

Ecosystem – Structure, Function & Types

1. Ecosystem: Concept & Definition

- An ecosystem is the **basic structural and functional unit of ecology**.
- **Odum (1963):**
“An ecosystem is a functional unit of nature that includes living organisms interacting with the physical environment, resulting in the flow of energy and cycling of materials.”
- Includes:
 - **Biotic components** (living)
 - **Abiotic components** (non-living)
- Interaction between these components creates a **characteristic physical structure and species composition**.

2. Structure of an Ecosystem

A. Abiotic (Non-living) Components

These regulate the **distribution, abundance, and functioning** of organisms.

- **Climate:** Temperature, rainfall, humidity
- **Soil:** Texture, nutrients, pH, moisture
- **Water:** Availability and quality
- **Light:** Controls photosynthesis
- **Topography:** Altitude, slope, drainage
- **Air:** Oxygen, CO₂ concentration
- **Natural disturbances:** Fire, floods, storms

Warm and moist climates → high productivity and faster decomposition

B. Biotic (Living) Components

1. Producers (Autotrophs)

They synthesize organic matter from inorganic substances.

(a) Photoautotrophs

- Use **sunlight** for photosynthesis
- Contain **chlorophyll**
- Examples:
 - Green plants
 - Algae

- Cyanobacteria

(b) Chemoautotrophs

- Use **chemical energy** (not sunlight)
- Found in **extreme environments**
- Examples:
 - Nitrifying bacteria
 - Sulphur bacteria
 - Archaea in hydrothermal vents

2. Consumers (Heterotrophs)

- Cannot synthesize food
- Depend on producers or other consumers

Types:

- **Primary consumers:** Herbivores (deer, cattle)
- **Secondary consumers:** Carnivores (frog, lizard)
- **Tertiary consumers:** Top carnivores (tiger, eagle)

Macroconsumers

- Large consumers at higher trophic levels
- Example: Lion, Shark

3. Decomposers / Microconsumers

- Mainly **bacteria and fungi**
- Feed on **dead organic matter (detritus)**
- Convert organic matter into **inorganic nutrients**
- Also called **saprotrophs**

3. Interaction of Biotic & Abiotic Components

- Leads to:
 - **Species composition**
 - **Vertical stratification**

Stratification (Vertical Distribution)

- Example (Forest):
 - **Top layer:** Trees
 - **Middle layer:** Shrubs
 - **Bottom layer:** Herbs & grasses

4. Functional Aspects of Ecosystem

(i) Productivity

Primary Productivity

- Rate of biomass production by plants
- Expressed as **weight or energy per unit area per time**

Types:

- **Gross Primary Productivity (GPP):**
Total photosynthetic production
- **Net Primary Productivity (NPP):**
Biomass available to consumers

Formula (Very Important for Prelims):

$$\text{NPP} = \text{GPP} - \text{Respiration (R)}$$

- **Secondary Productivity:**
Rate of biomass formation by consumers

Highest NPP: Tropical rainforests, estuaries

Lowest NPP: Deserts, tundra

(ii) Decomposition

- Breakdown of **dead organic matter** into inorganic substances
- Raw material: **Detritus** (dead leaves, bark, animal remains, faecal matter)

Steps of Decomposition (Mnemonic: FLC-HM)

1. **Fragmentation** – Detritivores (earthworms) break detritus
2. **Leaching** – Soluble nutrients seep into the soil
3. **Catabolism** – Microbial enzymes degrade detritus
4. **Humification** – Formation of humus (dark, resistant, colloidal)
5. **Mineralisation** – Release of inorganic nutrients

Faster decomposition:

- Warm, moist, aerobic conditions
- Detritus rich in nitrogen & sugars

Slower decomposition:

- Cold, dry, anaerobic conditions
- Detritus rich in lignin & chitin

(iii) Energy Flow

- Energy flows **unidirectionally**
- From:
 - Sun → Producers → Consumers → Decomposers
- **10% law**: Only ~10% energy is transferred to the next trophic level

Energy is never recycled; nutrients are recycled

(iv) Nutrient Cycling

- Cyclic movement of nutrients like:
 - Carbon
 - Nitrogen
 - Phosphorus
- Maintains ecosystem stability

5. Types of Ecosystems

A. Terrestrial Ecosystems

1. Forest Ecosystem

- High biodiversity
- Types:
 - Tropical rainforests
 - Temperate forests
 - Boreal (Taiga)

2. Grassland Ecosystem

- Moderate rainfall
- Dominated by grasses
- Types:
 - Savannah
 - Prairie
 - Steppe

3. Desert Ecosystem

- Low rainfall
- Sparse vegetation
- Types:
 - Hot desert (Sahara)
 - Cold desert (Gobi)

4. Tundra Ecosystem

- Arctic & alpine regions

- Permafrost
- Mosses, lichens, dwarf shrubs

B. Aquatic Ecosystems

1. Freshwater

- Rivers, lakes, ponds, wetlands

2. Marine

- Oceans, seas, coral reefs
- Highest biodiversity

3. Estuarine

- Freshwater meets seawater
- Highly productive
- Brackish water species

C. Artificial Ecosystems

- **Urban ecosystems:** Cities, towns
- **Agricultural ecosystems:** Croplands, livestock farms

D. Specialised Ecosystems

- **Wetland ecosystems:** Marshes, swamps, bogs
- **Mountain ecosystems:** Altitudinal zonation, endemic species

MCQs

1. With reference to an ecosystem, consider the following statements:

- I. Gross Primary Productivity includes the total rate of photosynthesis.
- II. Net Primary Productivity represents biomass available to heterotrophs.
- III. Net Primary Productivity is always greater than Gross Primary Productivity.

Which of the statements given above are correct?

- A. I and II only
- B. II and III only
- C. I and III only
- D. I, II, and III

Answer: A

2. In an ecosystem, which of the following are classified as abiotic components?

- I. Temperature
- II. Soil texture
- III. Decomposers
- IV. Light intensity

Select the correct answer using the code given below:

- A. I and II only
- B. I, II, and IV only
- C. II, III, and IV only
- D. I, II, III, and IV

Answer: B

3. With reference to producers in an ecosystem, consider the following statements:

- I. Photoautotrophs use sunlight to synthesize organic matter.
- II. Chemoautotrophs derive energy from inorganic chemical reactions.
- III. Chemoautotrophs require chlorophyll for energy production.

Which of the statements given above are correct?

- A. I and II only
- B. II and III only
- C. I and III only
- D. I, II, and III

Answer: A

4. Consider the following processes involved in decomposition:

- I. Fragmentation
- II. Leaching
- III. Humification
- IV. Mineralisation

Which of the above are correct steps in the process of decomposition?

- A. I and II only
- B. I, II, and III only
- C. I, II, III, and IV
- D. II and IV only

Answer: C

5. In terrestrial ecosystems, a major fraction of energy flow occurs through:

- A. Grazing food chain
- B. Parasitic food chain
- C. Detritus food chain
- D. Microbial loop

Answer: C

6. Which of the following ecosystems generally show the highest net primary productivity?

- A. Deserts
- B. Tundra
- C. Tropical rainforests
- D. Temperate grasslands

Answer: C

Aspire with Ram IAS