STRUCTURAL AND FUNCTIONAL COMPONENTS OF THE ECO SYSTEM

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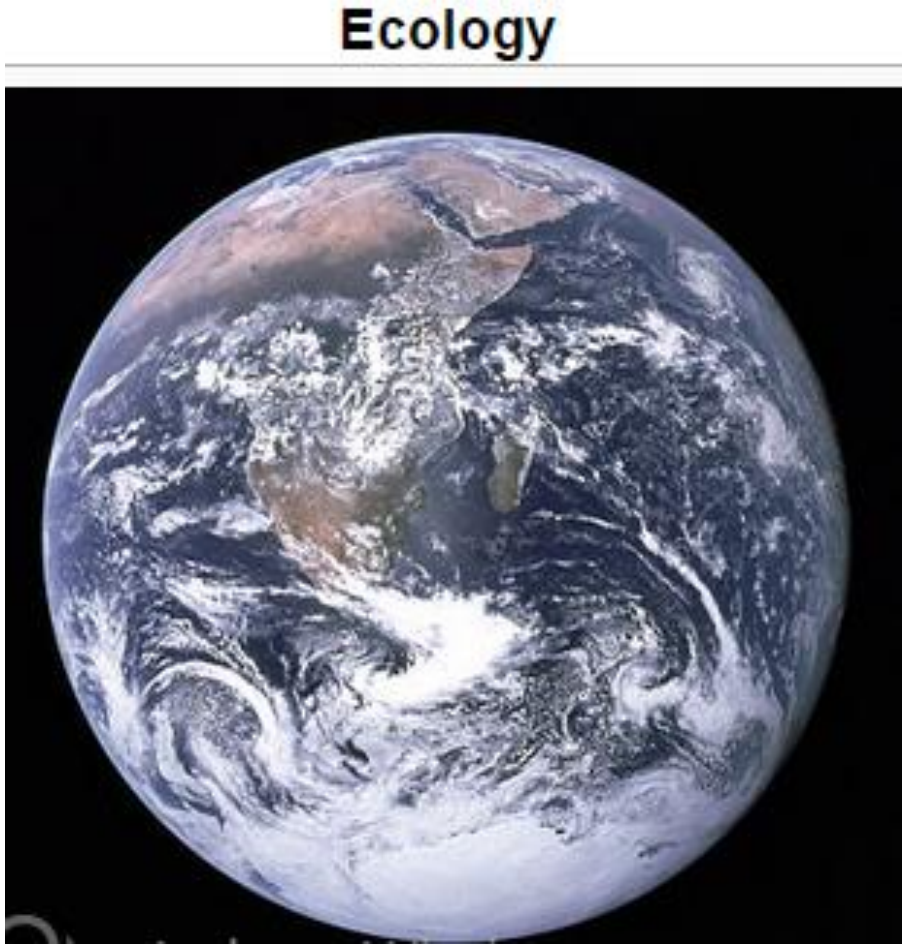
- **Ecology**
- Study of the “house/environment” in which we live.

Origin of the word…”ecology

- **Greek origin**
- OIKOS = household
- LOGOS = study of…

- **Ecology**

- Study of the “house/environment” in which we live.



Other Definition of Ecology

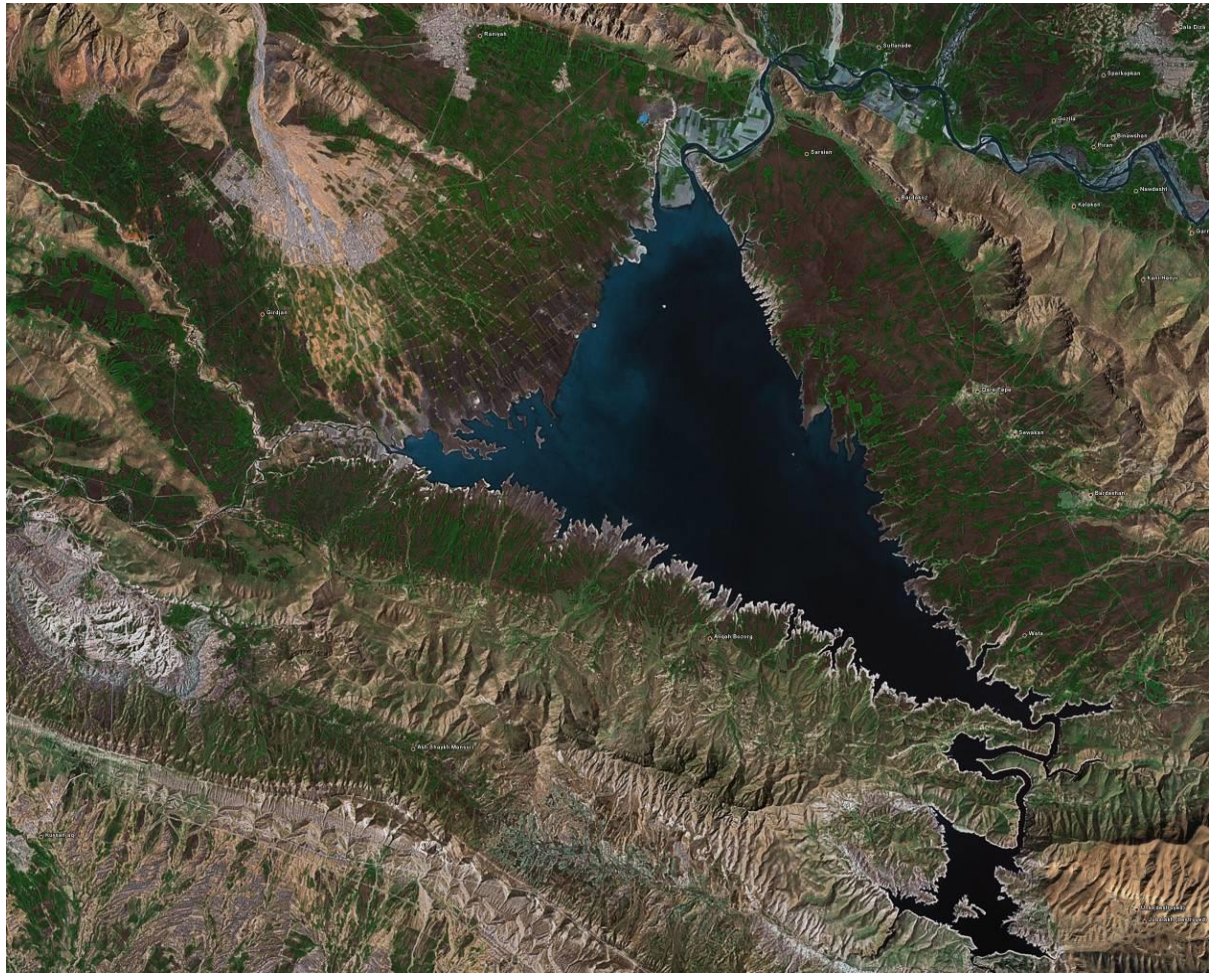
- **1866 Ernst Haeckel**: the comprehensive science of the **relationship of the organism to the environment**
- **1927 Charles Elton**: Scientific natural history
- **1963 E. P. Odum**: The study of the structure and function of nature
- **1972 C. J. Krebs**: The scientific study of the interactions that determine the distribution and abundance of organisms

