

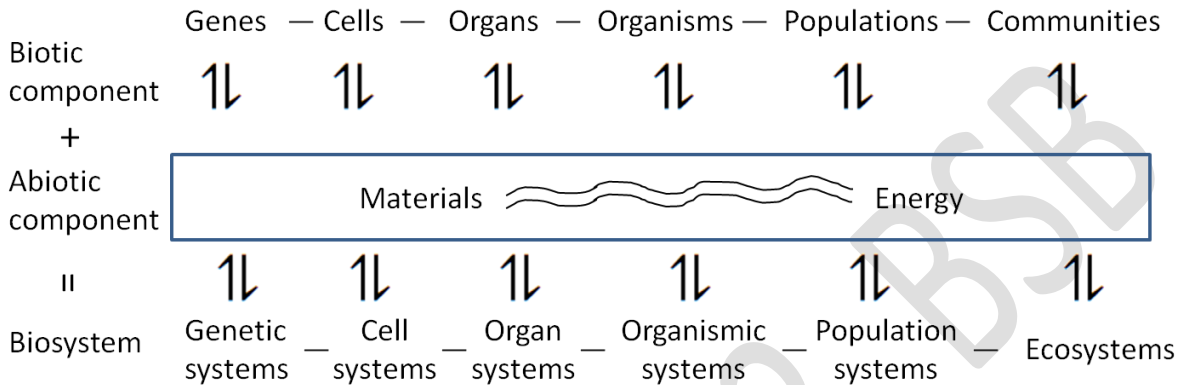
Ecology (Definition)

“The study of the relation of organisms or groups of organisms to their environment”

Or “The science of the interrelations between living organisms and their environment”

Or “The totality or patterns of relations between organisms and their environment”

Level of organization



- **System**
 - Regularly interacting and interdependent components forming a unified whole (Bio system)
- **Population**
 - Denote a group of individual organisms of the same species in a given area
- **Community**
 - Group of populations of different species in a given area
- *Ecological system is the whole biotic community in a given area plus its abiotic environment*

Subdivisions of Ecology

- **Taxonomic features**
 - Plant ecology
 - Animal Ecology
 - Avian ecology, Insect ecology, Bacterial ecology, Fungal ecology, Behavioural ecology, Mycorhyza ecology
- **Habitat**
 - Study of ecology based on the basis of the habitats and their interactions and the subsequent effects upon the organisms.
- **Organisation level**
 - Autecology
 - The study of the individual organisms
 - Synecology
 - The study of groups of organisms which are associated together as a unit

Types of synecology

- **Populations ecology**
 - Deals with study of pure rains of individuals belonging to a single species. E.g. Population Size, growth rate, death rate, survival rate etc.
- **Community ecology**
 - Study of groups of individuals belonging to different species of plants as well as animals.
- **Biome Ecology**
 - Study of interactions among different communities of a particular area.
- **Ecosystem ecology**
 - Deals with circulation of energy and nutrients among biotic and abiotic components of ecosystems.

Concept of ecosystem

- The system resulting from the integration of all living and non-living factors of the environment
- Based on interactions and exchange of materials
- Communities in a given area interact with physical environment. This flow of energy leads to trophic structure, biotic diversity and material cycle
- It is an overall integration of a whole mosaic of interacting organisms and their environment
- Ecosystem is the highest level of ecological integration which is energy-based and this functional unit is capable of energy transformation, accumulation and circulation

Types of ecosystem

- **Natural Ecosystems**
 - Self operating under natural conditions; no interference by man
- **Terrestrial ecosystems** e.g. forests, grassland
- **Aquatic ecosystems**
 - **Freshwater ecosystem**
 - **Lotic** – Running water e.g. river, stream, spring etc.
 - **Lentic** – Standing water e. g. lake, pond, well swamp etc.
 - **Marine ecosystems** e.g. ocean, sea etc.
- **Artificial Ecosystems**
 - Managed and maintained by man. E.g. cropland

Different aspects of ecosystem

Structural (architectural) aspect

- The composition of biological community including species, numbers, biomass, life history etc.
- The quantity and distribution of non-living materials like nutrients, water etc.
- The conditions of existence such as temperature, light etc.

