ECOSYSTEMS

1. CONCEPT OF ECOSYSTEM.

Various kinds of life supporting systems like the forests, grasslands, oceans, lakes, rivers, mountains, deserts.

Living entities interacting with their surroundings exchanging matter and energy.

How do they influence each other and regulate their stability are the questions that are answered by Ecology.

Ecology deals with the study of organisms in their natural home interacting with their surroundings.

An ecosystem is a self-regulating group of biotic communities of species interacting with one another and with their non-living environment exchanging energy and matter. Now ecology is often defined as "the study of ecosystems".

An ecosystem is an integrated unit consisting of interacting plants, animals and microorganisms whose survival depends upon the maintenance and regulation of

their biotic and abiotic structures and functions. The ecosystem is thus, a unit or a system which is composed of a number of sub-units, that are all directly or indirectly linked with each other. They may be freely exchanging energy and matter form.

2. ECOSYSTEM CHARACTERISTICS.

Ecosystem show large variations in their size, structure, composition etc., However, all the ecosystems are characterized by certain basic structural and functional features which are common.

STRUCTURAL FEATURES:

Composition and organization of biological communities and abiotic components constitute the structure of an ecosystem.

1. Biotic Structure:

The plants, animals and microorganisms present in an ecosystem form the biotic component.

These organisms have different nutritional behaviour and status in the ecosystems and are accordingly known as producers OR consumers, based on how do they get their food.

(a) Producers: They are mainly the green plants, which can synthesize their food themselves by making use of carbondioxide present in the air and water in the presence of sunlight by involving chlorophyll, the green pigment present in the leaves, through the process of photosynthesis. They are also known as photo autotrophs (auto = self; troph = food, photo = light).

(b) Consumers: All organisms which get their organic food by feeding upon other organisms are called consumers, which are of the following types:

(i) Herbivores (plant eaters): They feed directly on producers and hence also known as primary consumers. Eg., rabbit, insect, man.

(ii) Carnivores (meat eaters): They feed on other consumers. If they feed on herbivores they are called Secondary consumers. (eg., frog) and if they feed on other carnivores (Snake, big fish Etc.,) they are known as tertiary Carnivores / Consumers.

(iii) Omnivores: They feed on both plants and animals. Eg., humans, rat, fox, Many birds.

(iv) Detritivores (Detoritus feeders OR Saprotrophs): They feed on the parts of dead organisms, wastes of living organisms, their cast-offs and partially decomposed matter Eg., beetles, termites, ants, Crabs, Earthworms Etc.,

(C) Decomposers: They derive their nutrition by breaking down the complex organic molecules to simple organic compounds and ultimately into inorganic nutrients. Various bacteria and fungi are decomposers.

In all the ecosystems, this biotic structure prevails. However, in some, it is the

primary producers which predominate (eg., in forests, agroecosystems) while in others the decomposers predominate (eg., deep ocean).