- **Ecology** Is an enormously complex and exciting area of biology
- **Ecology** is the scientific discipline that is concerned with the **relationships between organisms and their past, present, and future environments.**
- **Organisms interact with one another and with their non-living environment**
- **These interactions**
  - Determine both the distribution of organisms and their abundance

Ecological spectrum

(Levels of Organization: a hierarchy of organization in the environment**)**

Biosphere, Biome. ***Ecosystem, Community, Population, Organism***, Organ system, Organ, Tissue, Cell, Subcellular organelles, Molecules



What is the organization of Ecological Study?

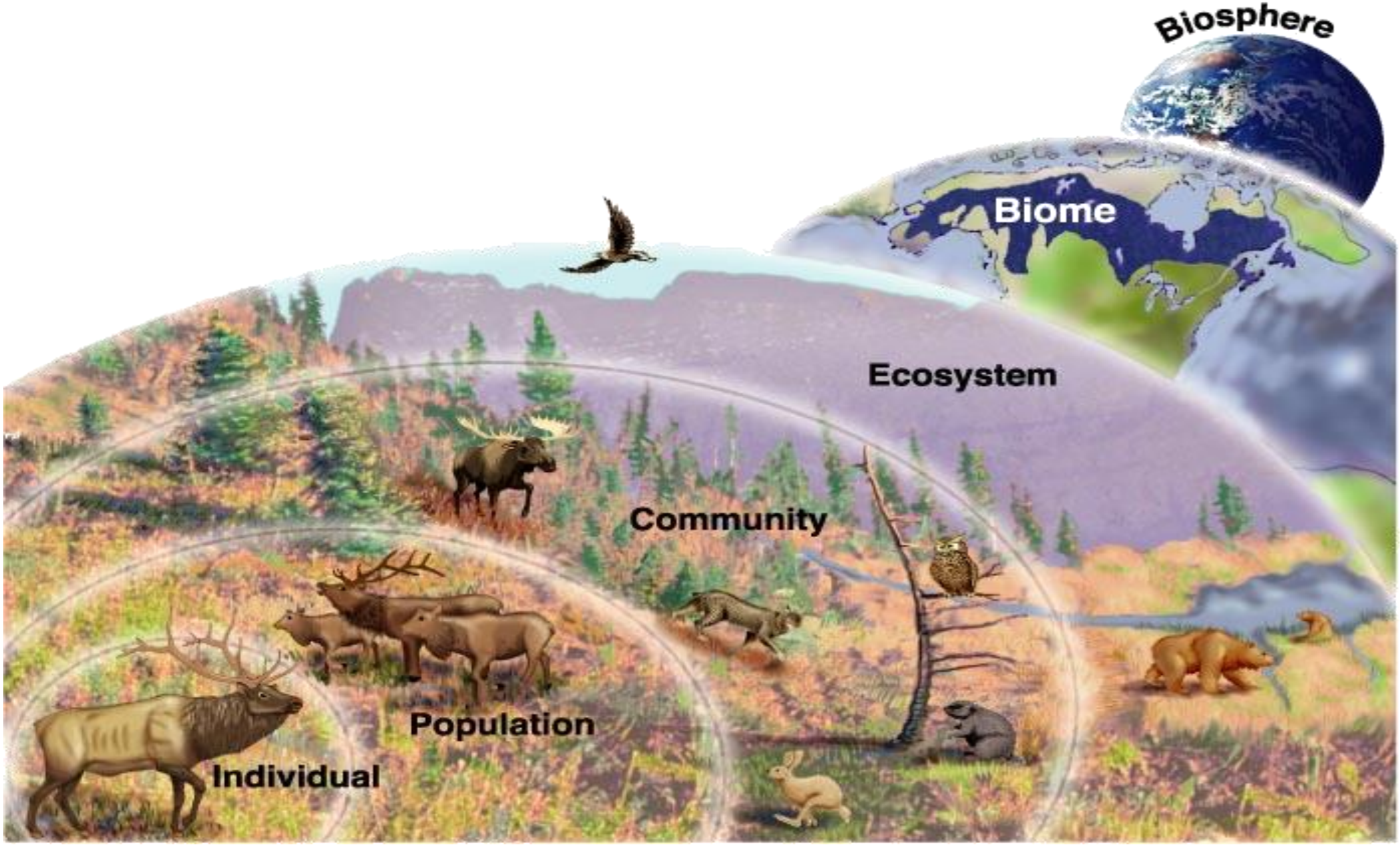
Organism

Population

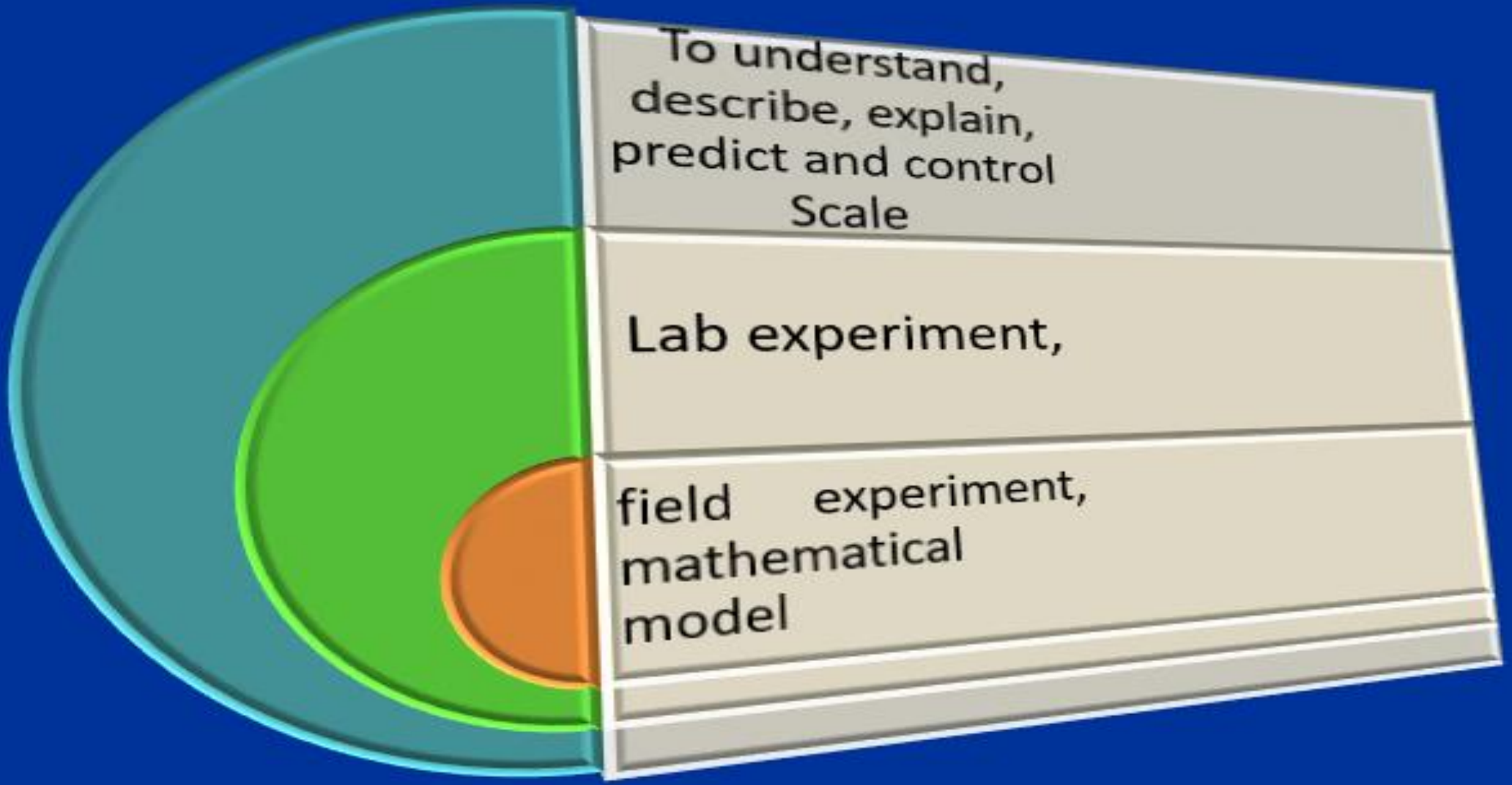
Community

Ecosystem

Biosphere


Biosphere
Biome
Ecosystem
Community
Population
Individual

Methods of studying ecology



What is an Ecosystem?

- System = regularly interacting and interdependent components forming a unified whole

- Ecosystem = an ecological system;

  = a community and its physical environment treated together as a functional system

- Ecosystem =Organisms live in a ***Habitat***

- Ecosystem =Organisms fit into a ***Niche*** of the environment

- **Habitat vs. Niche**
- **Habitat**- an area where an organism lives
- **Niche**- an organisms role in its environment
  - **full range of physical and biological conditions in which an organism lives and the way in which the organism uses those conditions.** Includes **where in the food chain** it is, **where an organism feeds**

- ***Habitat*** *is like an address in an ecosystem and a*
- ***niche*** *is like an occupation in an ecosystem*.

Community Interactions

- When organisms live together in an ecological community they interact constantly.

Three types of interactions

- Competition
- Predation
- Symbiosis

- **The term ecosystem** was first proposed by the **British ecologist A.G. Tansley (1871-1955)**. It consists of the **biological community, and the physical and chemical factors that make up its non-living or abiotic environment.**

Ecology and Ecosystem

- **The study and understanding of Ecology is an integral part of Environment Science learning.**
- The **study of interrelationships between organisms and group of organisms** is called the **science of Ecology**. **Ecology** is hence the study of interrelationship **among plants and animals** and their interactions with the **physical environment**.

- **Tansley (in 1935) defined the Eco-system as ‘the system resulting from the integrations of all the living and non-living actors of the environment’.**

There are many important divisions of Ecology. They are:

- **1-First classification depend on individuals**
- **(a) Autoecology or Species Ecology:** This is the **study of an individual species**. i.e. behavior, adaptation and interaction of a particular species in its environment.
- **(b) Synecology or Ecology of Communities:** This is the study of Communities and their interaction with the environment.

- **2-Second classification depend on type of organism**