Functional (working process) aspect

- The rate of energy flow
- The rate of material (nutrient) cycles
- Biological regulation including both regulation of organisms by environment (photoperiodism) and regulation of environment by the organism (nitrogen fixing organism)

Abiotic (non-living) components

- Includes inorganic substances (C, N, O, P, S etc.), inorganic chemicals (chlorophyll), organic materials (proteins, carbohydrates, lipids etc.)
- They are present either in biomass or in the environment

Biotic (living) components

- These are the trophic (nutritional) structure of ecosystem (trophic –feeding)
- Based on nutritional relationship they are distinguished

Autotrophic or self-nourishing components

- Use light energy to make food from simple inorganic substances (H_2O , CO_2) Photosynthesis, Known as producers
- Eg. Green plants, algae, photosynthetic bacteria

Heterotrophic or other-nourishing components

- Utilize rearrange and decompose the complex materials produced by the autotrophs, Known as consumers
- Eg. Fungi, animals, humans

Macro consumers (Phagotrophs)

- They feed on other organic and particulate organic matter
- Herbivores (feed on plants) Primary consumer
- Carnivores or predators (feed on other animals) secondary
- Omnivores (feed on plants and animals) tertiary consumer

Micro consumers (Saprotrophs)

- They are microscopic organisms
- Bacteria, actinomycetes, fungi
- Breakdown complex compounds of dead or living protoplasm
- Absorb some of the decomposed / breakdown products
- Release inorganic nutrient in to environment

Functional territory of nature

- Trophic level

The trophic structure of an ecosystem is one kind of producer-consumer arrangement where each step or level is know as trophic level

- Standing crop

The amount of living material in different trophic levels or in a component of population is known as standing crops

Expressed as "*number of organisms per unit area*"

Biomass i.e. *organism mass in unit area*

Measured as living weight, ash-free dry weight, carbon weight calories

Ecological pyramids

An ecological pyramid (also trophic pyramid or energy pyramid) is a graphical representation designed to show the biomass or biomass productivity at each trophic level in a given ecosystem.

Pyramids of numbers

Depicts number of individual organisms at each trophic level

Pyramids of Biomass

Showing the total dry weight, calorific value or other measure of the total living material

Pyramids of Energy

Depicts the rate of energy flow and/or productivity at successive trophic levels (**always upright**)

Pyramids of numbers

In grassland ecosystem it is upright in shape

This pyramid consists of a plot of relationships between the number producers, herbivores (primary consumers), first level carnivore (secondary consumers), second level carnivore (tertiary consumers) etc.

In forest ecosystem it is partially upright in shape

This pyramid consists of a plot of relationships between the number of producers, herbivores (primary consumers), first level carnivore (secondary consumers), second level carnivore (tertiary consumers) etc.

In Parasitic food chain it is always inverted in shape

This pyramid consists of a plot of relationships between the number of producers, herbivores and carnivores (primary consumers), parasites (secondary consumers), hyper parasites (tertiary consumers) etc.

Pyramids of numbers

Advantages to this pyramid	Disadvantages to this pyramid
Easy to count.	Ignores sizes of organisms.
No organisms killed.	Difficult to convert grass plant leaves to numbers which are worth comparing to others.
	Do not represent the true picture of food chain.
	Do not indicate the relative effect of geometric, food chain and size factor of the organisms.
	Since many communities live with different type of food chains in the same environment it is difficult to represent in same numerical scale.