II. Abiotic Structure.

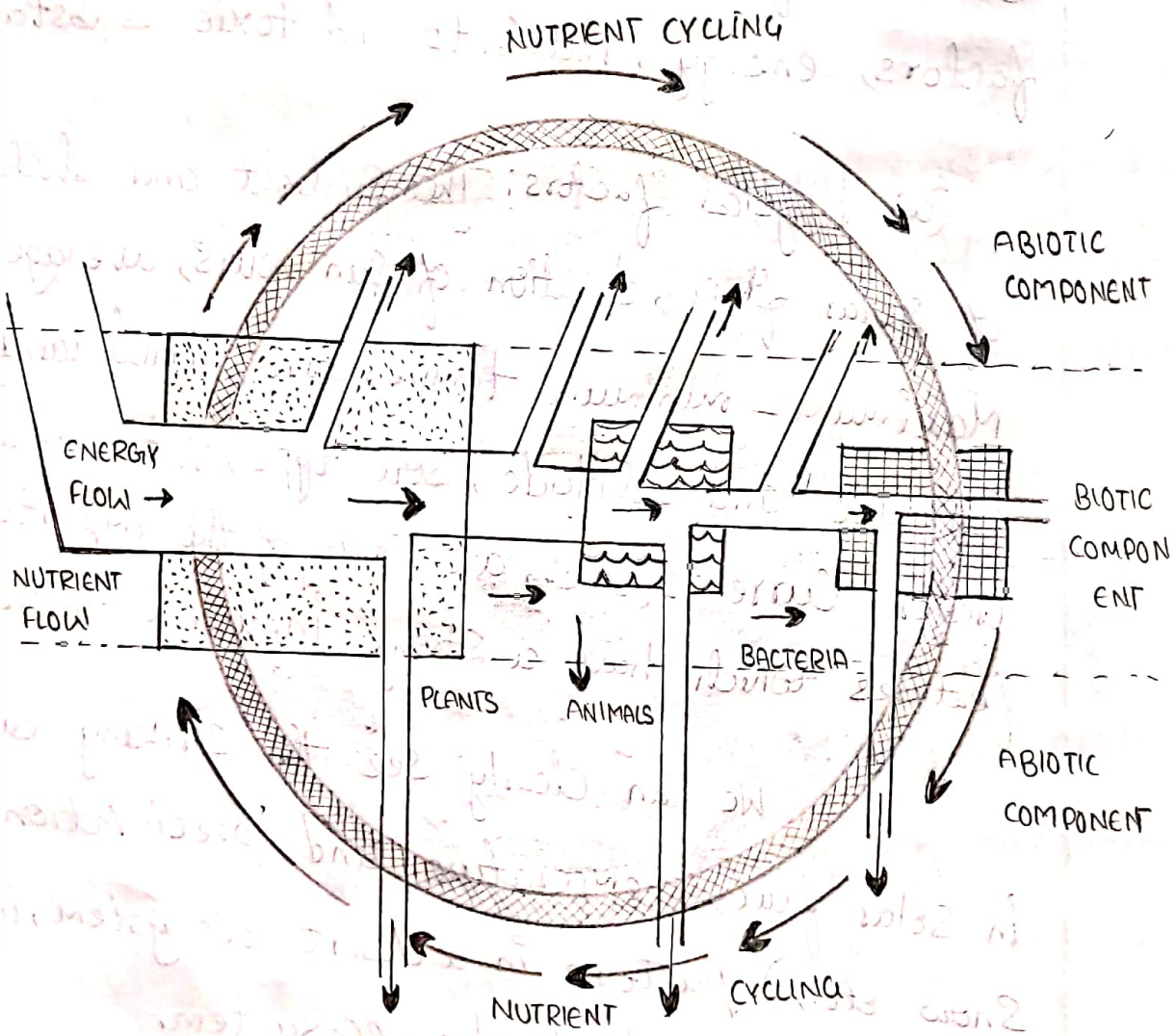
The physical and chemical components of an ecosystem constitute its abiotic structure. It includes climatic factors, edaphic (soil) factors, geographical factors, energy, nutrients and toxic substances.

(a) Physical factors: The sunlight and shade, intensity of solar flux, duration of sun hours, average temperature, maximum - minimum temperature, annual rainfall, wind, latitude and altitude, soil type, water availability, water currents etc., are some of the important physical features which have a strong influence on the ecosystem.

We can clearly see the striking differences in solar flux, temperature and precipitation (rainfall, snow etc.,) pattern in a desert ecosystem, in a tropical rainforest and in tundra ecosystem.

(b) Chemical factors:

Availability of Major essential nutrients like Carbon, nitrogen, phosphorus, potassium, hydrogen, oxygen and sulphur, level of toxic Substances, Salts Causing Salinity and various organic Substances present in the soil or water largely influence the functioning of the ecosystem.



3. FUNCTIONAL ATTRIBUTES

Every ecosystem performs under natural conditions in a systematic way. It receives energy from the sun and passes it on through various biotic components and in fact, all life depends upon this flow of energy. Besides energy, various nutrients and water are also required for life processes which are exchanged by the biotic components within themselves and with their abiotic components within OR outside the ecosystem. The biotic components also regulate themselves in a very systematic manner and show mechanisms to encounter some degree of environmental stress. The major functional attributes of an ecosystems are as follows:

(i) Food chain, food webs and trophic structure.
(ii) Energy flow.
(iii) Cycling of nutrients (Biogeochemical cycles)
(iv) primary and secondary production.
(v) Ecosystem development and regulation.

4. FOOD CHAINS

The sequence of eating and being eaten in an ecosystem is known as food chain.

All organisms, living or dead, are potential food for some other organisms and thus, there is essentially no waste in the functioning of a natural ecosystem.

