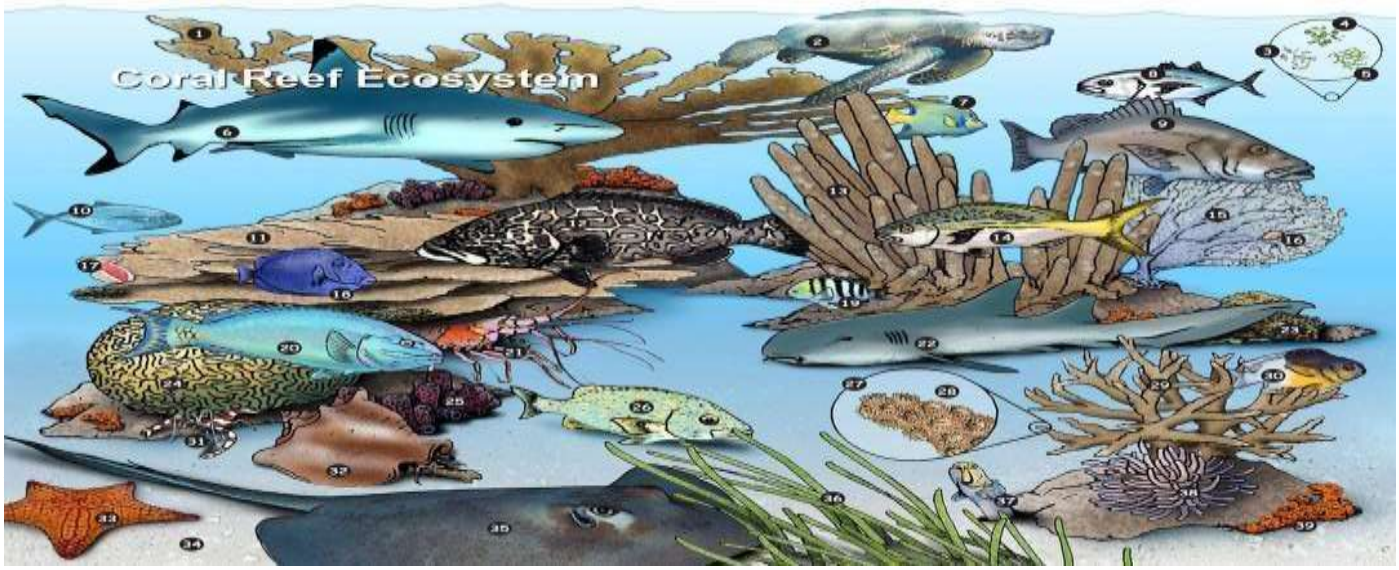
Freshwater ecosystems contain water with relatively low salt concentration. Examples:

- Pond
- Lake
- River
- Stream
- Wetland

Freshwater ecosystems can be divided into lentic and lotic systems.



7. Marine Ecosystem



- Coral reefs
- Estuaries
- Coastal ecosystems

Producers

The most important producers include:

- Phytoplankton
- Algae
- Marine plants
- Seagrasses

Consumers

Examples:

- Zooplankton
- Small fish
- Large fish

- Turtles
- Dolphins
- Seals
- Sharks

Simple Marine Food Chain

Phytoplankton → Zooplankton → Small Fish → Large Fish → Shark Importance

Marine ecosystems:

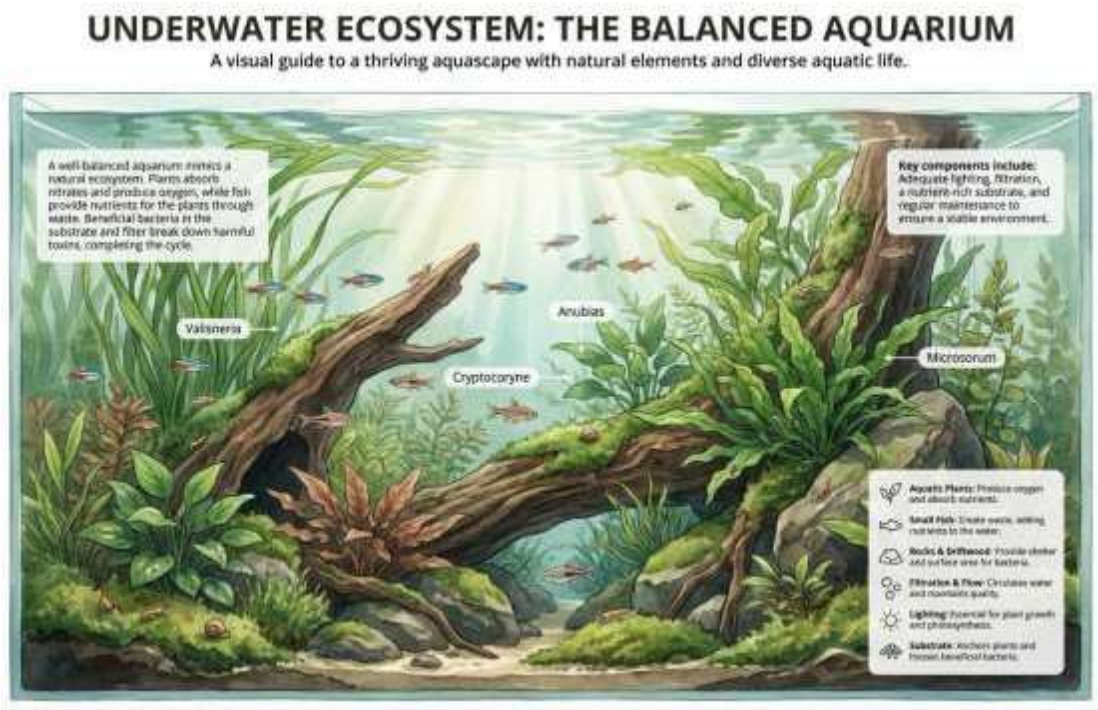
- Support enormous biodiversity.
- Provide food and livelihoods.
- Support fisheries.
- Participate in global carbon and nutrient cycles.
- Protect coastlines through ecosystems such as mangroves and coral reefs.

8. Artificial Ecosystem

Not all ecosystems are completely natural.
An artificial ecosystem is an ecosystem that is created or strongly managed by humans. Examples:

- Crop fields
- Gardens

- Aquariums
- Artificial ponds
- Urban ecosystems



Example: Crop Field

In a crop field:
Sunlight → Crop plants → Insects/animals → Humans
Farmers control many factors such as:

- Water
- Fertilizers
- Pesticides
- Crop selection
- Soil management

Therefore, artificial ecosystems often need human management and external inputs.

9. Energy Flow in an Ecosystem

One of the easiest ways to explain ecosystems to students is through energy flow.