Pyramids of biomass

- It gives a rough picture of the overall effect of food chain relationships on the ecological group
- It shows the quantitative relationship of standing crop
- Measured as dry weight in grams per sq. metre

1. In Lake ecosystem

Grass form base of the pyramid, upright in shape

2. In Coral reef ecosystem

Large trees form base of the pyramid, partially upright in shape

3. In pond ecosystem

Plants form base of the pyramid, always inverted in shape

Pyramids of energy

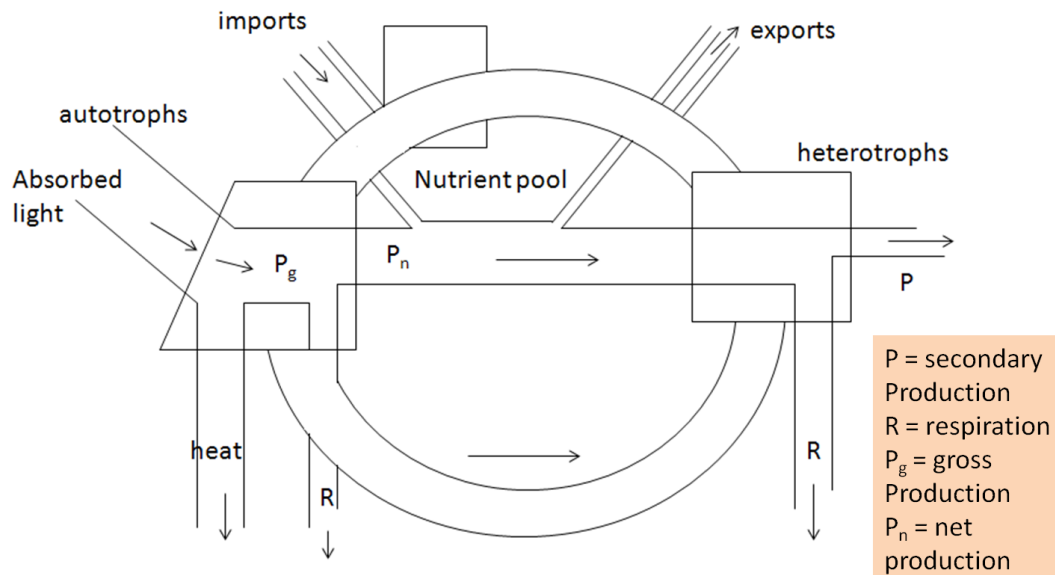
- It gives the best overall picture of the nature of an ecosystem
- The number and weight of organism at any level depends on the rate at which food is produced
- Unlike the other two cases this deals with rates of passage of food mass through the food chain

- Its shape is not affected by the size and metabolic rate of individuals

Functional aspects of Ecosystem

- Energy circuits
- Food chains
- Time and space diversity patterns
- Movement of nutrients (biogeochemical cycle)
- Development and evolution
- Control (cybernetics)

Community respiration



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Functional aspects of Ecosystem

Functional aspects include movement of materials and energy flow in an ecosystem

The two ecological processes of **energy flow** and **material cycling** is the main cause behind ecosystem dynamics

Energy flow in an ecosystem (unidirectional)

Nutrients flow in an ecosystem (cyclic in nature)

Mainly involves biogeochemical cycles.

Productivity concept of ecosystems

Productivity of an ecosystem is defined as “the rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producer organisms in the form of organic substances that can be used as food materials”

The amount of organic matter accumulated in any unit time is called productivity.

The different types of Productivity are

1. **Primary productivity**
2. **Secondary productivity**
3. **Net productivity**

The different types of Productivity are

1. **Primary productivity**
 - *“The rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producer “e.g. green plants, phytoplankton*
2. **Secondary productivity**
 - *“The rates of energy storage at consumer levels”*
 - It is dynamic i.e. keeps moving from one organism to another
 - Consumers assimilate and not produce (Odum)
3. **Net productivity**
 - *“The rate of storage of organic matter not used by the heterotrophs (consumers) during the unit period of time”*
 - It is the rate of increase of biomass of the primary producers which has been left over by the consumers
 - It is expressed as production of C g/m²/day.
 - Is also called as net community productivity

The different types of primary Productivity are

1. Gross primary productivity
 - *The total rate of photosynthesis including the organic matter used up in metabolism for a particular period of time (total photosynthesis or total assimilation)*
 - Measured as chlorophyll content (chl/g dry weight /unit area or photosynthetic number (amount of CO₂ fixed /g chl/hr)
2. Net primary productivity
 - *The rate of storage of organic matter in excess of metabolic utilisation by the autotrophs during the period of measurement (apparent photosynthesis or net assimilation)*
 - Net = Gross photosynthesis – Respiration (metabolism), death etc.

