UNIT-II

ECOSYSTEM AND BIODIVERSITY

2.1 ECOSYSTEM

An **ecosystem** is a community of organisms that interact with each other and non living components for sustainable development and adaptation to changing conditions. There are different type of ecosystems around us which involves living organisms and non living organisms. If we combine all the ecosystems present on earth, it is called **Biosphere**. The term ecosystem was first proposed by A.G.Tansley (1935) who defined ecosystem as follows: "Ecosystem is defined as a self-sustained community of plants and animals existing in its own environment."Odum (1971) defined ecosystem as any unit that includes all the organisms in a given area interacting with the physical environment, so that a flow of energy give rise to a clearly defined tropic structure, biotic diversity and material cycles within the system "Michael Allaby (1983) defined ecosystem as a community of interdependent organisms together with the environment

CONCEPT OF ECOSYSTEM:

In an ecosystem, the interaction of life with its environment takes place at many levels. A single bacteria in the soil interacts with water, air around it within a small space while a fish in a river interacts with water and other animals, rivals in a large space. .

Considering the operational point of view; the biotic and abiotic components of an ecosystem are so interlinked such that their separation from each other is practically difficult. So, in an ecosystem both organisms (biotic communities) and abiotic environment (rainfall, temperature, humidity) each influence the properties with other for maintenance of life.

STRUCTURE OF ECOSYSTEM

A structure of Ecosystem comprise of

•The Composition of biological community including, species number, biomass, life history, and distribution in space.

•The quantity and distribution of non-living material, such as nutrient water, etc.

•The rage of condition of existence such as temperature, light.

FUNCTION OF ECOSYSTEM:

•The rate of biological energy flow i.e. production & respiration rates of the community.

•The rate of material or nutrient cycles

•Biological or ecological regulation including both regulation of organism by environment and regulation of environment by the organisms.

2.1.1 COMPONENTS OF AN ECOSYSTEM:

There are two components of an ecosystem; Living components and non living components.

Non Living Components: (**Abiotic**) Non living components are the physical and chemical factors that directly or indirectly affect the living components e.g. air, water, land, rock etc. Non living components are also called **Abiotic** components.
Physical factors include sunlight, water, fire, soil, air, temperature etc.
Chemical factors include moisture, salinity of water, soil nutrients, oxygen dissolved in water etc.
Living Components: Living components in an ecosystem are either producers or consumers. They are also called **biotic** components. Producers can produce organic components e.g. plants can produce starch, carbohydrates, cellulose from a process called photosynthesis. Consumers are the components that are dependent on producers for their food e.g. human beings and animals•

Biotic Components are further classified into 3 main groups

•Producers •Consumers •Decomposers or Reducers

1. **Producer (Autotrophs):** The green plants have chlorophyll with the help of which they trap solar energy and change it into chemical energy of carbohydrates using simple inorganic compound namely, water and carbon dioxide. This process is known as photosynthesis. The chemical energy stored by the producers is utilized partly by the producers for their own growth and survival and the remaining is stored in the plants for their future use. They are classified into two categories based on their source of food.
   a)Photoautotrophs: An organism capable of synthesizing its own food from inorganic substances using light as an energy source. Green plants and photosynthetic bacteria are photoautotrophs.
   b)Chemotrophs: Organisms that obtain energy by the oxidation of electron donors in their environments. These molecules can be organic (chemoorganotrophs) or inorganic (chemolithotrophs).
2. **Consumers (Heterotrophs):** The animals lack chlorophyll and are unable to synthesis their own food therefore they depend on the producers for their food. •They are known as heterotrophs (i.e. heteros= others, trophs= feeder).The Consumers are of 4 types:
   (a) Primary Consumer: (Herbivores) i.e. Animal feeding on plants, e.g. Rabbit, deer, goat etc.
   (b) Secondary Consumers: The animal feeding on Herbivores are called as secondary Consumer or primary carnivores. e.g. Cats, foxes, snakes.
   (c) Tertiary Consumers: These are large carnivores which feed on secondary consumers. e.g. Wolves
   (d) Quaternary Consumers: They are also called omnivores these are largest carnivores Which feed on tertiary consumers and are not eaten up by any other animals. e.g. lion and Tiger.