- **(a)-Animal ecology**
- **(b)-Plant ecology**

3-Third classification depend on the habitat

A-Aquatic ecology

(a)-Freshwater ecology include lotic ecology like River, lentic ecology like Pond, Lake and groundwater like Wells

(b)-Estuarine ecology like Gulf

(c)-Oceanography like Oceans and Seas

B-Terrestrial ecology

(a)-Forest ecology

(b)-Hill ecology

(c)-Desert ecology

(d)-Polar ecology

- 4-Fourth classification depend on type and number of living organisms
- (a)-Individual ecology
- (b)-Population ecology
- (c)-Community ecology
- (d)-Biosphere ecology
-
- An Ecosystem is defined as a group of plants, animals or living organisms living together and interacting with the physical environment in which they live.
- Ecosystems can be large or small. Examples of large ecosystems are rain forests, deserts, salt marshes, coral reefs, lakes and ponds, open Ocean, grass lands etc.

HISTORICAL BACKGROUND

- The **terms ecosystems is most preferred**, where '**eco' implies the environment and 'system' implies an interacting, inter-dependent complex**.
- In this way, it can be said that **any unit that includes all the organisms *i.e.***
- ***or***
- **the communities in a given area, interact with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycle (*i.e.* exchange of materials between living and non-living components) within the system, is known as an ecological system or eco-system.**
- or
- **All primary and secondary producers composing the ecosystem are its essential elements. The unique feature of eco-systems is the maintenance of their chemical state and of their environment**.

- Thus an **eco-system is an integrated unit, consisting of interacting plants and animals whose survival depends upon the maintenance of abiotic *i.e.* physicochemical environment and gradients such as moisture, wind and solar radiation with its concomitants of light and heat, as well as biotic structures and functions**.

ASPECTS OF ECO-SYSTEM

- The **eco-system can be defined as any spatial or organizational unit including living organisms and non-living substances interacting to produce an exchange of materials between the living and non-living parts**.

The eco-system can be studied from either structural or functional aspects.

- **1. Structural Aspect**
- The **structural aspects** of ecosystem i**nclude a description of the arrangement, types and numbers of species and their life histories, along with a description of the physical features of the environment.**
- **2. Functional**
- The functional aspects of the ecosystem **include the flow of energy and the cycling of nutrients.**
-

- **STRUCTURE AND FUNCTIONAL COMPONENTS OF ECOSYSTEM**
- **STRUCTURE OF ECO-SYSTEMS**
- **Meaning of Structure**
- (*i*) The composition of biological community including species, numbers, biomass, life history and distribution in space *etc.*
- (*ii*) The quantity and distribution of the non-living materials, such as nutrients, water *etc.*
- (*iii*) Structure of an ecosystem the range, or gradient of conditions of existence, such as temperature.

