

Ecosystem

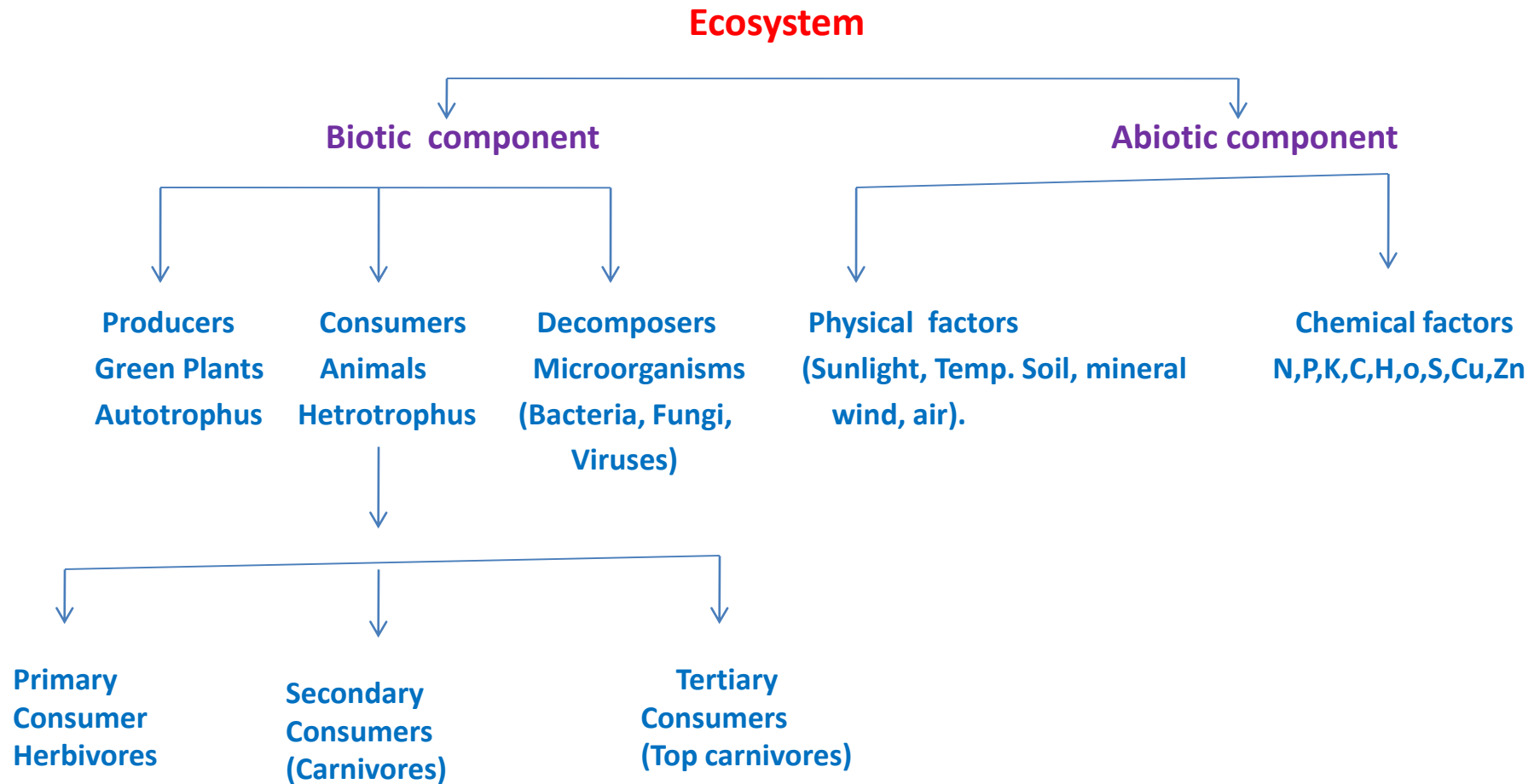
- It is derived from **Greek word...**
Oikos- home
Logy – to study
- So ecology deals with the study of organism in their natural home interacting with each other.
- The term Ecosystem was first defined by **A.G.Tansley** in **1935**.
- **Definition- “The system resulting from integration of all living organism and nonliving factors of the environment”**
 - **OR .**
- **Definition- “The combination of biotic (living organism) and abiotic (Non-living) component which are interacting with each other.”**

What is an Ecosystem?