Some common examples of simple food chains are:

- → Grass → Grasshopper → Frog → Snake → Hawk (Grass land ecosystem)
- Phytoplanktons → Water fleas → Small fish → Tuna fish (Pond ecosystem)
- Lichens → Reindeer → Man (Arctic tundran)

I. Grazing food chain:

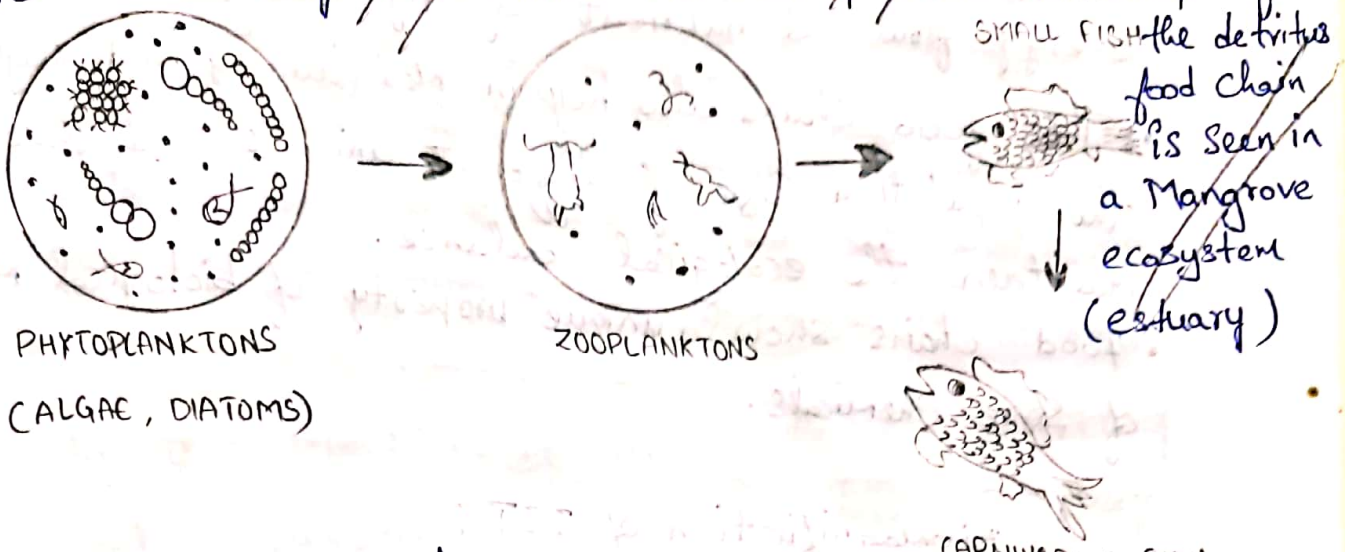
It starts with green plants (primary producers) and culminates in carnivores. All the examples cited above show this type of food chain.

Other examples could be

Grass → Rabbit → Fox

Algae → Water flea → Small fish → Tuna

II Detritus food Chain : It starts with dead organic matter which the detritivores and decomposers consume. Partially decomposed dead organic matter and even the decomposers are consumed by detritivores and their predators. An example of the detritus food chain is seen in a Mangrove ecosystem (estuary)



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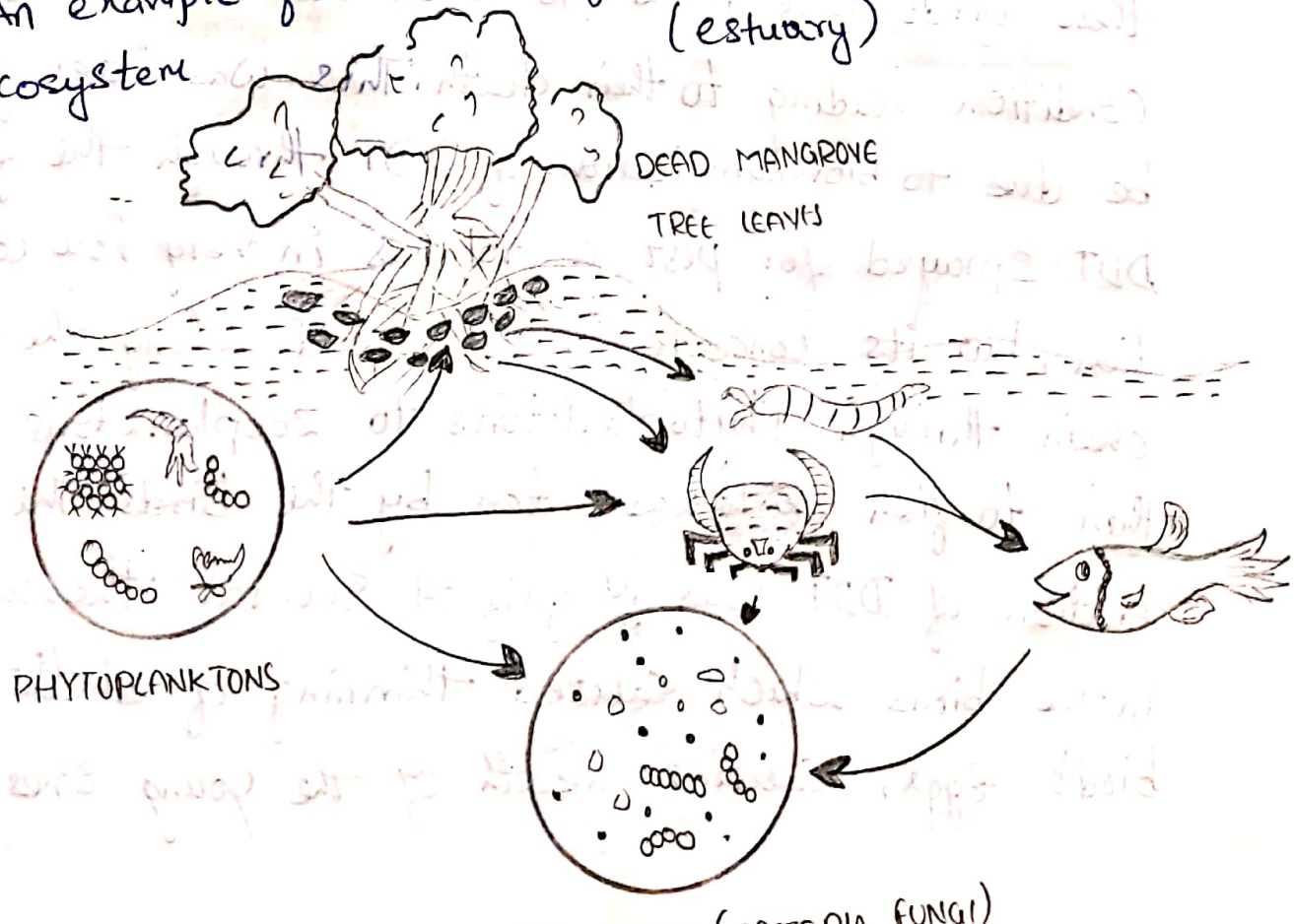