From structural point of view all ecosystems consist of following two basic components:

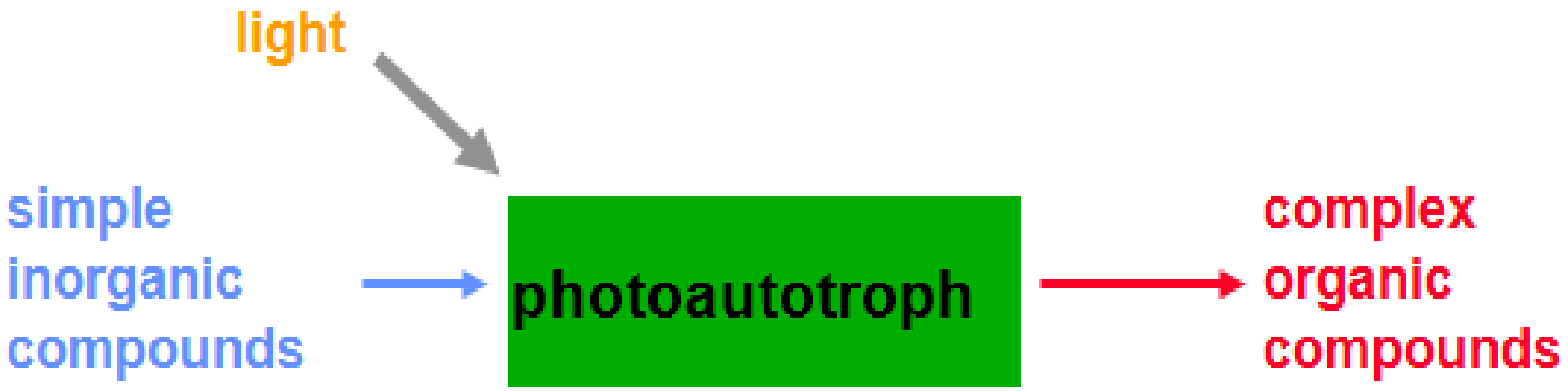
- **1. Abiotic Substances (Non-Living Components)**
- The Abiotic substances include basic inorganic and organic compounds of the environment or habitat of the organism.

- ***(a) Inorganic Components:*** The inorganic components of an ecosystem are as under carbon dioxide, water, nitrogen, calcium, and phosphate. All of these are involved in matter cycles (biogeochemical cycles).
- ***(b) Organic Components:*** The organic components of an ecosystem are proteins, carbohydrates; lipids and amino acids, **all of these are synthesized by the biota** (flora and fauna) of an ecosystem and are reached to ecosystem as their wastes, dead remains, *etc.*
- ***(c) The climate, temperature, light, soil etc.,*** are other abiotic components of the eco-system.

- **(2) *Biotic Substances (Living Components):*** This is indeed the **trophic structure of any ecosystem,** where living organisms are distinguished on the basis of their nutritional relationships. From this trophic (nutritional) standpoint, an ecosystem has two components:
-
- **(a) Autotrophic Component as Producers**
- These are the components in which fixation of light energy use of simple inorganic substances and build up of complex substance predominate.
- (*i*) The component is constituted **mainly by green plants, including photosynthetic bacteria.**
-
- (*ii*) To some lesser extent, **chemosynthetic microbes also contribute to the build up of organic matter.**

- (*iii*) Members of the a**utotrophic component are known as eco-system producers because they capture energy from non-organic sources**, especially light, and store some of the energy in the form of chemical bonds, for the later use.
- (*iv*) Algae of various types are the most important producers of aquatic eco-systems, although in estuaries and marshes, grasses may be important as producers.
-
- (*v*) **Terrestrial ecosystems have trees, herbs, grasses, and mosses that contribute with varying importance to the production of the eco-systems.**

- **A-Autotrophs**
- Autotrophs (=self-nourishing) are called primary producers.
- Photoautotrophs fix energy from the sun and store it in complex organic compounds
- (= green plants, algae, some bacteria)



- Chemoautotrophs (chemosynthesizers) are bacteria that oxidize reduced inorganic substances (typically sulfur and ammonia compounds) and produce complex organic compounds.

- Chemosynthesis near hydrothermal vents

Other chemoautotrophs:
Nitrifying bacteria in the soil under our feet!

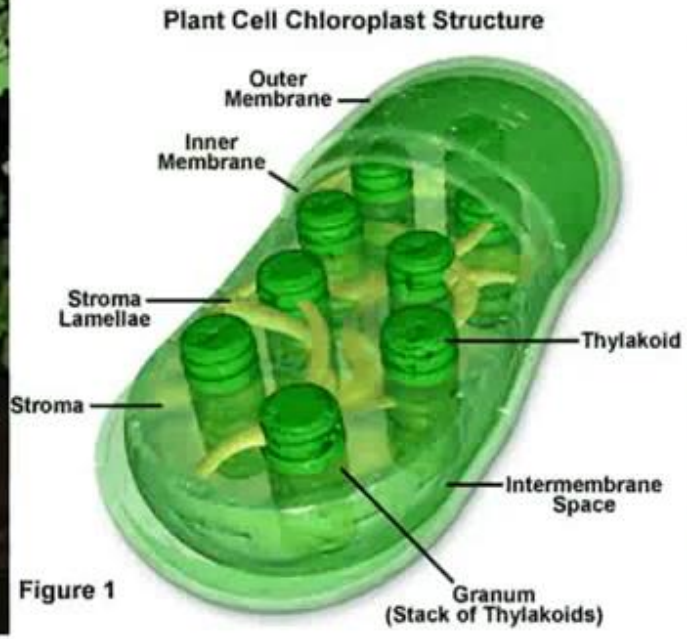
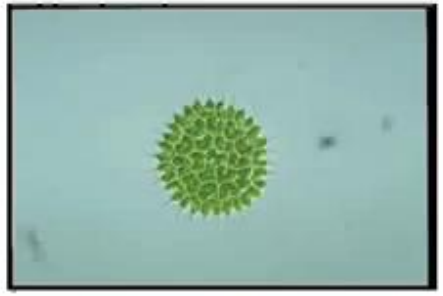
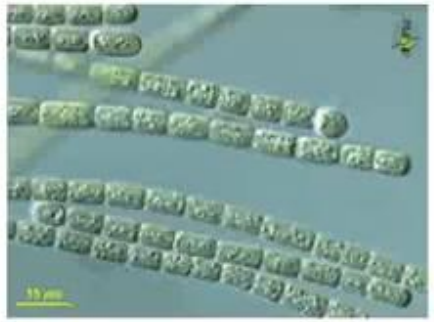

Plant Cell Chloroplast Structure
Outer Membrane
Inner Membrane
Stroma Lamellae
Thylakoid
Stroma
Intermembrane Space
Granum (Stack of Thylakoids)