- All living organisms + the nonliving environment in a certain geographical location
- In other words, an ecosystem is made up of biotic as well as abiotic factors
- Examples: a pond, a forest, an estuary, a grassland



Structure and function of an ecosystem



Abiotic Components

- These include the non-living, physico - chemical factors such as air, water, soil and the basic elements and compounds of the environment.
- Abiotic factors are broadly classified under two categories.
- **Physical factors** - which include the climatic regime and physical factors of the environment like light, humidity, atmospheric temperature, wind, etc.
- **Chemical factors** - like water, carbon, sulphur, nitrogen, phosphorus and so on. Organic substances like proteins, lipids, carbohydrates, humic substances etc.

Abiotic Factors



Biotic Components

- **It comprises the living part of the environment, which includes the association of a number of interrelated populations belonging to different species in a common environment.**
- **The populations are that of animal community, plant community and microbial community.**

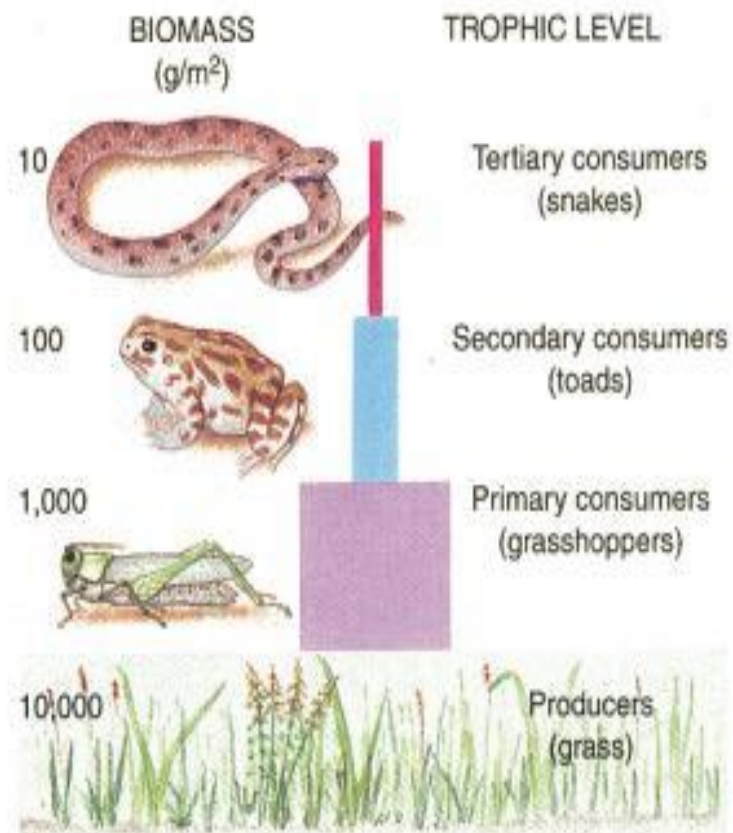
- **Producers :-** Autotrophs (auto - self, trophos - feeder)
- These are photosynthetic plants, generally chlorophyll bearing, which synthesize high-energy complex organic compounds (food) from inorganic raw materials with the help of sunlight, and the process is referred as photosynthesis.
- **Autotrophs** form the basis of any biotic system.
- In terrestrial ecosystems, the autotrophs are mainly the rooted plants.
- In aquatic ecosystems, floating plants called phytoplankton and shallow water rooted plants called macrophytes are the dominant producers.

Consumer

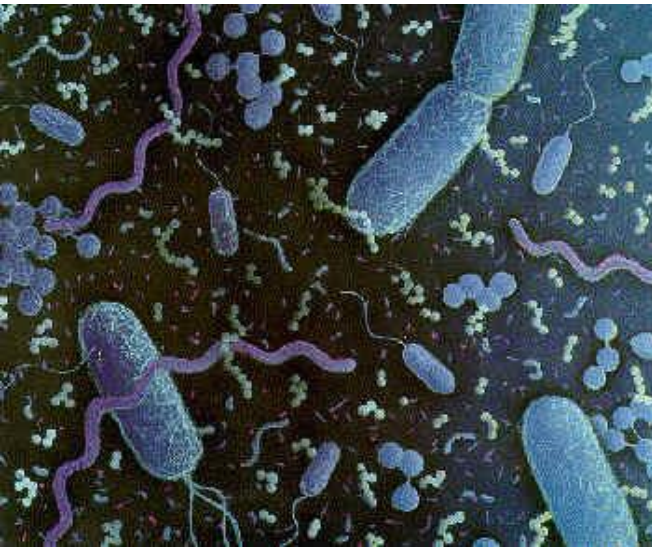
- All organisms which get their organic food by feeding upon other organism are called as Consumer.
Heterotrophs (heteros - other; trophs - feeder)