Significance of food Chains and food Webs.

- Food chains and food webs play a very significant role in the ecosystem because the two most important functions of energy flow and nutrient cycling take place through them.
- The food chains also help in maintaining and regulating the population size of different animals and thus, help maintain the ecological balance.
- Food chains show a unique property of biological magnification of some chemicals.

Biomagnification of DDT:

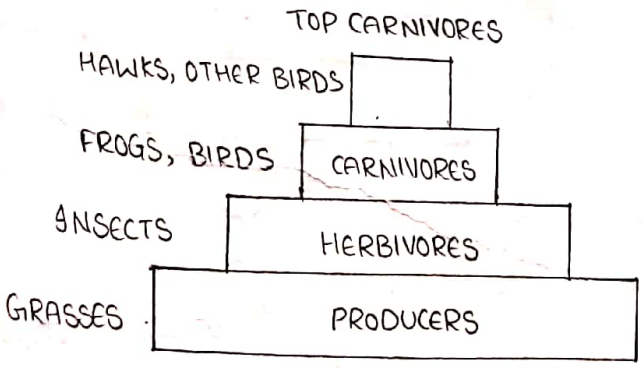
A striking case of biomagnification of DDT. (a broad range insecticide) was observed when some birds like Osprey were found to suffer a sharp decline in their population. The young ones of these birds were found to hatch out in premature condition leading to their death. This was later found to be due to biomagnification of DDT through the food chain. DDT sprayed for pest control was in very low concentration, but its concentration increased along the food chain through phytoplanktons to zooplanktons and then to fish which was eaten by the birds. The concentration of DDT was magnified several thousand times in the birds which caused thinning of shells in the bird's eggs, causing death of the young ones.

5. ECOLOGICAL PARAMIDS.

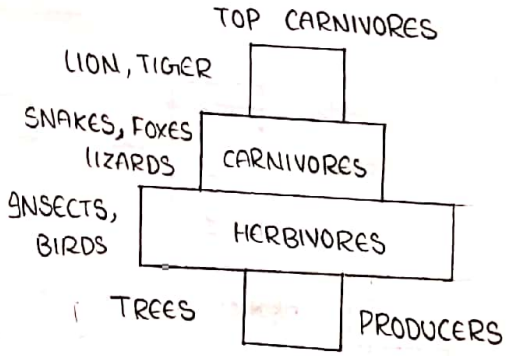
Graphic representation of trophic structure and function of an ecosystem, starting with producers at the base and successive trophic levels forming the apex is known as an ecological pyramid.

