

PUC Ist year – Semester - II

Unit no VI: Ecology and Environment

Module: 33. Energy flow in the Ecosystem, Food chains, Food web and Ecological Pyramids.

I. Energy flow in Ecosystem:

Energy can be defined as the capacity to do work. The existence of living world depends upon the flow of energy and circulation of materials through the ecosystem. The energy is required for the performance of all the life activities. The source of energy in the atmosphere is the solar energy.

The expenditure and storage of energy is described by two laws of thermodynamics. The first law of thermodynamics called law of conservation of energy states that “energy is neither created nor destroyed and is converted from one form to another. For example, solar energy changes into energy of food and heat. The second law of thermodynamics states that “when ever energy is transformed from one kind to another, there is an increase in entropy and a decrease in the amount of useful energy”. For example, when energy in the form of food is transferred from one organism to the next, some energy is lost at every step as heat.

Plants store the energy in the form of potential energy in food stuff by producers. When an herbivore animal eats a plant and these organic compounds are oxidized, the energy liberated is just equal to the amount of energy used in synthesizing the substances (first law of Thermodynamics), but some of the energy is heat and not useful energy (second law of Thermodynamics). If this animal in turn is eaten by another one, along with transfer of energy from a herbivore to carnivore, a further decrease in useful energy occurs. As the second animal (Carnivore) oxidizes the organic substances of the first (Herbivore) to liberate

energy to synthesize its own cellular constituents. It is evident that at each step in the transfer of energy from one trophic level to another a large amount of energy is converted into heat and never returns back to the ecosystem. Such transfer of energy from organism to organism sustains the ecosystem. From the above factors it is clear that energy flows in a single direction, and keeps on decreasing at every level.

II. Food Chains and Food web:

The transfer of food energy from the producers, through a series of organisms (herbivore to Carnivores to decomposers) with repeated eating and being eaten is known as a food chain.

Plant → herbivore → carnivore

This is one form of trophic relation ship in which plants are producers, herbivores are primary consumers and the carnivores secondary consumers. There may exist tertiary consumers also. The plants are said to be at the first trophic level. The herbivores represent second trophic level. Similarly, primary carnivores (animals those feed on herbivore) constitute the third trophic level where as secondary carnivores (eg: Large fish, man etc) constitute the fourth trophic level in an ecosystem. Thus the energy is transferred through series of stages in an ecosystem and this is explained as Food chain.

$$\begin{array}{ccccccccc}
 T_1 & & T_2 & & T_3 & & T_4 & & T_5 \\
 \text{Producers} & \longrightarrow & \text{Herbivores} & \longrightarrow & \text{Primary} & \longrightarrow & \text{Secondary} & \longrightarrow & \text{Tertiary}
 \end{array}$$