Three types-

- **Primary Consumer** :- They feed directly on producers and hence also known as Herbivores.
- **Secondary Consumers** :- They feed on other consumers. If they feed on herbivores they are called as carnivores
- **Tertiary Consumers** :- They feed on both plants and animals .also called as top carnivores



Biotic Factors





Carnivore



Carnivore



Carnivore



Herbivore



Plant

**Quaternary
consumers**

**Tertiary
consumers**

**Secondary
consumers**

**Primary
consumers**

**Primary
producers**

A TERRESTRIAL FOOD CHAIN

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Carnivore



Carnivore



Carnivore



Zooplankton



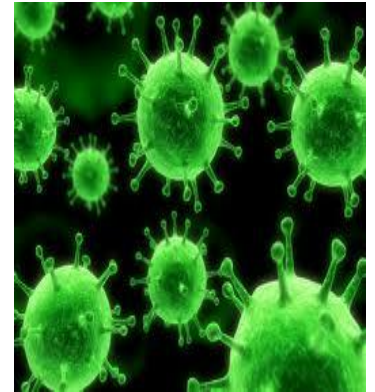
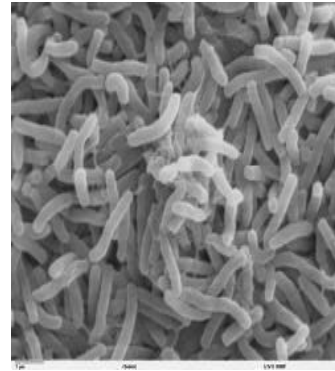
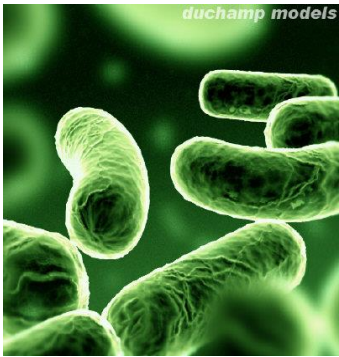
Phytoplankton

A MARINE FOOD CHAIN

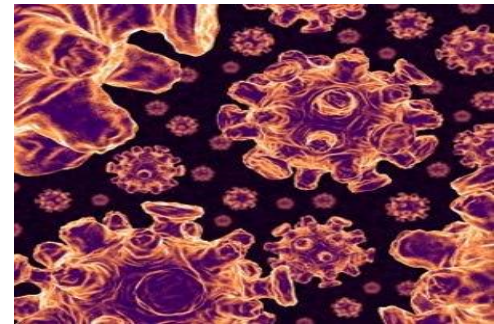
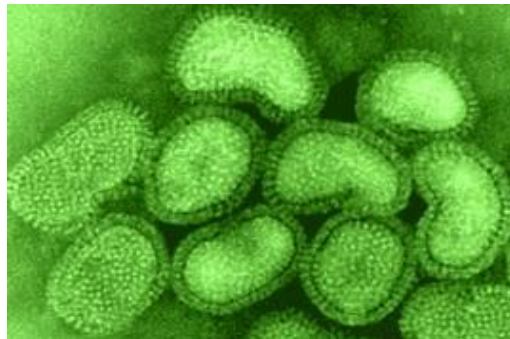
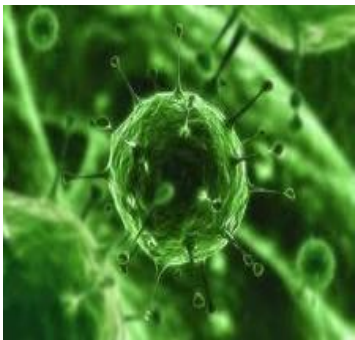
- **Decomposers:-**

- They derive their nutrition by breaking down the complex organic molecules to simpler organic compounds and ultimately in to inorganic nutrients like C,H,O,N,P,K,S etc.

e.g . Bacteria , Viruses ,Fungi.