Food chains

“The transfer of food energy from the producer through a series of organisms herbivores, carnivores, decomposers with repeated eating and being eaten “is called food chain.

In grassland ecosystem

This food chain consists of relationships between the producers, herbivores (primary consumers), first level carnivore (secondary consumers), second level carnivore (tertiary consumers) etc.

Food chains are mainly of two types

1. Grazing food chain
2. Detritus food chain

Grazing food chain

Grazing food chain starts with green plant base, goes to grazing herbivores (organism that eat plants and their predators) and finally to the carnivores (flesh eaters). It also depends on capture of energy by the autotrophs and the movement of captured energy to herbivores

Detritus food chain

This food chain starts from dead organic matter and then goes on to detritus-feeding organisms (detritivores) and their predators.

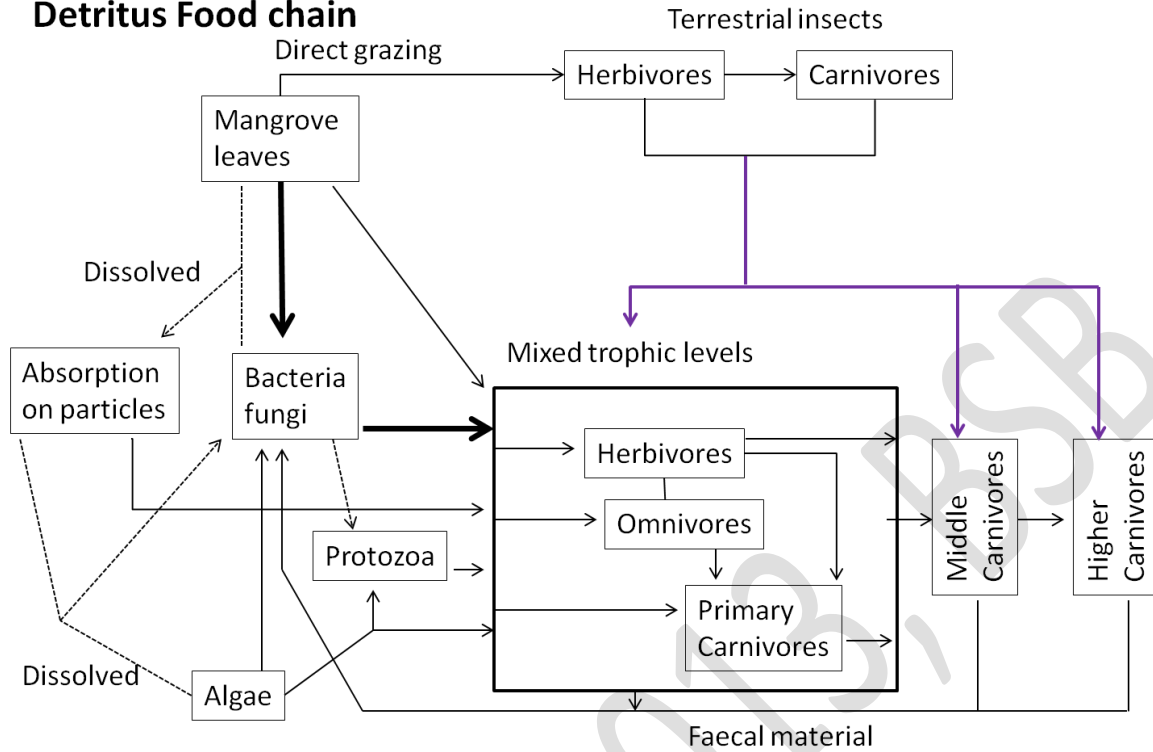
They are less dependent of solar energy.