Ecological pyramids are of three types:

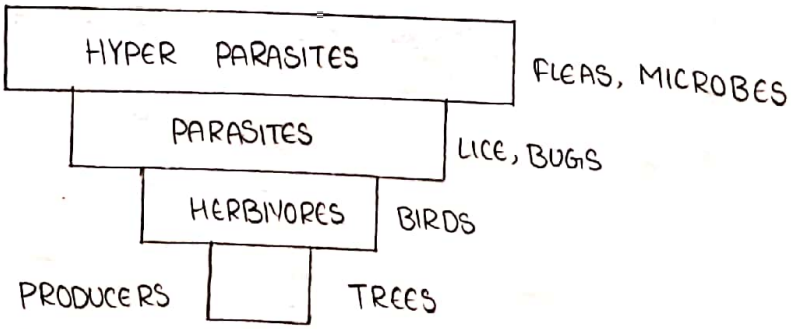
1. Pyramid of numbers: It represents the number of individual organisms at each trophic level. We may have upright or inverted pyramid of numbers, depending upon the type of ecosystem and food chain.



(a) GRASSLAND



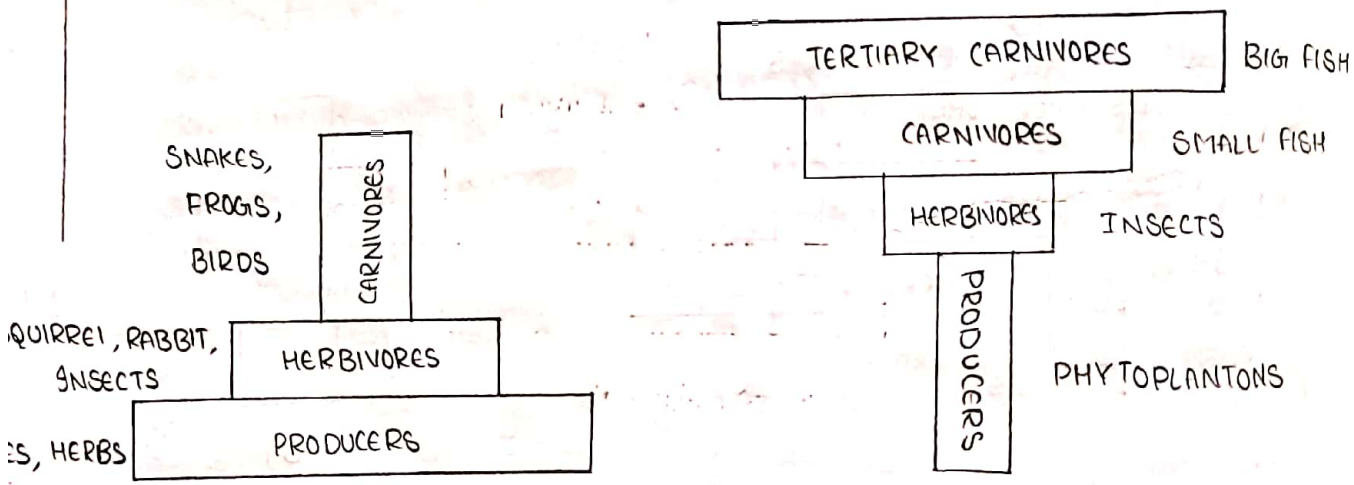
(b) FOREST



(c)

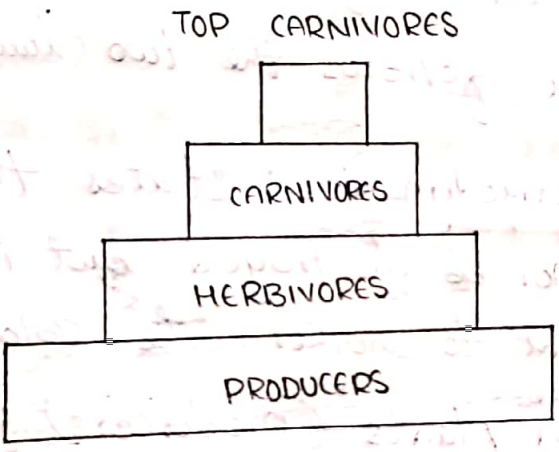
PARASITIC FOOD CHAIN

2. Pyramid of biomass: It is based upon the total biomass (dry matter) at each trophic level in a food chain. The pyramid of biomass can also be upright or inverte show pyramids of biomass in a forest and an aquatic ecosystem. The pyramid of biomass in a forest is upright in contrast to its pyramid of numbers. This is because the producers (trees) accumulate a huge biomass while the consumers' total biomass feeding on them declines at higher trophic levels, resulting in broad base and narrowing top.



(a) GRASSLAND (b) POND

3. Pyramid of energy : The amount of energy present at each trophic level is considered for this type of pyramid. Pyramid of energy gives the best representation of the trophic relationships and it is always upright.