SUN

↓

PRODUCERS

Plants

PRIMARY CONSUMERS

Herbivores

SECONDARY CONSUMERS

Carnivores

TOP CONSUMERS

Large predators

↓

DECOMPOSERS

Bacteria + Fungi

↓

Nutrients

↓

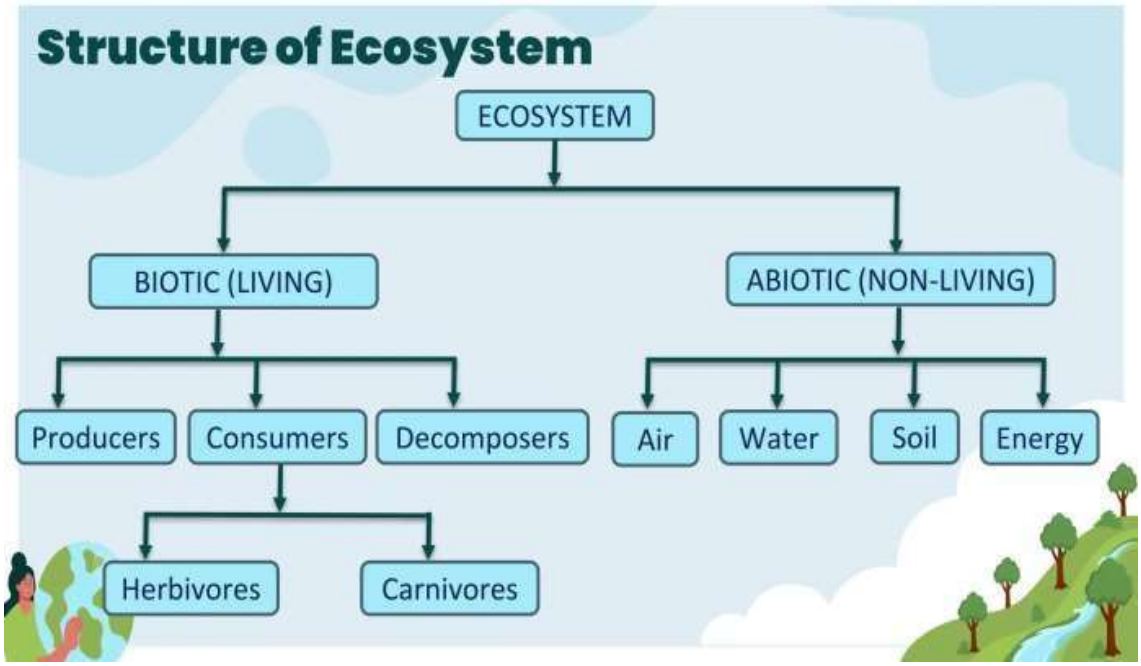
Plants

❖ STRUCTURE AND FUNCTION OF ECOSYSTEM

An ecosystem is a natural system where living organisms interact with each other and with non-living components such as sunlight, air, water, soil and temperature.

To understand an ecosystem properly, we study two things:

1. Structure of Ecosystem – *What is present in an ecosystem?*
2. Functions of Ecosystem – *What happens inside the ecosystem?*



PART A – STRUCTURE OF ECOSYSTEM

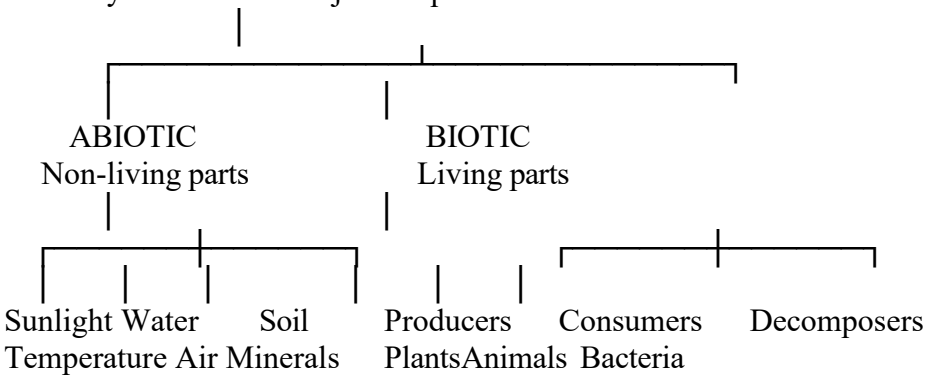
1. Meaning of Structure

The structure of an ecosystem means the different living and non-living components present in an ecosystem and their relationships with each other.

In very simple words:

Structure = What an ecosystem is made up of.

An ecosystem has two major components: ECOSYSTEM



2. Abiotic Components

Abiotic means non-living.
These are the physical and chemical factors that influence living organisms.
Major abiotic components

A. Sunlight

Sunlight is the main source of energy for most ecosystems. Green plants use sunlight during photosynthesis to prepare food. Sunlight → Plants → Animals

B. Water

Water is essential for:

- Plants
- Animals
- Microorganisms
- Photosynthesis
- Transportation of nutrients
- Maintaining body temperature

Without sufficient water, most ecosystems cannot function normally.

C. Air

Air provides important gases.
Oxygen is required by most organisms for respiration.
Carbon dioxide is required by green plants for photosynthesis.

D. Soil

Soil provides:

- Water
- Minerals
- Nutrients
- Support for plants

For example, plants obtain minerals such as nitrogen and phosphorus from soil.

E. Temperature

Temperature affects:

- Growth of plants
- Animal activity
- Reproduction
- Distribution of organisms
- Decomposition

For example, organisms living in a desert have different adaptations from organisms living in a cold tundra ecosystem.