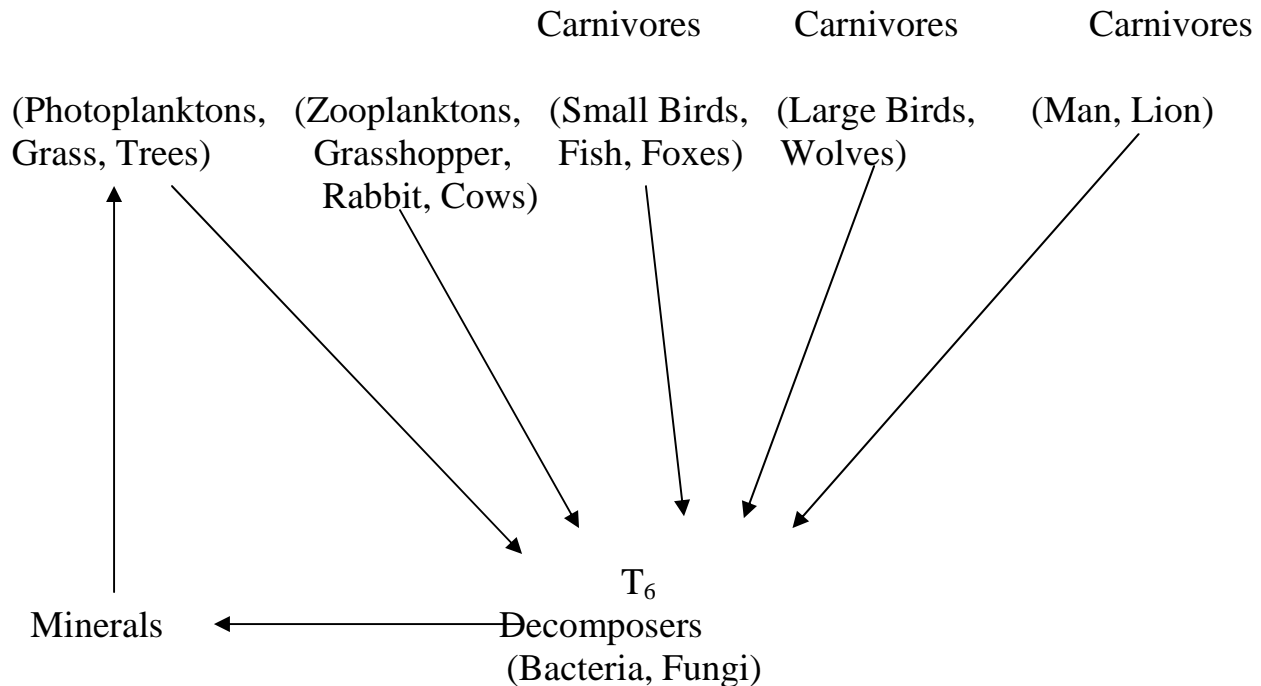


Fig: Trophic Levels

There are two types of food chains found in terrestrial ecosystem. They are

- Grazing food chain and
- Detritus food chain

a) Grazing food chain: This food chain begin with a green plant which is the original source of all food and goes through smaller to larger animals, i.e., grazing herbivores to carnivores. Ecosystems with such type of food chains are directly dependent on an influx of solar radiation. Most of the ecosystems in nature follow this type of food chain. Few examples of grazing food chain are as follows.

Type of	Producer	Herbivores	Primary	Secondary	Tertiary
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Ecosystem			Consumer	Consumer	Consumer
A. Grassland Ecosystem	1. Grasses	→	Insects	→	Frogs
				→	Snakes
					Predatory Birds
	2. Grasses	→	Rats and Mice	→	Snakes
					Predatory Birds
	3. Grasses	→	Rabbit	→	Fox
					Wolf
					Lion
B. Pond Ecosystem	Phytoplankton	→	Zooplanktons	→	Small Fishes
					Large Fishes
					Predatory Birds
C. Forest Ecosystem	Trees	→	Phytophagous insects, Herbivore Mammals	→	Lizards
					Birds
					Foxes
					Lion
					Tiger etc.

Fig: Grazing type Food Chain

b) Detritus food Chain:

The organic wastes, disintegrated dead bodies of plants and animals are called detritus. The detritus eating organisms are detritivores. The detritivores are bacteria, algae, fungi, protozoans, nematodes, annelids, arthropods, molluscs, ducks etc. This type of food chain goes from dead organic matter into microorganisms and then to organisms.

This can be represented as follows.

Detritus	Detritivores	Detritivore Consumers	small Carnivores	Large Carnivores
Mangrove	Fungi,	Insect Larvae	Minnows	Large Fish
Fallen Leaves	bacteria	Certain Crustaceans	small	Fish eating
And	and	Molluscs and	game Fish	Birds
Dead bodies	Protozoans	Fishes	etc.	

Fig: Detritus Food Chain

Such ecosystems are thus less dependent on direct solar energy.

Food web: We have studied in food chain that in an ecosystem various food chains appear in a simple linear sequence. But in an ecosystem it is not so simple. Usually each organism feeds on two or more different kinds of organisms and is in turn eaten by two or more different animals. This means that there is an interaction and inter connection between different food chains. This interconnection of number of food chains forms a food web. So a food web can be defined as a network of food chains which becomes inter connected at different trophic levels so as to form a number of feeding connections amongst different organisms of a biotic community. Food webs are very important in maintaining the stability of an ecosystem in nature.