PYRAMID OF ENERGY

ENERGY FLOW IN AN ECOSYSTEM.

Energy flows from one organism to another in an ecosystem in a unidirectional manner. Flow of energy in an ecosystem takes place through the food chain and it is this energy flow which keeps the ecosystem going. The most important feature of this energy flow is that it is unidirectional. Unlike the nutrients (like carbon, nitrogen, phosphorus etc.,) which move in a cyclic manner and are reused by the producers after flowing through the food chain, energy is not reused in the food chain. The flow of energy in an ecosystem follows the two laws of Thermodynamics:

I st Law of Thermodynamics: states that energy can neither be created nor be destroyed but it can be transformed from one form to another. The solar energy captured by the green plants (producers) gets converted into biochemical energy of plants and later into that of consumers.

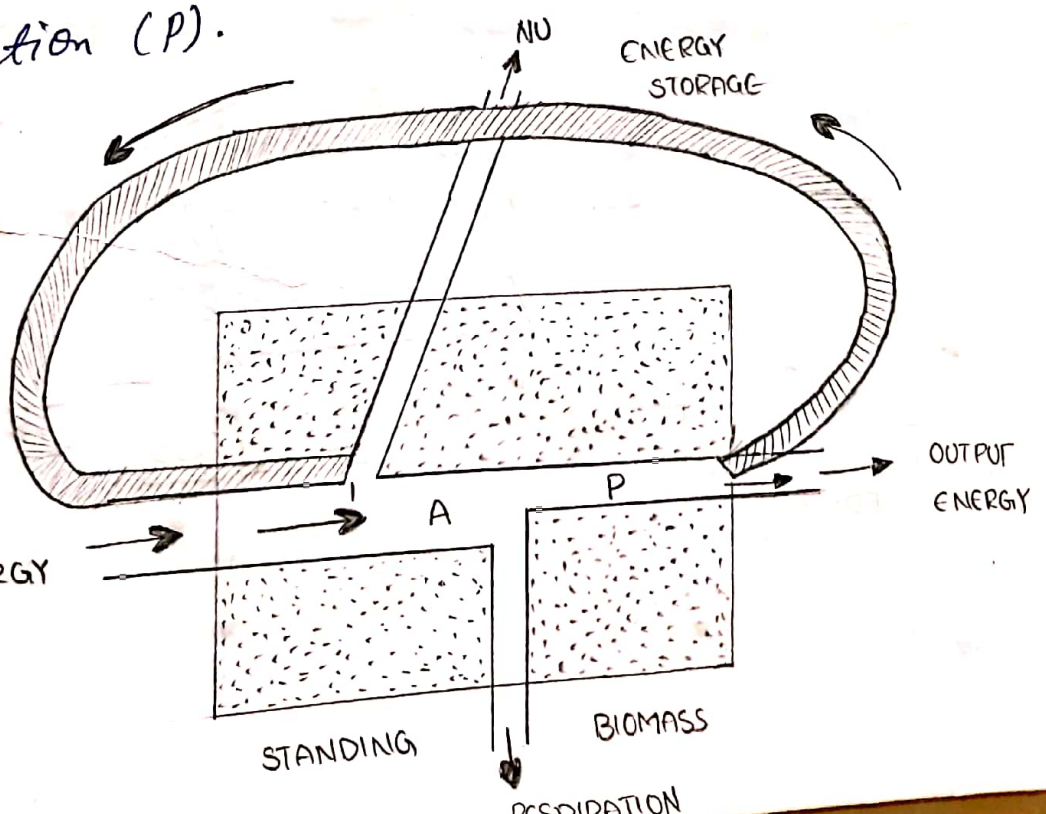
II nd Law of Thermodynamics: states that energy dissipates as it is used OR in other words, it gets converted from a more concentrated to dispersed form. As energy flows through the food chain, there occurs dissipation of energy at every trophic level. The loss of energy

takes place through respiration, loss of energy in locomotion, running, hunting and other activities. At every level there is about 90% loss of energy and the energy transferred from one trophic level to the other is only about 10%.