F. Minerals and Nutrients

Important nutrients include:

- Nitrogen
- Phosphorus
- Potassium
- Calcium
- Sulphur

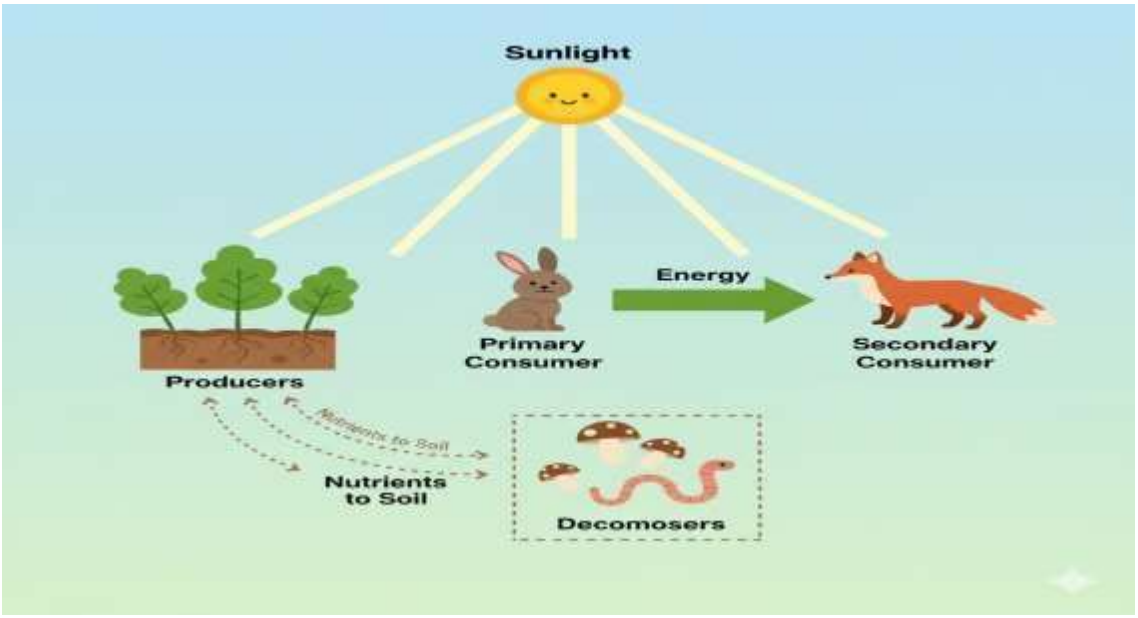
These nutrients move between soil, organisms, water and the atmosphere through nutrient cycles.

3. Biotic Components

Biotic means living.

The biotic components of an ecosystem are mainly divided into:

1. Producers
2. Consumers
3. Decomposers



4. Producers

Producers are organisms that make their own food. Most producers are green plants and algae.

They use:

Sunlight + Carbon dioxide + Water → Food This process is called photosynthesis.

Examples

- Trees
- Grass
- Crops
- Algae
- Phytoplankton

Why are producers important?

They are the first level of most food chains and introduce energy into the biological community.

Example

Sun → Grass → Deer → Tiger Here, grass is the producer.

5. Consumers

Consumers cannot make their own food. They obtain energy by eating plants or other animals. They can be divided into different levels.

A. Primary Consumers

They eat producers.

They are generally herbivores. Examples:

- Cow
- Deer
- Rabbit
- Goat
- Grasshopper

Example:
Grass → Deer

B. Secondary Consumers
They eat primary consumers.
Examples:
- Frog
- Snake
- Fox
- Some birds

Example:
Grass → Grasshopper → Frog
Here, the frog is a secondary consumer.