Figure 1



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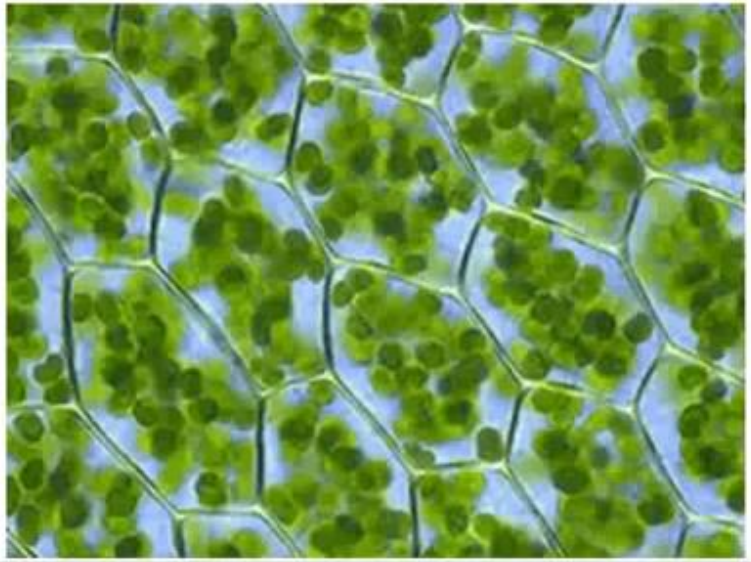

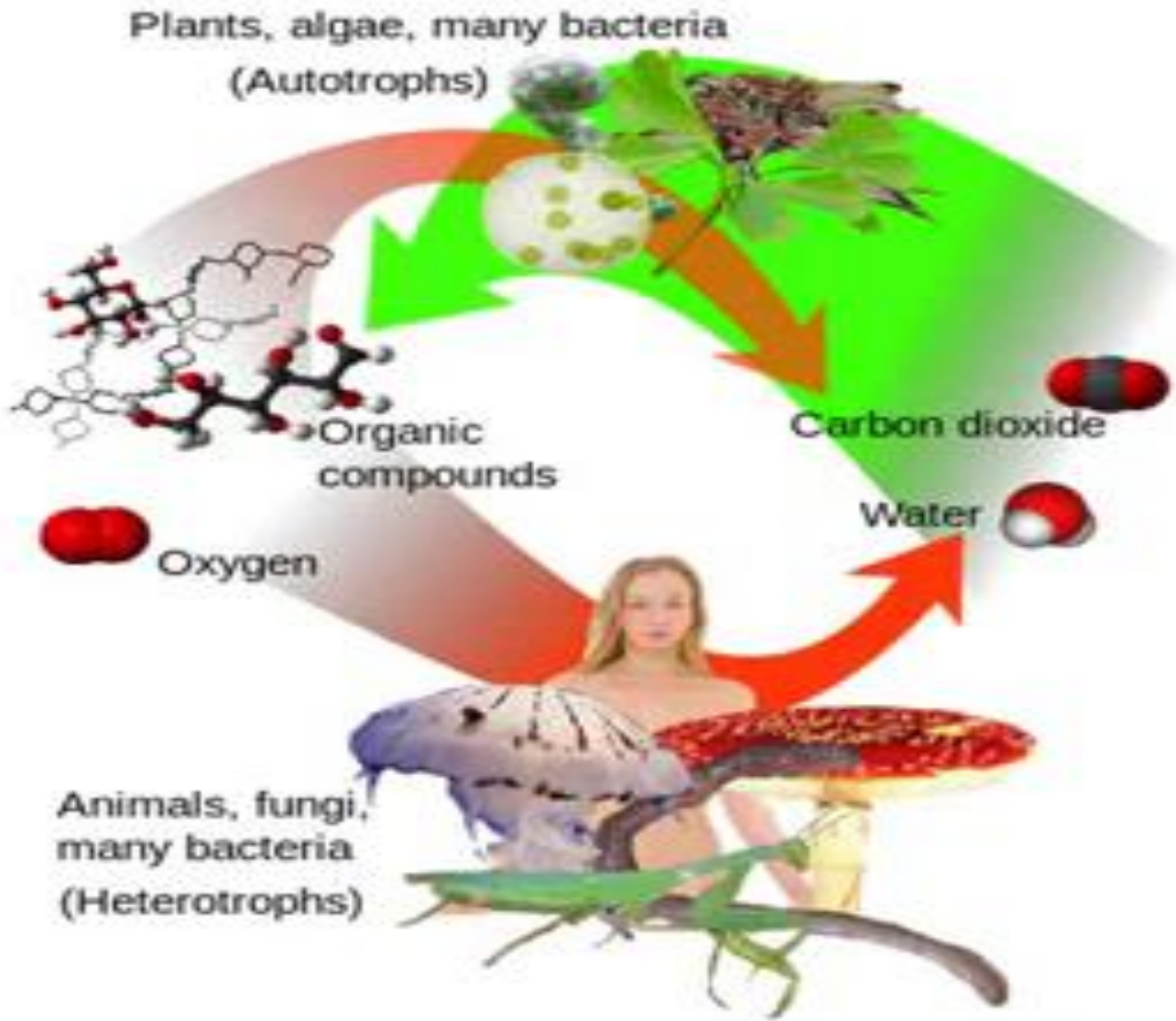
Plants, algae, many bacteria
(Autotrophs)
Organic
compounds
Carbon dioxide
Water
Oxygen
Animals, fungi,
many bacteria
(Heterotrophs)

- **<u>(b) Heterotrophic Component or Consumers</u>**
- These are the components in which **utilization; rearrangement and decomposition of complex materials predominate**. The consumers are further categorized as:
- **(i) Macroconsumers**
- Marcoconsumers are the consumers, which in a order as they occur in a food chain are, herbivores, carnivores (or omnivores).
- (*a*) **Herbivores** are also known as primary consumers.

- (*b*) **Secondary** and tertiary consumers, if preset, **are carnivores or omnivores. They include animals that ingest other organic and particulate** organic matter.
-
- (ii) **Microconsumers**
- These are popularly known as **decomposers**. They are saprotrophs (=**osmotrophs**) they include mainly **bacteria, actinomycetes and fungi**. They breakdown complex compounds of dead or living protoplasm, they **absorb some of the decomposition or breakdown products.** Based on the type of nutrition and the energy source used.

