

UNIT 3 LECTURE 2

STRUCTURE AND FUNCTION OF ECOSYSTEM

SLIDE 1

Ecosystems are the basic functional unit of the environment. It is difficult to define what an ecosystem precisely is, but the following definition is acceptable:

An ecosystem is a more-or-less self-contained ecological entity, consisting of both organisms and their complete biotic (living) and abiotic (non-living) environment found in a particular place at a particular time.

STRUCTURE OF ECOSYSTEM

Ecosystem structure can be listed under the headings "abiotic" and "biotic".

Abiotic Components

Sunlight
Temperature
Water or moisture
Atmospheric Gases
Wind
Soil

Biotic Components

Primary producers
Herbivores
Carnivores
Omnivores
Detritivores

All of these vary over space/time

SLIDE 2

Abiotic Components

Sunlight

Light energy (sunlight) is the primary source of energy in nearly all ecosystems. It is the energy that is used by green plants (which contain chlorophyll) during the process of photosynthesis; a process during which plants manufacture organic substances by combining inorganic substances. Visible light is of the greatest importance to plants because it is necessary for photosynthesis. Factors such as **quality of light, intensity of light** and the **length of the light period (day length)** play an important part in an ecosystem.

Temperature

The distribution of plants and animals is greatly influenced by extremes in temperature for instance the warm season. The occurrence or non-occurrence of frost is a particularly important determinant of plant distribution since many plants cannot prevent their tissues from freezing or survive the freezing and thawing processes. The following are examples of temperature effects with ecosystems:

- (1) The opening of the flowers of various plants during the day and night is often due to temperature difference between the day and night;
- (2) Deciduous trees lose their leaves in winter and enter into a state of dormancy, where the buds are covered for protection against the cold;
- (3) In desert conditions there is a greater temperature variation between day and night and organisms have distinct periods of activity.
- (4) Seasonal changes have also a great influence on animal life in an ecosystem; torpor in winter is common in reptiles and some mammals, but a winter sleep occurs in bears; some animals collect fat or other resources during favourable periods (often summer and autumn) and become dormant (this is called hibernation), there are also animals that are dormant during warm and dry conditions and this is known as aestivation;
- (5) Seasonal movements occur in some animals; this phenomenon is called seasonal migration, examples of such animals are various marine animals like whales, penguins and marine turtles.

Water

Plant and animal habitats vary from entirely aquatic environments to very dry deserts. Water is essential for life and all organisms depend on it to survive in especially desert areas.

Atmospheric gases

The most important gases used by plants and animals are oxygen, carbon dioxide and nitrogen.

- **Oxygen** is used by all living organisms during respiration.
- **Carbon dioxide** is used by green plants during photosynthesis.
- **Nitrogen** is made available to plants by certain bacteria and through the action of lightning.

Wind

Winds or air currents arise on a world-wide scale as a result of a complex interaction between hot air expanding and rising (convection) in the mid latitudes. Winds carry water vapour, which may condense and fall in the form of rain, snow or hail. Wind plays a role in pollination and seed dispersal of some plants, as well as the dispersal of some animals, such as insects. Wind erosion can remove and redistribute topsoil, especially where vegetation has been reduced.

Soil

These factors include **soil texture**, **soil air**, **soil temperature**, **soil water**, **soil solution** and **pH**, together with **soil organisms** and **decaying matter**.

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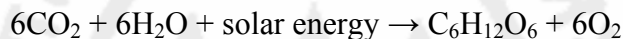
Biotic Components

The Biotic environment involves all the living organisms that come regularly into contact with each other, how they interact and their mutual influences. An ecosystem consists basically of the following:

Organisms that make up the biotic factors of an ecosystem are usually classified as **autotrophs** and **heterotrophs**, based on how they get their food or organic nutrients they need to survive.

Autotrophs (producers)-are organisms that can manufacture the organic compounds they need as nutrients from simple inorganic compounds obtained from their environment. In most terrestrial ecosystems, green plants are the producers. In aquatic ecosystems, most of the producers are phytoplankton, consisting of various species of floating and drifting bacteria and protist.

Most producers make their organic nutrients they need through **photosynthesis**. The overall net chemical change can be summarized as follows:



Some producers, mostly specialized bacteria, can extract inorganic compounds from their environment and convert them into organic nutrient compounds without the presence of sunlight. This process is called **chemosynthesis**.

Consumers – This component is made up of organisms, which cannot make organic compounds from inorganic substances. They are dependant upon autotrophic organisms and are the consumers or heterotrophic organisms in an ecosystem. The consumers are further subdivided on the basis of their diet into:

- o **Herbivores** or plant eaters, which are the primary consumers e.g. cows, giraffes, elephants, etc;
- o **Carnivores** or meat eaters which are the secondary consumers; some carnivores are called predators (e.g. lions, leopard, fish eagle, etc) which catch their prey, kill it and then eat it; others are called scavengers (e.g. vultures) which usually eat what is left by the predators;
- o **Omnivores** eat plant and animal material and can be primary, secondary and tertiary consumers simultaneously; a human being is an example of an omnivore.

There are several classes of consumers, depending on their food source.

1. **Primary consumers** (herbivores) feed directly on plants or other producers.
2. **Secondary consumers** (carnivores) feed only on primary consumers.
3. **Tertiary or higher level consumers** feed only on animal-eating animals.