C. Tertiary Consumers
They eat secondary consumers. Examples:
- Eagle
- Large snakes
- Some large predatory fish

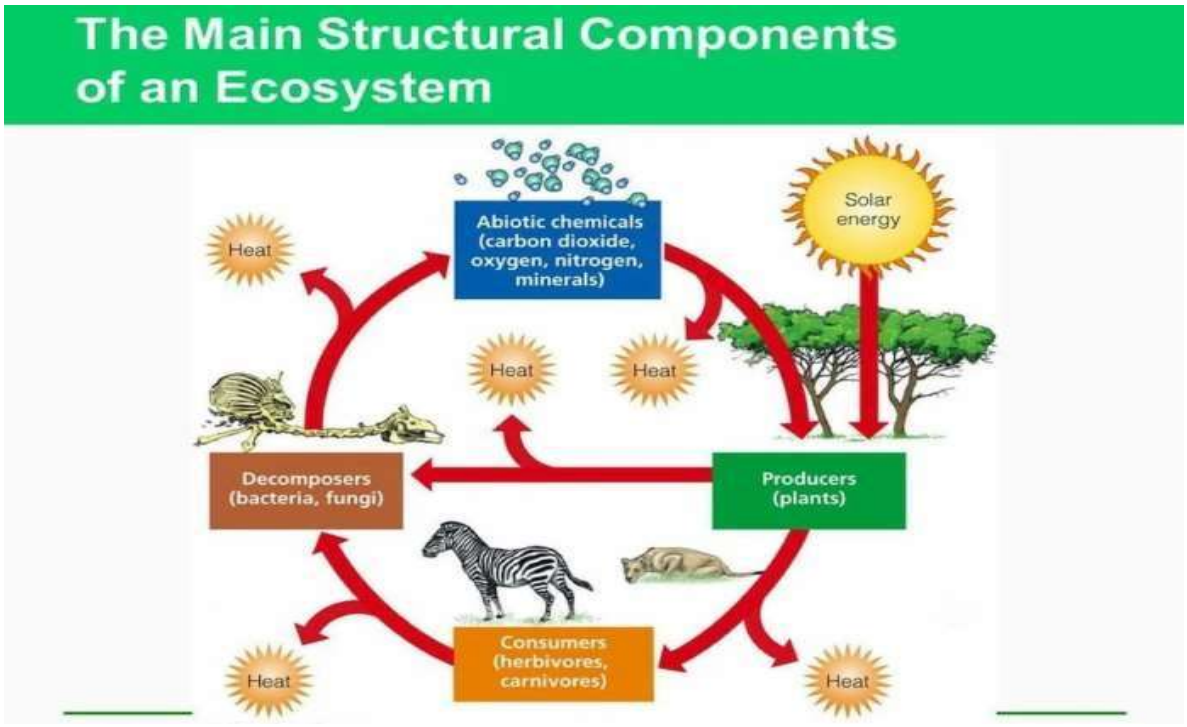
Example:
Grass → Grasshopper → Frog → Snake → Eagle

D. Top Consumers
These are predators that may occupy the highest trophic level in a particular food chain. Examples:
- Tiger
- Lion
- Eagle
- Shark

6. Decomposers
Decomposers break down dead plants, dead animals and organic waste into simpler substances.
Main decomposers include:
- Bacteria
- Fungi

Other organisms such as earthworms and some detritivores help break down dead matter, although they are not technically decomposers in the same sense as bacteria and fungi.

Example
Dead leaves
↓
Bacteria + Fungi
↓
Organic matter broken down
↓
Nutrients released
↓
Soil
↓
Plants absorb nutrients
Why are decomposers important?
Without decomposers, dead organic matter would accumulate and nutrients would not be efficiently returned to the environment.



❖ FUNCTIONS OF ECOSYSTEM

- **Meaning of Function**

The functions of an ecosystem refer to the processes that take place inside the ecosystem. In simple language:
Structure = What is present? Function =
What does it do? Major functions include:

1. Energy flow
2. Food chains
3. Food webs
4. Nutrient cycling
5. Decomposition
6. Productivity
7. Ecological balance
8. Regulation and ecosystem services

1. Energy Flow

Energy flow is one of the most important functions of an ecosystem. The main source of energy is generally the Sun.

SUN
↓
PRODUCERS
↓
HERBIVORES
↓
CARNIVORES
↓
TOP PREDATOR

Plants capture solar energy through photosynthesis. Animals obtain energy by eating plants or other animals. Important point
Energy flows through an ecosystem and is not continuously recycled in the same way as nutrients.