- Besides, they **release inorganic nutrients in environment, making them available again to autotrophs**.
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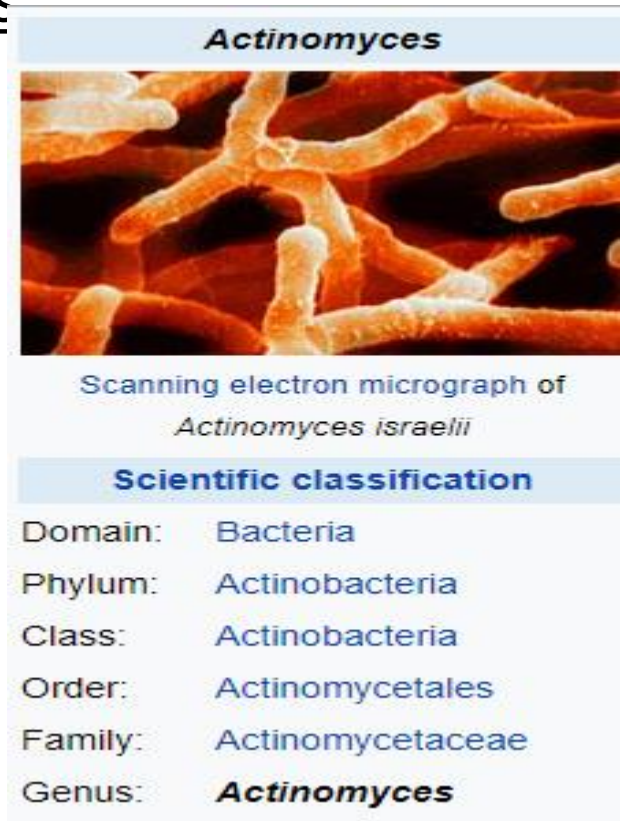
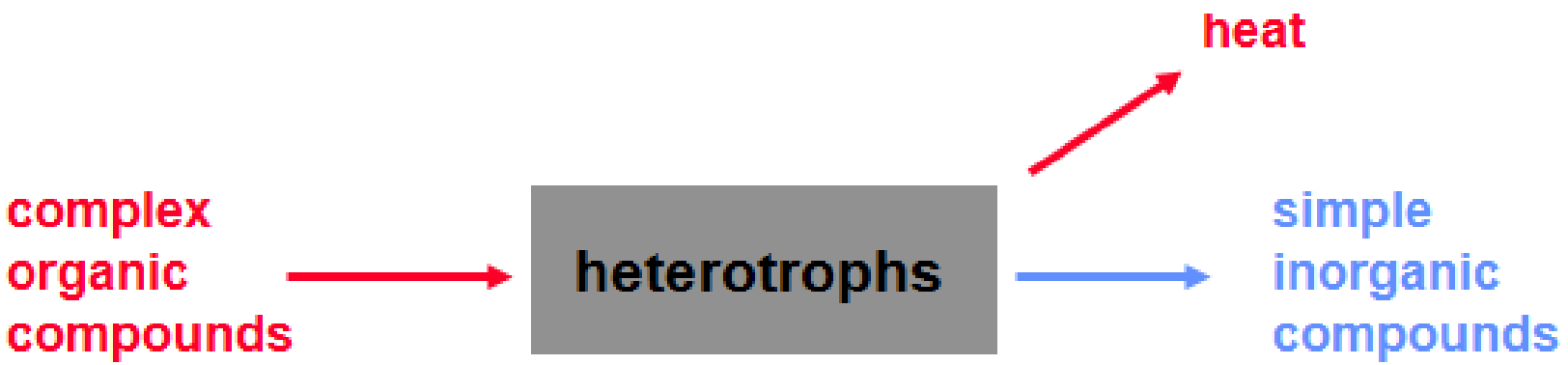
- The **trophic structure of an ecosystem is one kind of producer consumer arrangement, where each "food"** level is known as **trophic level**.

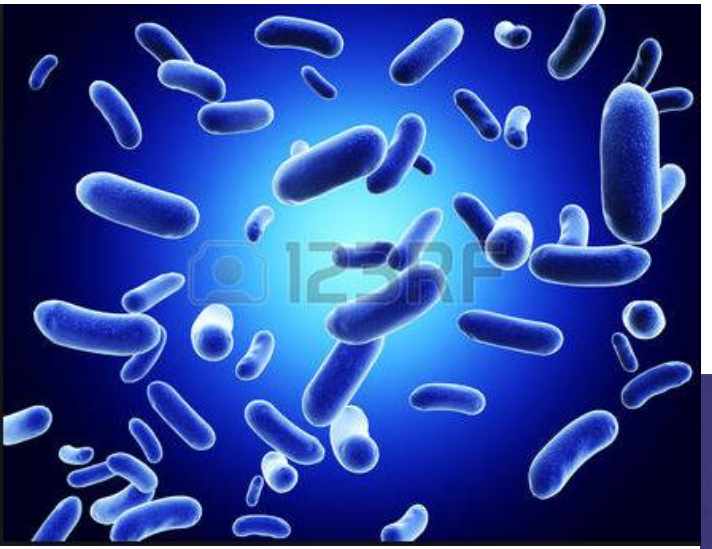


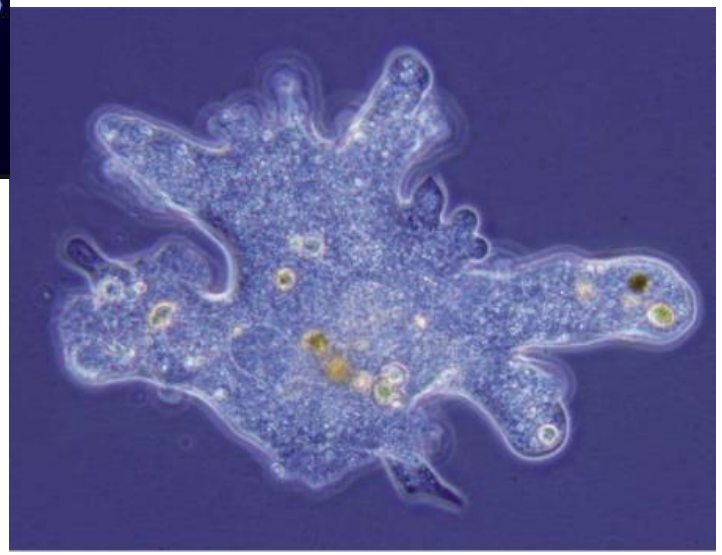
- **Heterotrophs** (=other-nourishing) cannot produce their own food directly from sunlight+ inorganic compounds. They require energy previously stored in complex molecules.