3. **Decomposers or Detrivores:**Bacteria & fungi belong to this category. They break down the dead organic matter of producers & consumers for their food and release to the environment the simple inorganic and organic substance. These simple substances are reused by the producers resulting in a cyclic exchange of material between biotic & abiotic environment.
   Eg: Bacteria, Earth worms, Beetles etc

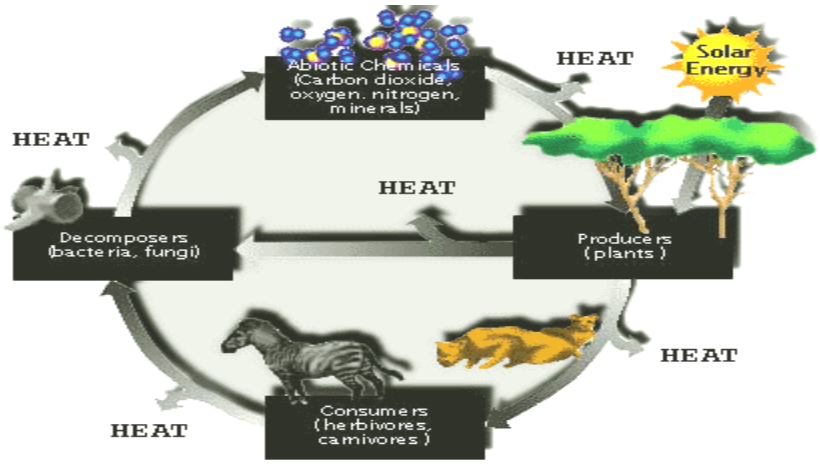
2.1.2 ENERGY FLOW IN AN ECOSYSTEM

•Biological activities require energy which ultimately comes from the sun. Solar energy is transformed into chemical energy by a process of photosynthesis this energy is stored in plant tissue and then transformed into heat energy during metabolic activities.
•Thus in biological world the energy flows from the sun to plants and then to all heterotrophic organisms. The flow of energy is unidirectional and non-cyclic.
This one way flow of energy is governed by laws of thermodynamics which states that:

(a) Energy can neither be created nor be destroyed but may be transformed from one form to another

(b) During the energy transfer there is degradation of energy from a concentrated form (mechanical, chemical, or electrical etc.) to a dispersed form (heat).

No energy transformation is 100 % efficient; it is always accompanied by some dispersion or loss of energy in the form heat. Therefore, biological systems including ecosystems must be supplied with energy on a continuous Basis.



MODELS OF ENERGY FLOW IN ECOSYSTEM

1. Single Channel Energy Flow Model: The flow of energy takes place in a unidirectional manner through a single channel of producers to herbivores and carnivores. The energy captured by autotrophs does not revert back to solar input but passes to herbivores; and that which passes to herbivores does not go back to autotrophs but passes to consumers. Due to one way flow of energy, the entire system would collapse if primary source of energy were cut off. At each tropic level there occurs progressive decrease in energy which is mainly due to loss of energy as heat in metabolic reactions and also some of the energy is utilized at each tropic level

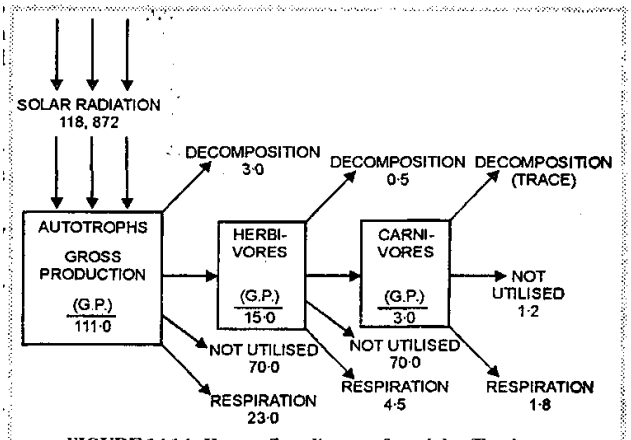


FIGURE 14.14. Energy flow diagram for a lake (Freshwater ecosystem) in g cal/cm^2/yr (modified from Lindeman, 1942).