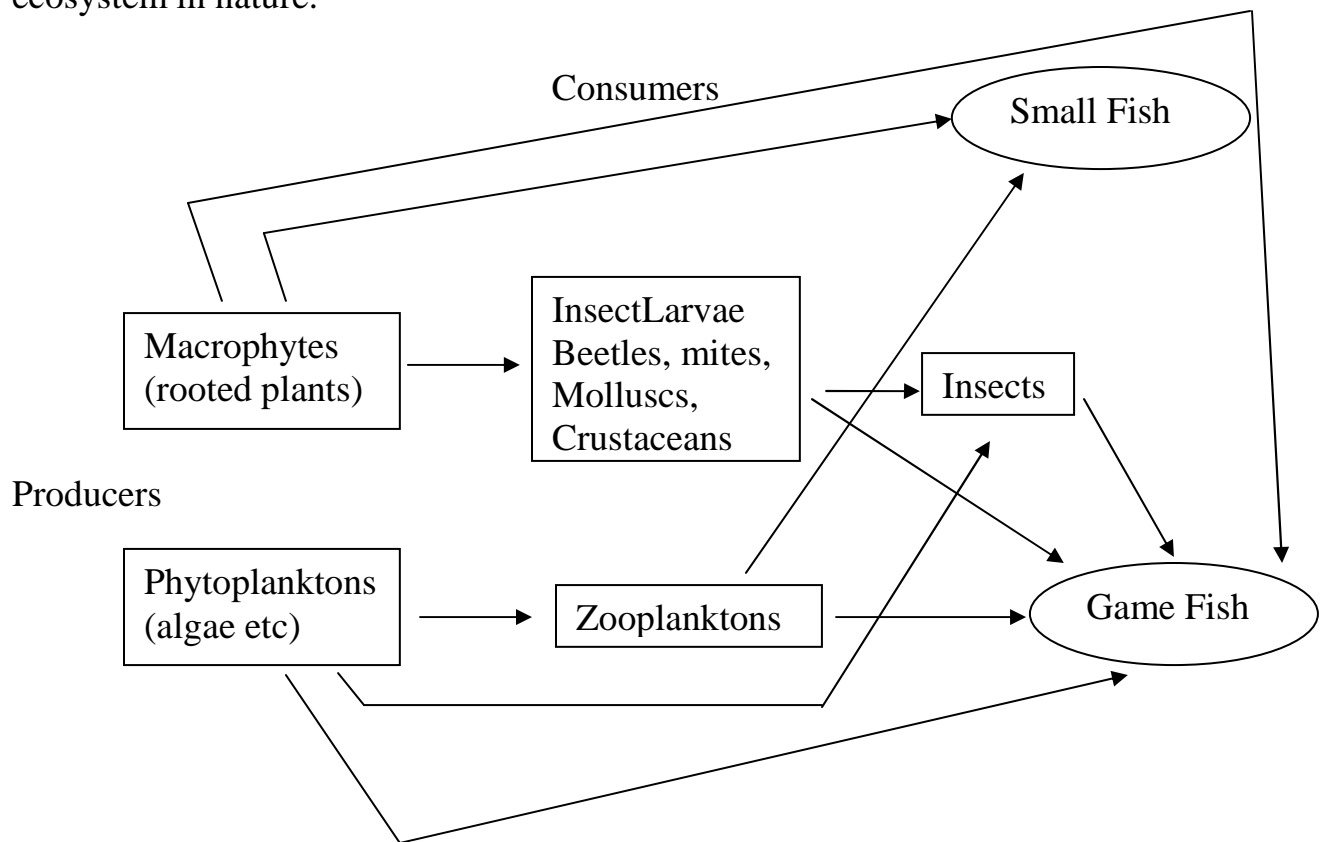


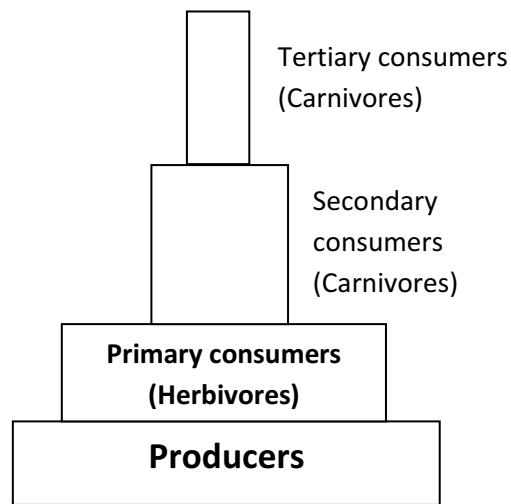
Fig: Food Web in Pond

Ecological Pyramids:

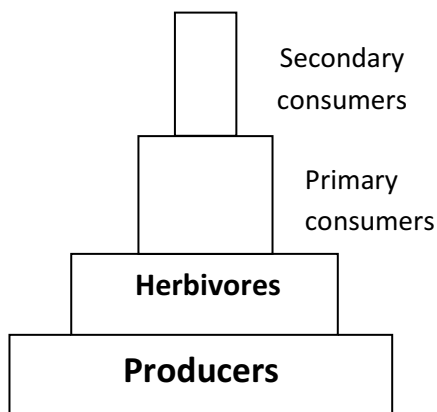
An ecological pyramid is a graphic representation of an ecological parameter like number, biomass or energy at different trophic levels in a food chain in an ecosystem. Pyramid is a conical structure and in ecological pyramid the first trophic level forms the base and the successive trophic levels above the base makes up the apex. Ecological pyramids are classified into three types depending upon their nature.

1. Pyramid of number
2. Pyramid of biomass
3. Pyramid of energy

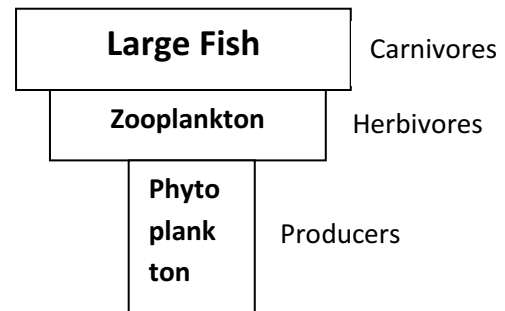
1. Pyramid of number: It is graphic representation showing the arrangement of number of individuals of different trophic levels in a Food chain in an ecosystem. We find that the largest number is of producers and the number keeps on decreasing as we move forward in the food chain. For example in a grass land ecosystem, the producers which are mainly grasses, are always maximum in number. This number then shows a decrease towards the apex, as the primary consumers (herbivores) like rabbits, mice etc, are lesser in number than the grasses; the secondary consumers, snakes and lizards are lesser in number than the rabbit and mice. Finally, the top (tertiary) consumer's hawks or other birds are less in number. Thus, the pyramid becomes upright.



2. Pyramids of biomass: Biomass may be defined as the total weight of dry matter present in the ecosystem at any one time. By using the weight of organisms in the different trophic levels a pyramid of biomass results. Pyramid of biomass is a graphic representation of biomass present per unit area in different trophic levels. In grass land and forest ecosystem, there is a gradual decrease in biomass of organisms at successive trophic levels from the producers to the carnivores. Thus the pyramid is upright. But in pond ecosystem, producers are small organisms therefore, biomass shows an increasing tendency. Thus making the pyramid inverted in shape.



Grass Land



Pond

Pyramid of Energy: It is a graphic representation of amount of energy trapped per unit time and area in different trophic levels of a food chain.

This pyramid represents the number of calories transferred from one trophic level to the next. This pyramid is always upright as the energy that flows always decreases with every trophic level. It is maximum in producers and least in carnivores.