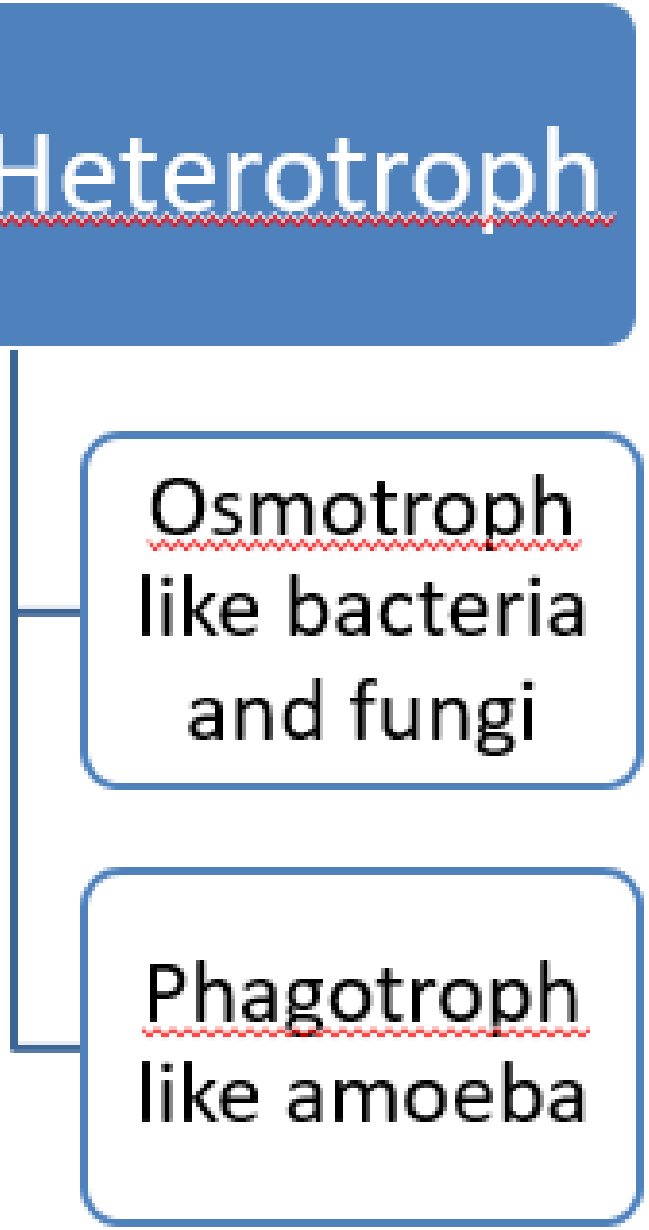


(this may include several steps, with several different types of organisms)

- Heterotrophs can be grouped as:
-
- consumers
- decomposers







- **Standing Corp**
- The **amount of living material in different trophic levels or in a component population is known as the standing corp**.

The standing crop may be expressed in terms

- **(*i*) Number of organisms per unit area,**
- **(*ii*) Biomass *i.e.* organism mass in unit area, we can measure it as living weight, dry weight, ash-free dry weight of carbon weight,** or calories or any other convenient unit suitable.

Decomposers

- **In the absence of decomposers, no ecosystem could function long. In their absence, dead organisms would pile up (COLLECTED) without rotting, as would waste products**, the reason is **the dead corpses littering the landscape**. **The decomposers tear apart organisms and in their metabolic processes release to the environment atoms and molecules that can be reused again by autotrophic point of view**
- **Energy cannot be recycled, but matter can be**. **Matter must be recycled again and again by an ecological process called biogeochemical cycle.**
-

- **Ecosystems can be classified in to:**

Complete ecosystem •

- **All ecosystem that have all components** (biotic and a biotic) considered complete ecosystem like **river, forest or ornament pool fishes.**

Incomplete ecosystem •

- **Some ecosystem is not contained one or more of the basic component (biotic or a biotic) is called incomplete ecosystem** like **depth of the oceans** , in this region not found producer because the light is not reach in this depth, and the **cave is other example in this side**.

There are two types of Microecosystem:-

- **1-Microecosystem** derived directly from nature by multiple seeding of culture media with environmental samples.
- **2-System** built up by adding species from axenic culture (free from others living organisms) until the desired combinations are obtained.

- ***Homeostasis in the ecosystem***
- **Ecosystem** is capable of self-maintaining and self-relation as are their component population and organisms. **Homeostasis** is term generally **applied to the tendency for biological systems to resist change and remain in a state of equilibrium**. **Any disturbance in ecosystem considered as pollution**.

General characteristics of an ecosystem

According to Smith following are the general characteristics of eco-system.

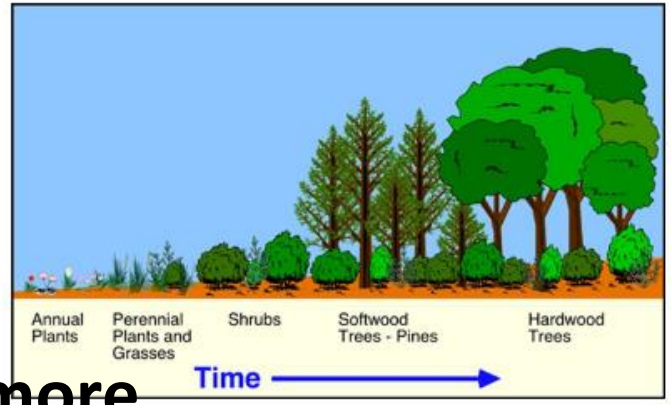
(1) The ecosystem is a **major structural and functional unit of ecology**.

(2) The **structure of an eco-system is related to its species diversity; as such the more complex ecosystem has high species diversity.**

(3) The **relative amount of energy required to maintain an ecosystem**. **The more complex the structure, the lesser the energy it requires to maintain itself.**

(4) The **function of the ecosystem is related to energy flow and material cycling.**

Plant Succession



- (5) E**cosystems mature by passing from less complex to more complex states. Early stages of such succession have an excess of potential energy. Later (mature) stages have less energy accumulation.**
- (6) Both the **environment and the energy fixation in any given ecosystem are limited. They cannot be exceeded in any way without causing serious undesirable effect.**
- (7) **Alterations in the environments** represent selective **pressures upon the population to which it must adjust**. **Organisms, which fail to adjust to the changed environment, must vanish.**

- **To conclude the eco-system is an integrated unit or zone of variable size, it comprises: vegetation, fauna, microbes and the environment.**

Basic Theme (Subject) of Ecosystems

- **(1) Relationship**
- The first and foremost **theme of an ecosystem in that everything is somehow or other related to everything else**, the **relationships include interlocking functioning of organisms among themselves besides with their environment**.
-
- **(2) Limitation**
- The second basis theme is **Limitation which means that limits are ubiquitous (wide distribuation) and that no individual or species goes on growing indefinitely**. Various **species control and limit their own growth** in response to **overcrowding or other environmental signals and the total numbers keep pace (Speed) with the resources variable.**

- **(3) Complexity**
- **Complexity** is a third characteristic of any eco-system**. The three-dimensional interactions** of the various constituent elements of an ecosystem are highly complex and often beyond the **comprehension on the human brain.**