Detritus consumers are mixed groups with respect to trophic level

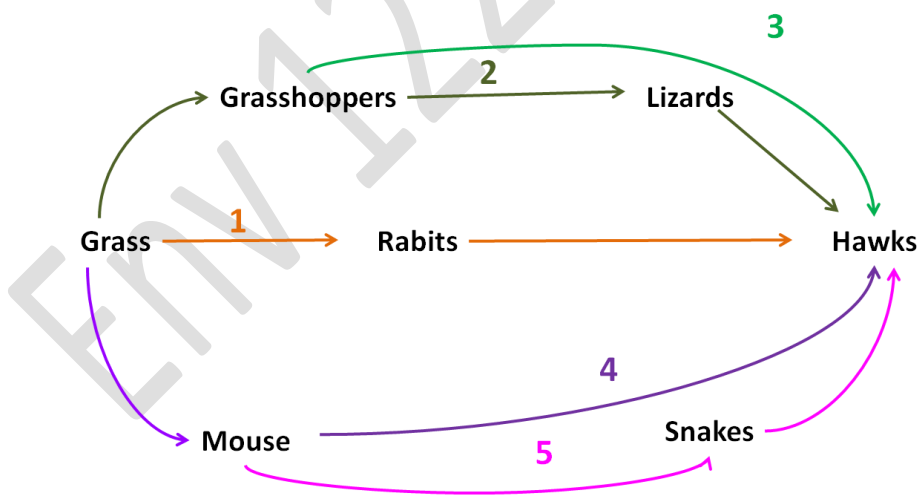
1. Grazing insects
2. Saprotrophs (fungi, bacteria, protozoa)
3. Coprophagy (coprophagy is the consumption of feces) (crab, copepod, insect)

Detritus feeders obtain some energy from plants, mostly from microorganism (secondarily), some through carnivores (tertiary)

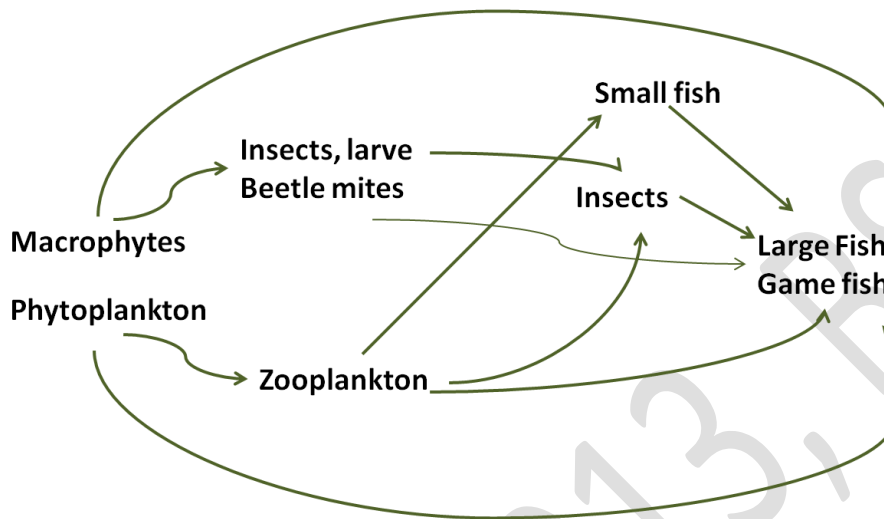
Detritus Food chain



Food web in grassland ecosystem



Food web in pond ecosystem



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Food webs

- Food webs are important in maintaining the stability of an ecosystem. If one link is reduced that would cause increase of population of downstream and decrease of population of upstream. It will ultimately disturb the balance.
1. **Length of the food chain:** Diversity in the organisms based on their food habits would determine the length of the food chain.
 2. **Substitutes at various points of consumers in the chain:** more the substitutes more would be the networks that make the ecosystem stable.