2. Food Chain

A food chain shows how food and energy pass from one organism to another.
Example 1
Grass → Grasshopper → Frog → Snake → Eagle Example 2
Grass → Deer → Tiger
Example 3
Phytoplankton → Small fish → Large fish → Shark

3. Food Web ⊣

In nature, an animal usually eats more than one type of food.
Therefore, many food chains become interconnected and form a food web. Example

Grass
↙ ↓ ↘
Rabbit Deer Grasshopper
↓ ↓ ↓
Fox Tiger Frog
↘ ↓ ↓
Eagle ← Snake

A food web is more realistic than a single food chain because ecosystems contain many interconnected feeding relationships.

- **Nutrient Cycling**

Unlike energy, many nutrients are recycled within ecosystems. Important nutrient cycles include:

- Water cycle
- Carbon cycle
- Nitrogen cycle
- Phosphorus cycle

Simple example
Plants
↓
Animals eat plants
↓
Waste + Dead organisms
↓
Decomposers
↓
Nutrients return to soil
↓
Plants absorb nutrients
Therefore:
Nutrients are recycled, while energy flows through the ecosystem.

- **Productivity of Ecosystem**

Productivity refers to the rate at which living organisms produce organic matter/biomass.

Primary Productivity

Plants produce organic matter through photosynthesis. There are two commonly discussed terms:

Gross Primary Productivity (GPP) = Total energy/organic matter captured by producers through photosynthesis.

Net Primary Productivity (NPP) = Energy/biomass remaining after producers use some energy for respiration. In simple form:

NPP = GPP − Respiration

NPP represents the energy available to the rest of the ecosystem from producers.

⬬ 15. Ecological Balance

A healthy ecosystem maintains a dynamic balance between its components. For example:

Plants
↓
Herbivores
↓
Carnivores
↓
Decomposers
↓
Nutrients
↓
Plants

If one component changes drastically, other components can also be affected.

Example

Suppose a forest loses a large number of predators.

Predators ↓ → Herbivores ↑ → Plants ↓ → Food shortage → Ecosystem disturbance

This shows the interdependence of organisms.

❖ ENERGY FLOW IN THE ECOSYSTEM AND BIOGEOCHEMICAL CYCLE'S INTRODUCTION

An ecosystem is a natural system where living organisms such as plants, animals, microorganisms, and non-living components like air, water, soil, and sunlight interact with each other. Every ecosystem needs a continuous supply of energy to support life. This energy comes mainly from the Sun. Along with energy flow, nature also recycles important substances like water, carbon, oxygen, and nitrogen through different natural cycles. These cycles are known as biogeochemical cycles because they involve biological, geological, and chemical processes. They help maintain ecological balance and ensure that essential elements are continuously available to all living organisms.

1. Energy Flow in the Ecosystem

Energy flow is the movement of energy from the Sun to plants and then to animals and decomposers. The Sun is the primary source of energy for almost all ecosystems. Green plants capture solar energy through the process of photosynthesis and convert it into food. Therefore, plants are called producers.

Animals that eat plants are called primary consumers, while animals that eat other animals are called secondary and tertiary consumers. When plants and animals die, decomposers such as bacteria and fungi break down their remains and return nutrients to the soil.

Energy flows in one direction only. It does not return to the Sun. At each trophic level, a large amount of energy is lost as heat, and only about 10% of the energy is transferred to the next level. This is known as the 10% Law.

Example:

Sun → Grass → Deer → Tiger → Decomposers

Sun

↓

Producers

↓

Primary Consumers

↓

Secondary Consumers

↓

Tertiary Consumers

↓

Decomposers

2. The Water Cycle

The water cycle is the continuous movement of water between the Earth's surface and the atmosphere. It ensures that fresh water is always available for living organisms.

The process begins with evaporation, where heat from the Sun changes water from rivers, lakes, and oceans into water vapour. Plants also release water vapour through transpiration. The water vapour rises, cools, and forms clouds through condensation. When clouds become heavy, water falls as precipitation in the form of rain, snow, or hail. Some water flows into rivers and oceans as runoff, while some enters the ground through infiltration, becoming groundwater.

The water cycle helps maintain rainfall, agriculture, drinking water, and climate balance.