2. **Y- shaped model: shows** a common boundary, light and heat flow as well as import, export and storage of organic matter . Decomposers are placed in separate box to partially separate the grazing and detritus food chains. In terms of energy levels decomposers are in fact a mixed group. •Y- shaped energy flow is more realistic and practical than the single channel energy flow model because: •It conforms to the basic stratified structure of ecosystems •It separates the two chains i.e. grazing & detritus food chain in both time and space. •Micro consumers (bacteria & fungi) and the macro consumers (animals) differ greatly in size- metabolism relations in two models.

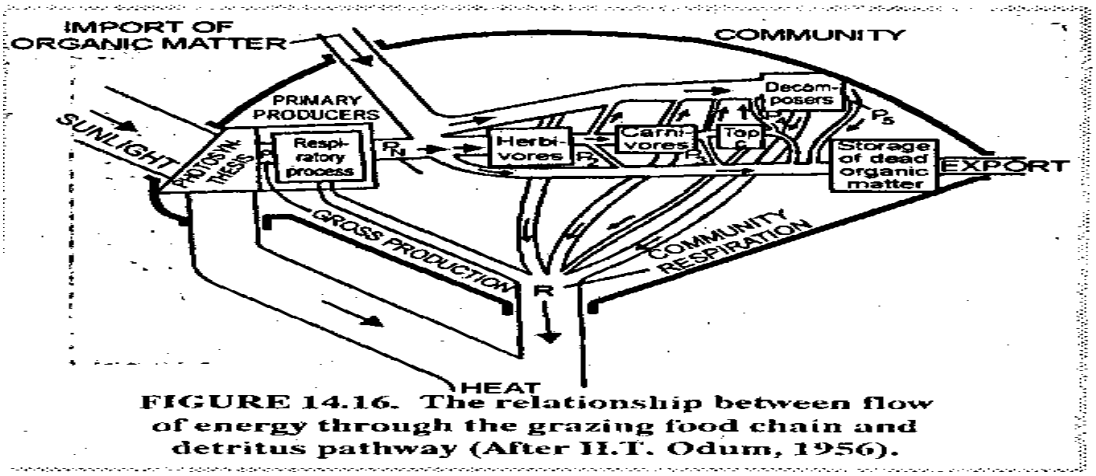


FIGURE 14.16. The relationship between flow of energy through the grazing food chain and detritus pathway (After H.T. Odum, 1956).

3.Universal energy flow model :As the flow of energy takes place, there is gradual loss of energy at each level there by resulting in less energy available at the next tropic level as indicated by narrower pipes (energy flow) and smaller boxes (stored energy in biomass). The loss of energy is mainly the energy which is not utilized (U). This is the energy loss in locomotion, excretion etc. or it the energy lost in respiration (CR) which is for maintenance. The remaining energy is used for production (P).