4. **Omnivores** can eat both plants and animals. Examples are pigs, rats, cockroaches, and humans.
5. **Detritivores** (decomposers and detritus feeders) live off of detritus, parts of dead organisms and castoff fragments and waste of living organisms. These are usually saprophytic organisms such as bacteria and fungi and that obtain their energy by decomposing the corpses and other dead parts of organisms. They break down all the organic material of the bodies of producers and consumers into inorganic materials that are restored to the soil or water to be reused by producers.

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Types of Species Found in Ecosystems

1. **Native species** – normally live and thrive in a particular ecosystem.
2. **Immigrant species** – migrates into an ecosystem or which are deliberately or accidentally introduced into an ecosystem by humans.
3. **Indicator species** – serves as a early warning that a community or an ecosystem is being degraded.
4. **Keystone species** – plays a role affecting many other organisms in an ecosystem. The loss of a keystone species can lead to sharp population drops and extinction of other species that depend on it for certain services.

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Principal Ways Species Interact

1. **Interspecific competition** – competition from one or more species for one or more to the limited resources it needs.
2. **Predation** – an individual organism of one species, known as a predator, feeds on parts or all of an organism of another species, the prey, but does not live in or on the prey.
3. **Parasitism** – A parasite is a consumer that feeds on another living organism (its host) by living on or in its host organism for all or most of the host's life.
4. **Mutualism** – a type of interaction in which both participating species generally benefit.
5. **Commensalism** – one species benefits, while the other is neither helped nor harmed to any great degree.

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FUNCTIONS OF ECOSYSTEM

An understanding and appreciation of the ecosystem as process or processes – **energy flow, nutrient cycling, water cycle, and succession** – allows us to work with, rather than against, the complexity of the ecosystem.

Energy Flow

Solar energy flow is not a cycle, but a flow from the sun to the biosphere. It is one of the four basic ecosystem processes through which we can begin to perceive the ecosystem as a whole.

Energy flow is the capture of solar energy through photosynthesis, which is the process used by green plants to convert radiant energy from the sun into organic compounds such as glucose. A small fraction of the solar energy striking the earth is captured by photosynthesis and stored as chemical energy in organic compounds.

With the known exception of organisms that live along thermal vents in the deep ocean floor, all organisms--including humankind--nurture themselves, directly or indirectly, on the products of photosynthesis.

At each stage in the food chain or energy pyramid, organisms turn the energy into growth, heat, and activity. Often forms of energy are either interchangeable or replaceable. This is true of energy in thermal, mechanical, or electrical forms. But there is no replacement for photosynthetic or biological energy.

Nutrient Cycling

Nutrients, the chemicals essential to life, are cycled in the ecosphere and in the mature ecosystems. In these cycles, nutrients move from the environment, through organisms, and back to the environment.

Inorganic nutrients occur in limited quantities and their loss to an ecosystem or retention and re-use is of great importance. The cycles of chemical elements in an ecosystem are known as nutrient cycles. If there is no loss to the ecosystem the cycle is said to be a 'perfect cycle' and if loss does occur the cycle is said to be 'imperfect'. The decomposers play an important role in these cycles because they break down dead organisms and make the nutrient components available once more to other organisms.

(1) The Carbon Cycle – All organic compounds contain carbon and the most important sources of all inorganic carbon is carbon dioxide in the atmosphere.

(2) Nitrogen cycle – Nitrogen is an element essential in all organisms, occurring in proteins and other nitrogenous compounds, e.g. nucleic acids. Although organisms live in nitrogen-rich environments (78% of the atmosphere is nitrogen) the gaseous forms of nitrogen can only be used by certain organisms. Free nitrogen in the atmosphere is mainly fixed by two groups of bacteria, *Azotobacter* and *Clostridium*. These two cycles emphasize the mutual interdependence of producers, consumers and decomposers in an ecosystem.

(3) Phosphorus Cycle – the phosphorous cycle begins when phosphorous compounds are leached from rocks and minerals over long periods of time. As phosphorous has no

atmospheric form, it is usually transported in aqueous form. Inorganic phosphorous is taken by producer organisms, incorporated into organic molecules, and then passed on to consumers. It is returned to the environment by decomposition. Deep sediments of the ocean are significant phosphorous sinks of extreme longevity.

(4) The Water Cycle-Water is an important medium for the movement of nutrients into and out of ecosystems. The sun's rays cause fresh water to evaporate from seawater and the salts are left behind. Vaporized fresh water rises into the atmosphere, cools and falls as rain over the oceans and the land. A smaller amount of water also evaporates from bodies of fresh water. Since land lies above sea level, gravity eventually returns all fresh water to the sea, but in the meantime, it is contained within the standing water bodies such as lakes and ponds, flowing water (streams and rivers) and groundwater. When rain falls, some of the water sinks or percolates into the ground and saturates the earth to a certain level. The top of the saturation level is called the groundwater table or simply the water table.

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Succession is a real process. A barren area will be invaded by pioneer plants, which often do not persist; they are joined and their place is taken by other plants. The early years will likely show a rapid change of vegetation until a more stable ecosystem develops.

Each phase of vegetation modifies the habitat, creating opportunities for other plants that can exploit the resources better. Barring disaster, the productivity of the system will tend to increase. The vegetation that develops may resemble the characteristic biome of the area even if the mix of species varies

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Examples of succession - All areas, even the ponds tended towards a terrestrial plant community dominated by trees.

SLIDE 9

Example of succession - On bare rock the first plants will be lichens. As soil builds up the surface can hold water so that mosses become established.