Models of energy flow: The flow of energy through various trophic levels in an ecosystem can be explained with the help of various energy flow models. [proposed by E.P. Odum, 1971] *

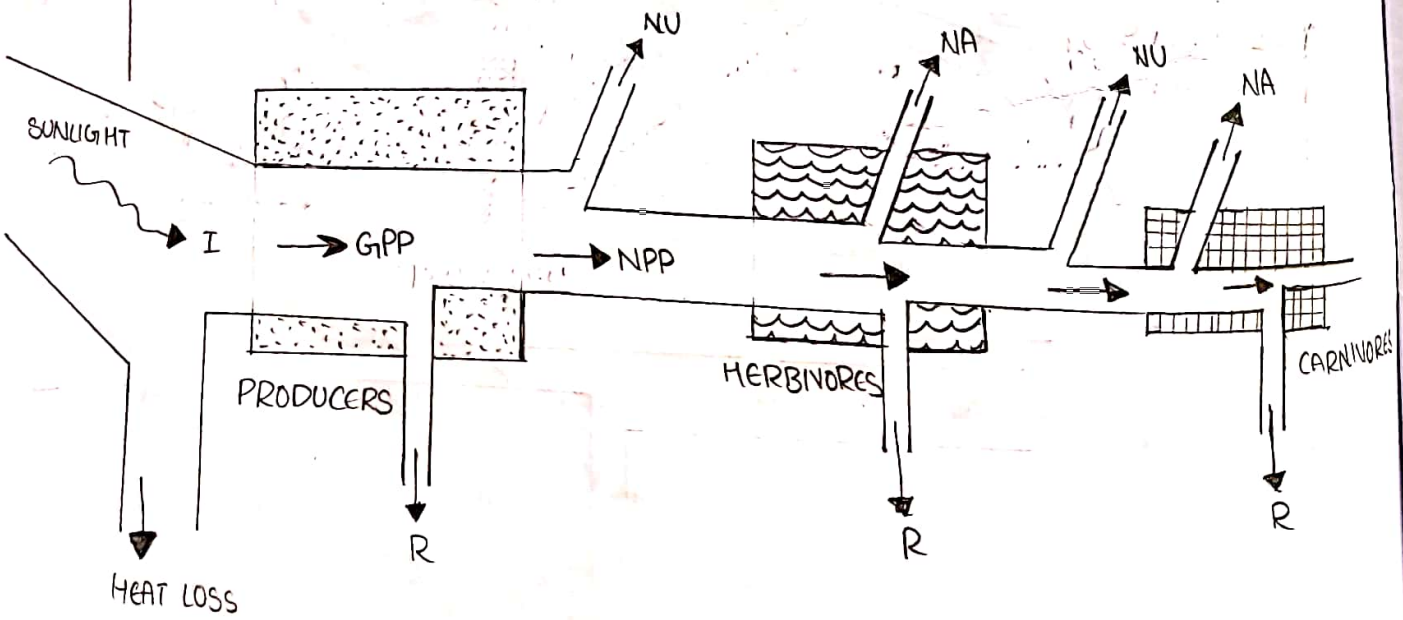
(a) Universal energy flow Model:

Energy flow through an ecosystem was explained by odum as the Universal energy flow Model. As the flow of energy takes place, there is a gradual loss of energy at every level, there by resulting in less energy available at next trophic level as indicated by narrower pipes (energy flow) and smaller boxes (stored energy in biomass). The loss of energy is mainly the energy not utilized (NU). This is the energy lost in respiration (R) which is for maintenance. The rest of the energy is used for production (P).