Example: Rainwater fills rivers, farmers use it for irrigation, plants absorb it, and the process continues.

Diagram

Ocean

↑

Evaporation

↑

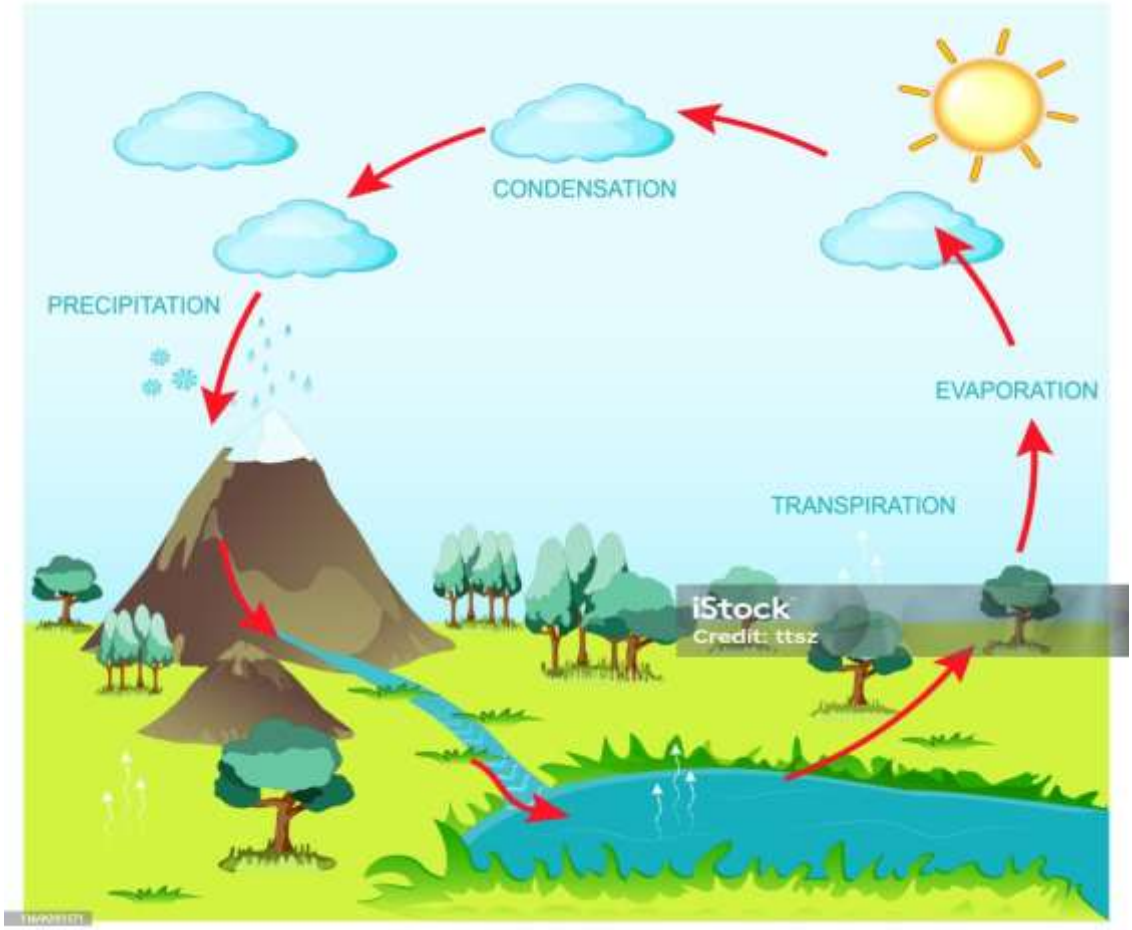
Clouds

↓

Rain

↓

Rivers → Ocean



3. The Carbon Cycle

The carbon cycle is the movement of carbon between the atmosphere, plants, animals, soil, and oceans. Carbon is an essential element because all living organisms contain carbon compounds.