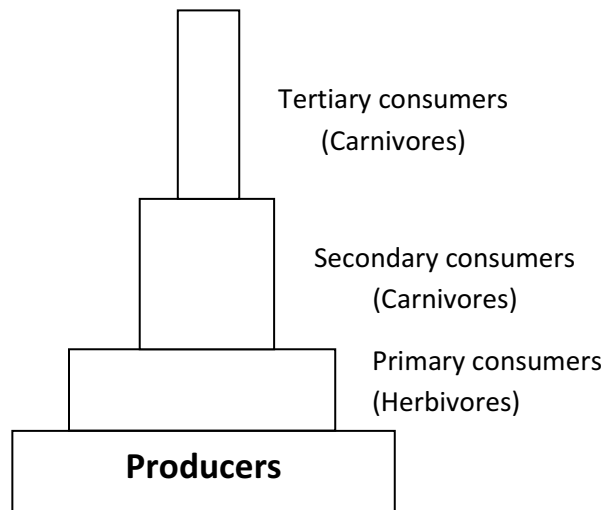


Fig: Pyramid of energy K. cal per unit area within unit time, season or years in any ecosystem.

Check Points

- Sun is the only source of energy for all living organisms.
- Energy flows in a single direction and keeps on decreasing at every level.
- Food chain consists of a series of a group of organisms called trophic levels in which there is repeated eating and being eaten by so that the energy can be transmitted from one trophic level to the next.
- Grazing food chain starts from the green plants goes to grazing herbivores.
- Grazing food chain directly dependent on an influx of solar radiation.

- Detritus food chain goes from dead organic matter into microorganisms and then to organisms.
- Detritus food chain is less dependent on direct solar energy but depend chiefly on the influx of organic matter produced in another system.
- Food chains are inter connected and inter locked to form food web.
- Graphic representation of trophic structure is called pyramid.
- Pyramid of numbers showing the number of individual organisms at each level.
- Pyramid of biomass showing the total dry weight of living matter.
- Pyramid of energy showing the rate of energy flow at successive trophic levels.

Glossary:

Entropy: A measure of the amount of energy unavailable for work in a thermodynamic system.

Object Type Questions:

1. Green plants constitute

- A. **1st Trophic level** B. 2nd Trophic level C. 3rd Trophic level
D. 4th Trophic level

2. The pyramid of numbers in a grass land ecosystem is

- A. **Upright** B. Linear C. Inverted D. Irregular

3. Inverted pyramid of Biomass is generally found in

- A. Grass land B. Forest **C. Pond** D. All

4. Inter locking network of food chains is called

- A. Pyramid B. Biomass **C. Food web** D. None

5. Graphic representation of trophic structure is called
A. Food chain B. Food web **C. Pyramid** D. Ecosystem
6. The simple chain of eating and being eaten away is known as
A. **Food chain** B. Food web C. Ecosystem D. Pyramids
7. The top of ecosystem is occupied by
A. Producers B. Herbivores **C. Carnivores** D. All
8. Pyramid of Biomass is
A. Showing the total dry weight of living matter
B. Showing the number of individual organisms at each level
C. Showing the rate of energy flow at successive trophic levels
D. None of the above.
9. In a food chain, the graph showing the amount of living matter in different trophic levels is called
A. Pyramid of energy
B. Pyramid of Biomass
C. Pyramid of numbers
D. None of these
10. Pyramid of energy is always
A. Inverted **B. Upright** C. Spindle Shaped D. Cup - shaped
11. Green Plants constitute
A. Ist trophic level
B. IInd trophic level
C. IIIrd trophic level
D. IVth trophic level
12. The flow of energy among various trophic levels of an ecosystem is
A. Unidirectional B. Bidirectional C. Multidirectional D. Circular

13. Detritus food chain starts from

- A. Algae
- B. Bacteria**
- C. Protozoan
- D. Viruses

14. The flow of energy in an ecosystem can be explained with the help of

- A. Hardy – Weinberg law
- B. Law of Thermodynamics**
- C. Law of conservation of energy
- D. Blackman's Law of limiting factors

Short Answer Questions

1. What is Food web?
2. Describe Detritus food chain?
3. Describe Pyramid of energy?
4. What are Pyramids?

Long Answer Questions

1. Describe the energy flow in an ecosystem?
2. What is food chain. Describe the different types of food chain?
3. Describe Ecological pyramids?