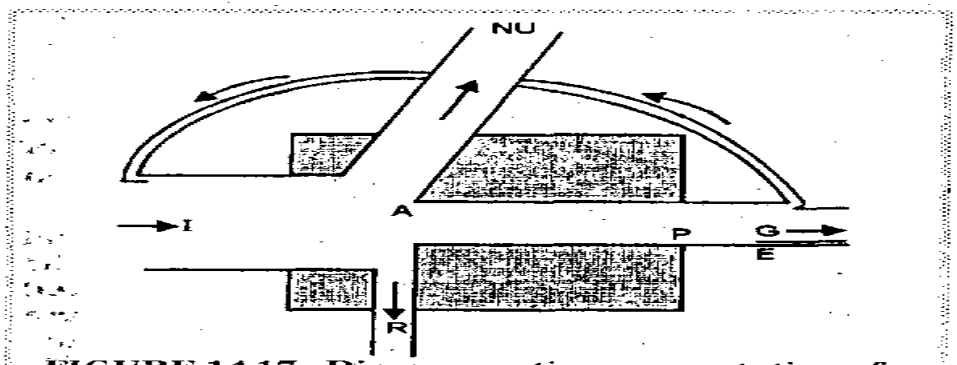


FIGURE 14.17. Diagrammatic representation of a universal model of energy flow at one trophic level (After E.P. Odum ; 1968).

2.1.3 ECOLOGICAL SUCCESSION

Ecological Succession is the phenomenon or process by which a community progressively transforms itself until a stable community is formed. It is a fundamental concept in ecology, refers to more or less predictable and orderly changes in the composition or structure of an ecological community. Succession may be initiated either by formation of new, unoccupied habitat (e.g., a lava flow or a severe landslide) or by some form of disturbance (e.g. fire, severe wind throw , logging) of an existing community. Succession that begins in areas where no soil is initially present is called primary succession, whereas succession that begins in areas where soil is already present is called secondary succession.

Clement's theory of succession/Mechanisms of succession

F.E. Clement (1916) developed a descriptive theory of succession and advanced it as a general ecological concept. His theory of succession had a powerful influence on ecological thought. Clement's concept is usually termed classical ecological theory. According to Clement, succession is a process involving several phases:

1. **Nudation**: Succession begins with the development of a bare site, called Nudation (disturbance).
2. **Migration**: It refers to arrival of propagules.
3. **Ecesis**: It involves establishment and initial growth of vegetation.
4. **Competition**: As vegetation became well established, grew, and spread, various species began to compete for space, light and nutrients. This phase is called competition.
5. **Reaction**: During this phase autogenic changes affect the habitat resulting in replacement of one plant community by another.
6. **Stabilization:** Reaction phase leads to development of a climax community.

Seral communities:

A seral community is an intermediate stage found in an ecosystem advancing towards its climax community. In many cases more than one seral stage evolves until climax conditions are attained. A prisere is a collection of seres making up the development of an area from non-vegetated surfaces to a climax community. Depending on the substratum and climate, a seral community can be one of the following:

Hydrosere : Community in freshwater
Lithosere **:** Community on rock
Psammosere **:** Community on sand
Xerosere **:** Community in dry area
Halosere **:** Community in saline body (e.g. a marsh)

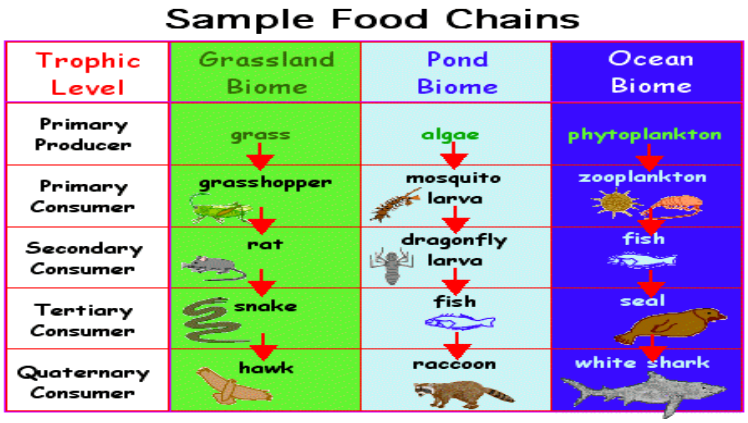
Climax community

The final or stable community in a sere is the climax community or climatic vegetation. It is self-perpetuating and in equilibrium with the physical habitat. There is no net annual accumulation of organic matter in a climax community mostly. The annual production and use of energy is balanced in such a community.