Ecological Energetics

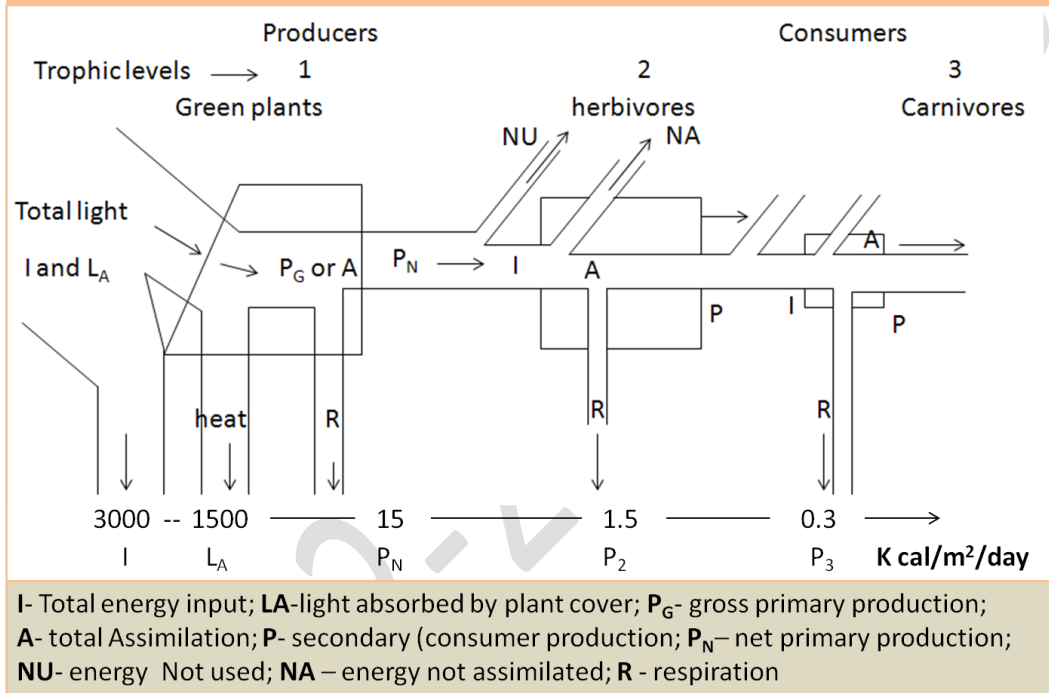
- The branch of ecological science that deals with the quantity, utilisation, behaviour or energy and energy flow in a ecosystem is called ecological energetics.
1. Energy circuits
 2. Quantity of solar energy reaching an ecosystem
 3. Quantity of energy utilised for photosynthesis by producers
 4. Quantity of energy flow path in the trophic components

Energy flow in Ecosystem

- The behaviour of energy in an ecosystem is termed as energy flow. It is unidirectional
- There is progressive decrease in energy content at each trophic level
- *First law of Thermodynamics:*

- Energy can neither be created nor destroyed, it can only be transformed from one to another
- Second law of Thermodynamics:*
- The energy transfer is always accompanied by dispersion of energy into unavailable heat (entropy)

Flow diagram showing trophic levels



Ecological interactions

Population of two species are always interacting with each other from the view point of nutrient resources, habitat and protection.

Two species can interact in many ways.

- “0” no interaction
- “+” population growth/beneficial/favourable
- “-” population inhibition/harmful/adverse

Ecological interactions

Species

<i>Type of interaction</i>	<i>1</i>	<i>2</i>	<i>General nature of interaction</i>
1. Neutralism	0	0	Neither population affects the other
2. competition: direct interference type	-	-	Direct inhibition of each species by the other
3. Competition: Resource use type	-	-	Indirect inhibition when common resource is in short supply
4. Amensalism	-	0	Population 1 inhibited, 2 not affected
5. Parasitism	+	-	Population 1 (parasite) < Population 2 (host)
6. Predation	+	-	Population 1 (predator) > Population 2 (prey)
7. Commensalism	+	0	Population 1 (commensal) benefits, Population 2 (host) not affected
8. Protocooperation	+	+	Interaction favourable to both but not obligatory
9. Mutualism	+	+	Interaction favourable to both but obligatory

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