- **Function of an ecosystem**
- **The function of ecosystems includes the process *how an eco-system works or operates in normal condition which are:***

- **1. Transformation of Solar Energy into Food Energy**
- The **solar radiation is major source of energy in the ecosystem**. **The green plants receive it. And is converted into heat energy.**

- **2. The Circulation of elements through Energy Flow**
- It is seen that in the various biotic components of **the ecosystem the energy flow is the main driving force of nutrient circulation**. **The organic and inorganic substances are moved reversibly through various closed system of cycles in the biosphere, atmosphere, hydrosphere and lithosphere.**
-

- **3. The Conversion of Elements into Inorganic Flow**
- The organic elements of plants and animals are released in the under mentioned ways:
- (*i*) **Decomposition of leaf falls from the plants dead plants and animals by decomposers** and their conversion into **soluble inorganic form**.
- (*ii*) **Burning of vegetation by lighting, accidental forest fire or deliberate action of man. When burnt, the portions of organic matter are released to the atmosphere and these again fall down, under the impact of precipitation, on the ground. Then they become soluble inorganic form of element to join soil storage, some portions in the form of ashes are decomposed by bacterial activities**.
- (*iii*) **The waste materials released by animals are decomposed by bacteria. They find their way in soluble inorganic form to soil storage**.

- **4. The Growth and Development of Plants**
- In the **biogeochemical cycles are included the uptake of nutrients of inorganic elements by the plants through their roots**. The nutrients are derived from the soil where these inorganic elements are stored. **The decomposition of leaves, plants and animals and their conversion into soluble inorganic form are stored into soil contributing to the growth and development of plants.**
-
- **5. Productivity of ecosystem**
- The productivity of an ecosystem refers to the rate of production i.e. the **amount of organic matter, which is accumulated in any unit time**.

Productivity is of the following types:

(1) Primary productivity:

Primary productivity is the rate of energy capture by producers.

= the amount of new biomass of producers, per unit time and space. Primary productivity is further distinguished as:

Gross primary productivity: Gross Primary Productivity is the **rate of storage of organic matter in plant tissues in excess of the respiratory utilization by plants during the measurement period**.(Gross primary production (GPP)= total amount of energy captured).

- (2) **Secondary productivity:** T***hese are the rates of energy storage at consumer's level***. **Since consumers only utilize food materials (already produced) in their respiration, simply covering the food matters to different tissues by an overall process. The secondary productivity is not divided into 'gross' and 'net' amount.**

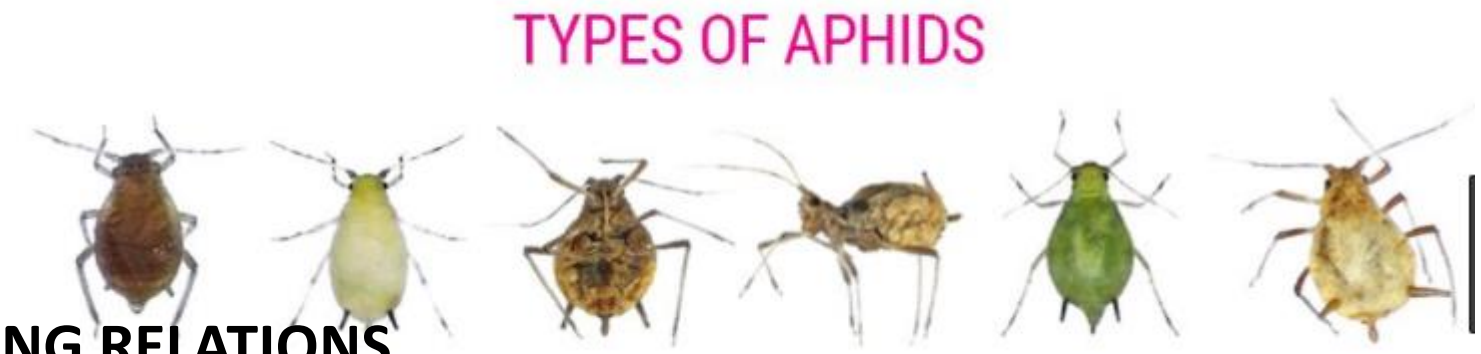
(3) **Net Productivity:** Net productivity refers to the **rate of storage of organic matter not used by the heterotrophs (consumer) i.e. equivalent to net primary production minus consumption by the heterotrophs during the unit period.** It is thus **the rate of increase of biomass of the primary producers, which has been left over by the consumers**.

Net primary production (NPP)= GPP - respiration

Net primary production is thus the amount of energy stored by the producers and potentially available to consumers and decomposers.

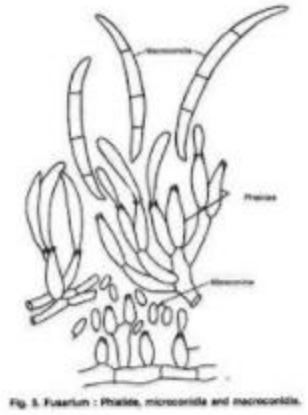
(4) **Stability of Ecosystem:** The stability of ecosystems refers to the **balance between production and consumption of each element in the ecosystem**.

- **Function of Decomposition**
- The two major functions of decomposition within ecosystems are as under:-
- **(1) The mineralization of essential elements,**
- (2) The **formation (conversion) of soil organic matter to inorganic form**.
- The **formation of soil organic matter in nature is a slow process**. **The decomposition of any piece of plant detritus may take hundreds of years to complete. However, some residues of decomposition within this period do contribute to the formation of soil organic matter.**



- **DECOMPOSERS WITH VARYING RELATIONS**
- Some **decomposer organisms cannot be assigned a rigid or fixed position in the food web. Their trophic relations can vary from time to time.**
-
- **1. Nectroph:** Some decomposers are nectrophs. **They cause rapid death of the food source because they have a short-term exploitation of living organism**. **Nectrophs include many plant parasitic microbes as well as some herbivores, predators, and microtrophs (organisms which feed on living bacteria and fungi.)**
- **2. Biotrophs:** On the other hand biotrohps resort to a **long-term exploitation of their living food resource. For example, root-feeding nematodes and aphids**, **obligate plant parasites**, *e.g.,* and mycorhizae and root nodules, *etc.*
- **3. Sapotrophs:** The apostrophes utilize food already dead and most of the decomposers belong to this category.






- **Decomposers occupying different trophic levels**
- There are some such organisms causing **decompositions as can occupy various trophic levels under different conditions**. For instance the **root parasites like *Fusarium and Thizoctonia* are necrotrophs**, which often show a saprotrophic tendency. **In the same way, the predators (foxes and kites) sometime behave as saprotrophs. Biotrophs sometime act as necrotrophs or as saprotrophs.**