

Introduction to Ecosystems

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Key concepts, components, and processes

1. What Is an Ecosystem?

Definition	Explanation
Ecosystem	A community of living organisms (plants, animals, microbes) interacting with one another and with the non-living (abiotic) environment in a defined area.
Scope	Can be as small as a pond or as large as a forest biome; the boundaries are set by the researcher's purpose, not by a hard physical line.
Dynamic	Ecosystems are constantly changing through energy flow, material cycles, and species interactions.

2. Major Components

Biotic (Living)	Abiotic (Non-living)
Producers (autotrophs) – plants, algae, cyanobacteria that convert solar energy into chemical energy (photosynthesis).	Sunlight – primary energy source.
Consumers – herbivores, carnivores, omnivores, and decomposers that obtain energy by eating other organisms.	Water – medium for biochemical reactions, transport, and habitat.
Decomposers – fungi, bacteria, detritivores that break down dead material, releasing nutrients back to the system.	Soil/ substrate – provides minerals, structure, and habitat for many organisms.
Microorganisms – bacteria, archaea, protists that drive nutrient cycling (e.g., nitrogen fixation).	Temperature & Climate – affect metabolic rates, distribution of species.
Keystone species – organisms that have a disproportionately large effect on ecosystem structure (e.g., sea otters in kelp forests).	Atmospheric gases – CO ₂ , O ₂ , N ₂ , etc., involved in photosynthesis, respiration, and nitrogen cycle.

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3. Energy Flow

1. Solar Radiation ? Primary Production

- Photosynthetic organisms capture sunlight, converting it to chemical energy (glucose).

2. Trophic Levels

- **1st level:** Producers (autotrophs).
- **2nd level:** Primary consumers (herbivores).
- **3rd level:** Secondary consumers (carnivores that eat herbivores).
- **4th level:** Tertiary/Quaternary consumers (top predators).

3. Energy Loss

- ~90% of energy is lost as heat at each trophic transfer (Second Law of Thermodynamics).
- Only ~10% passes to the next level ? pyramidal shape of energy pyramids.

4. Food Webs

- Interconnected feeding relationships; more realistic than simple linear food chains.

4. Matter (Nutrient) Cycling

Cycle	Core Process	Key Organisms/Agents
Carbon	Photosynthesis (CO ₂ ? organic C) ?	
	Respiration (organic C ? CO ₂) ?	Plants, animals, microbes,
	Decomposition ? Fossilization (long-term storage)	oceans
Nitrogen	N ₂ fixation ? Nitrification ? Assimilation ?	Nitrogen-fixing bacteria,
	Ammonification ? Denitrification (return to N ₂)	nitrifying bacteria, plants, fungi
Phosphorus	Weathering ? Uptake by plants ? Consumption ? Decomposition ? Sedimentation (slow return)	Soil microbes, plants, aquatic organisms
Water (Hydrologic) Cycle	Evaporation ? Condensation ? Precipitation ? Runoff/	