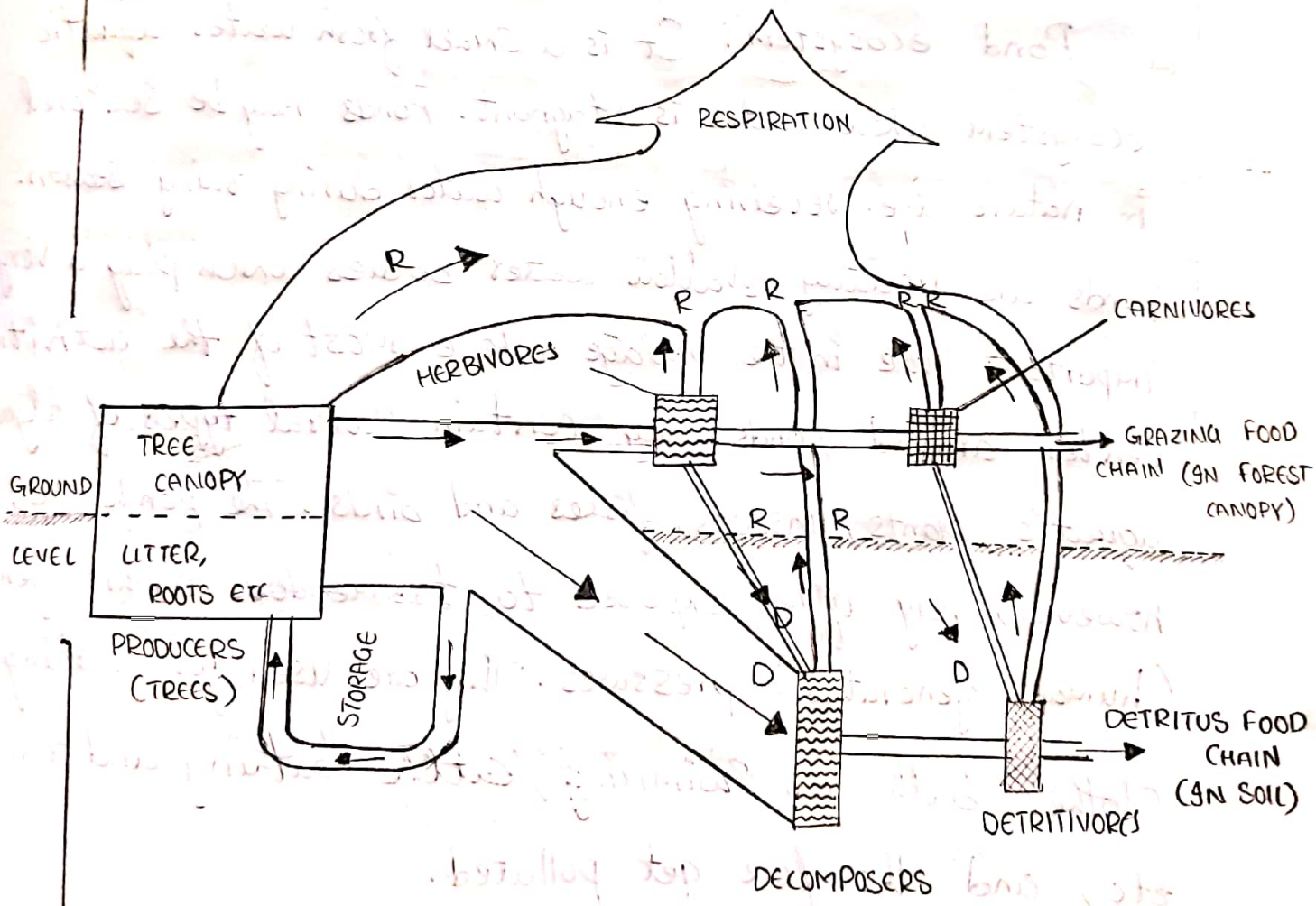
(b) Single channel energy flow model:

The flow of energy takes place in a unidirectional manner through a single channel of green plants or producers to herbivores and carnivores. Figure 3.12 depicts such a model and illustrated the gradual decline in energy level due to loss of energy at each successive trophic level in a grazing food chain.



(c) **Double Channel OR Y-shaped energy flow Model:**

In nature, both grazing food chain and detritus food chain operate in the same ecosystem. Sometimes it is the grazing food chain which predominates. It happens in marine ecosystem where primary production in the open sea is limited and a major portion of it is eaten by herbivorous marine animals. Therefore, very little primary production is left to be passed on to the dead OR detritus compartment.



AQUATIC ECOSYSTEMS.

Aquatic ecosystems dealing with water bodies and the biotic communities present in them are either freshwater or marine. Freshwater ecosystems are further of standing type (lentic) like ponds and lakes or free-flowing type (lotic), like rivers. Let us consider some important aquatic ecosystems.

(a) Pond ecosystem: It is a small fresh water aquatic ecosystem where water is stagnant. Ponds may be seasonal in nature i.e. receiving enough water during rainy season. Ponds are usually shallow water bodies which play a very important role in the village where most of the activities center around ponds. They contain several types of algae, aquatic plants, insects, fishes and birds. The ponds are, however, very often exposed to tremendous anthropogenic (human-generated) pressures. They are used for washing clothes, bathing, swimming, cattle bathing and drinking etc., and therefore get polluted.

(b) Lake ecosystem: Lakes are usually big fresh-water bodies with standing water. They have a shallow water zone called Littoral zone, an open-water zone where effective penetration of solar light takes place, called Limnentic zone and a deep bottom area where light penetration is negligible, known as profundale zone.

Streams:

These are freshwater aquatic ecosystems where water current is a major controlling factor, oxygen and nutrient in the water is more uniform and land-water exchange is more extensive.

River Ecosystem:

Rivers are large streams that flow downward from mountain highlands and flowing through the plains fall into the sea. So the river ecosystems show a series of different conditions.

Oceans:

These are gigantic reservoirs of water covering more than 70% of our earth's surface and play a key role in the survival of about 2,50,000 marine species, serving as food for humans and other organisms, give a huge variety of sea-products and drugs. Oceans provide us iron, phosphorus, magnesium, Oil, natural gas, Sand and gravel.

Estuary:

An estuary is a partially enclosed coastal area at the mouth of a river where freshwater and salty ~~Sea~~ Seawater meet.