2.1.4 FOOD CHAIN, FOOD WEB & ECOLOGICAL PYRAMIDS:

FOOD CHAIN:

In food chain each organism eats the smaller organisms and is eaten by the larger one. All those organisms which are interlinked with each other through food to gather constitute the ecosystem. •The different levels in a food chain are called tropic levels, Each food chain has three main tropic levels:- Producer level, Consumer level, and decomposer level. If any of the intermediate stage of the food chain is removed, the succeeding links of the food chain will be affected.



Types of Food Chains*:*

a) **Grazing Food Chain:** This type of food chain starts from living green plants goes to grazing herbivores and onto carnivores. Ecosystem with such type of food chain directly

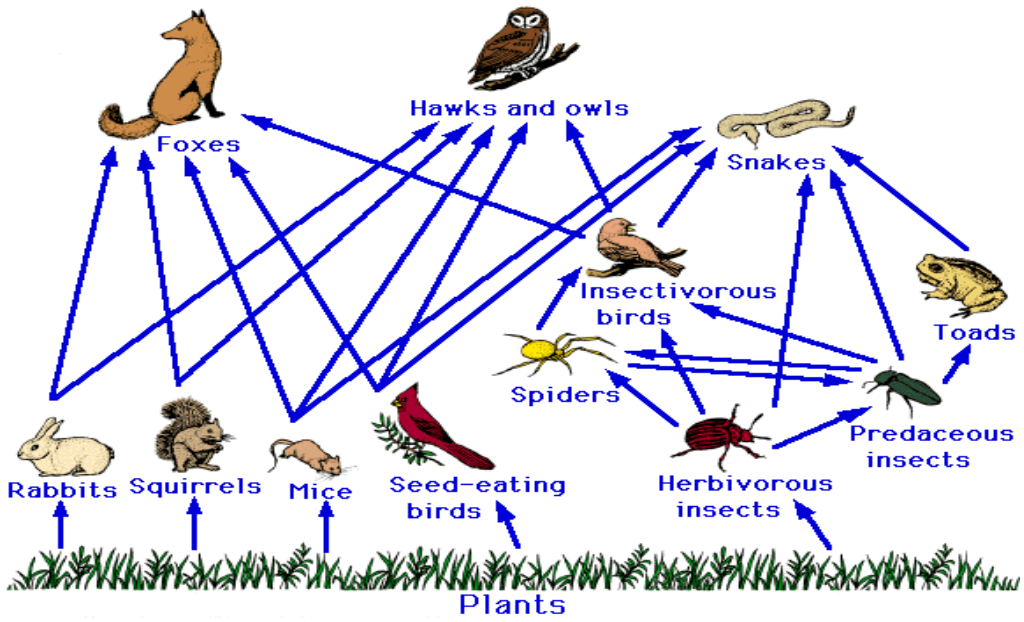
depends upon the solar energy for their food requirements. Most of the ecosystem in nature follows this type of food chain.

b) **Detritus food Chain:** This type of food chain goes from dead organic matter onto microorganisms and then to the organisms feeding on detritus and their predators. Such ecosystems are less dependent on direct solar energy.

c) **Parasitic Food Chain:** This type of food chain starts from big hosts and ends with parasitic organisms

FOOD WEB*:*

The interconnected, interlocking pattern of food chain is known as food web. •Under natural condition of the linear arrangement of food chain hardly occurs and they remain interconnected with each other through different types of organisms at different levels Such a interconnected and interlocking pattern of food chain is known as food web..



ECOLOGICAL PYRAMIDS

The different species in a food chain are called tropic levels. Each food chain has 3 main trophic level, producer, consumer, and decomposers. •Thus Graphical representation of these trophic levels is called as Ecological Pyramids. It was devised by an ecologist "**Charles Elton**" therefore this pyramid are also called Ecological pyramid or **Eltonian pyramids**.

Types of Ecological Pyramids:

Ecological pyramids are of three types: I

I) Pyramid of Number II)Pyramid of biomass
III)Pyramid of Energy