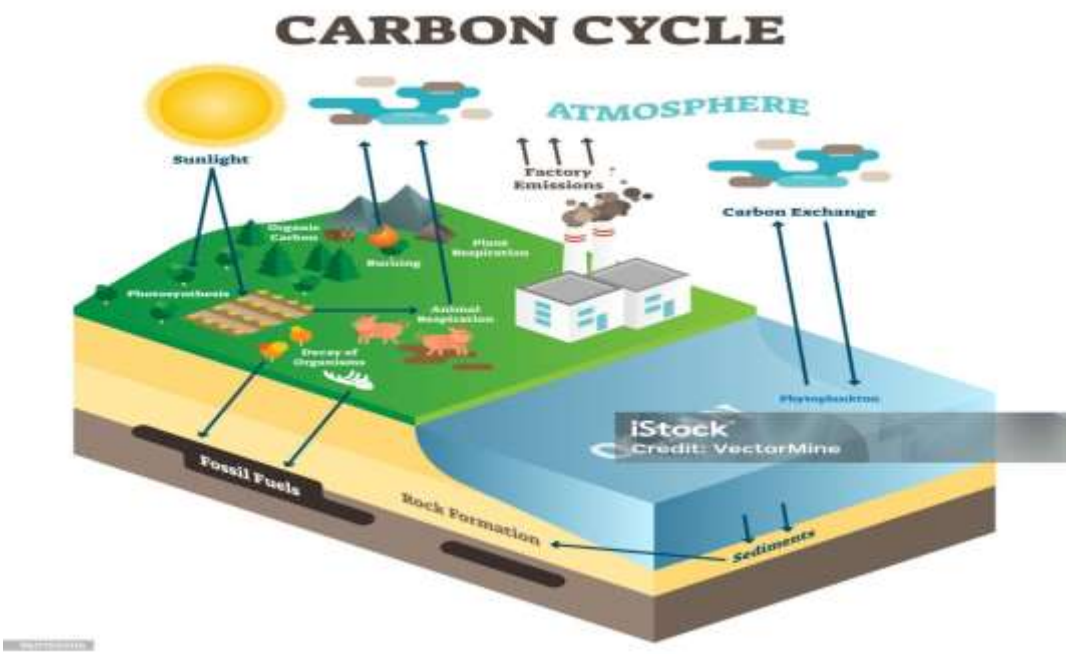
Plants absorb carbon dioxide (CO_2) from the atmosphere during photosynthesis and prepare food. Animals obtain carbon by eating plants or other animals. During respiration, plants and animals release carbon dioxide back into the atmosphere. When organisms die, decomposers break them down, releasing carbon into the soil and air. Burning fossil fuels and forests also releases large amounts of carbon dioxide.

The carbon cycle helps regulate Earth's climate and supports life.

Example: A tree absorbs carbon dioxide, a cow eats the grass, and both release carbon dioxide through respiration.

Diagram

CO_2 in Atmosphere
↓
Plants
↓
Animals
↓
Respiration
↓
CO_2 in Atmosphere



4. The Oxygen Cycle

The oxygen cycle describes how oxygen moves between the atmosphere, plants, animals, and water. Oxygen is essential for respiration in almost all living organisms.
Plants release oxygen during photosynthesis. Animals and humans use oxygen for breathing and release carbon dioxide. Aquatic plants also produce oxygen, which is used by fish and other aquatic organisms. Oxygen is also involved in combustion and decomposition.
The oxygen cycle works closely with the carbon cycle because plants and animals continuously exchange oxygen and carbon dioxide.
Example: During the day, trees release oxygen that humans and animals breathe.
Diagram

Plants
↓
Oxygen
↓
Animals & Humans
↓
Carbon Dioxide
↓
Plants

decomposers return nutrients to the soil after organisms die. Energy from the Sun drives all these cycles. If any one cycle is disturbed, the entire ecosystem is affected. For example, deforestation reduces oxygen production, increases carbon dioxide, disturbs rainfall, and affects wildlife. Pollution and excessive use of fossil fuels also disturb these natural cycles.
Therefore, protecting forests, conserving water, reducing pollution, and using natural resources wisely help maintain the balance of all ecosystems.
Integrated Diagram

Sun
↓

Plants
↙ ↓ ↘
Water Oxygen Carbon
Cycle ↓ Cycle
↘ Animals ↙
↓
Decomposers
↓
Nitrogen to Soil
↓
Plants