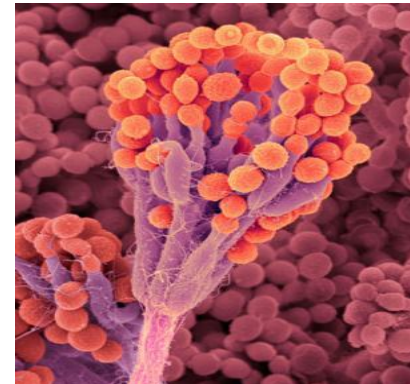
Bacteria



Viruses



Fungi.



Food chain

- "Food chain is a series of groups of organisms called trophic levels, in which, there is repeated eating and eaten by so as to transfer food energy".
- Or
- "The sequence of eating and being eaten in an ecosystem is called a food chain".



Carnivore



Carnivore



Carnivore



Herbivore



Plant

**Quaternary
consumers**

**Tertiary
consumers**

**Secondary
consumers**

**Primary
consumers**

**Primary
producers**

A TERRESTRIAL FOOD CHAIN

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Carnivore



Carnivore



Carnivore



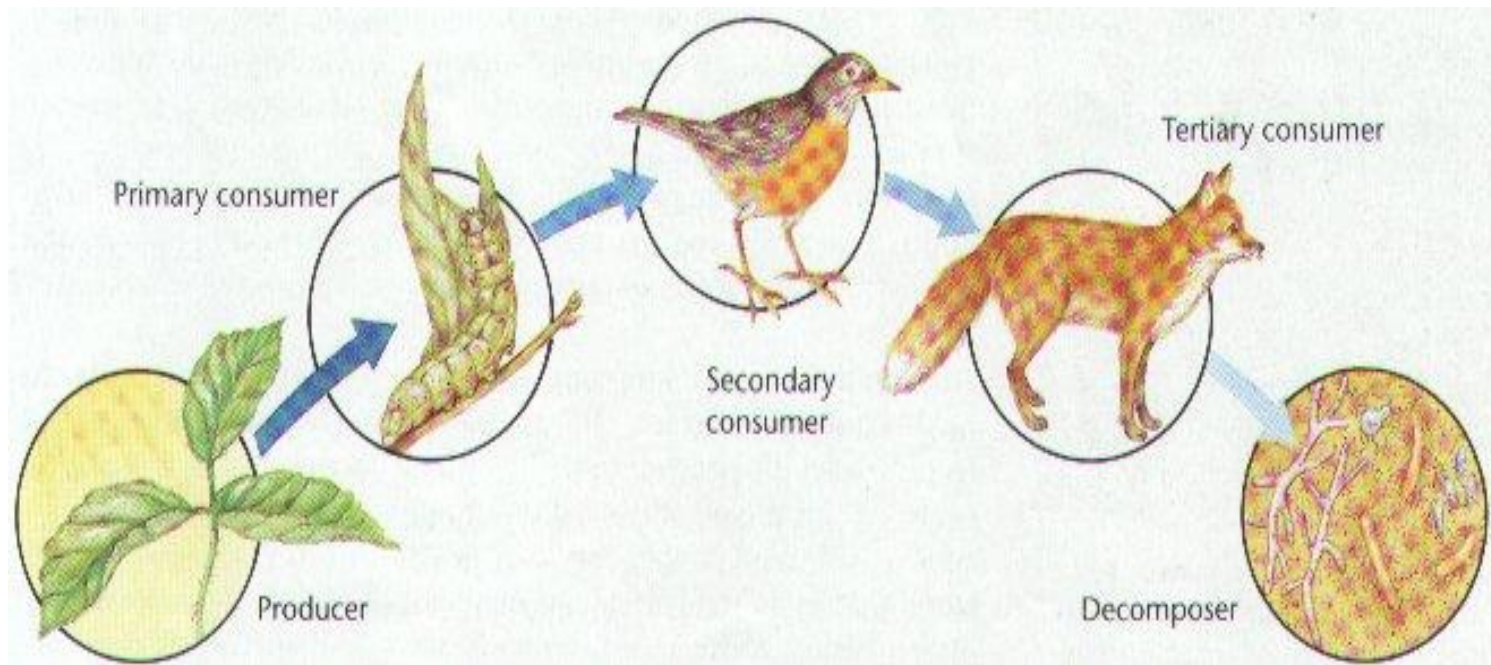
Zooplankton



Phytoplankton

A MARINE FOOD CHAIN

Example of a Food Chain



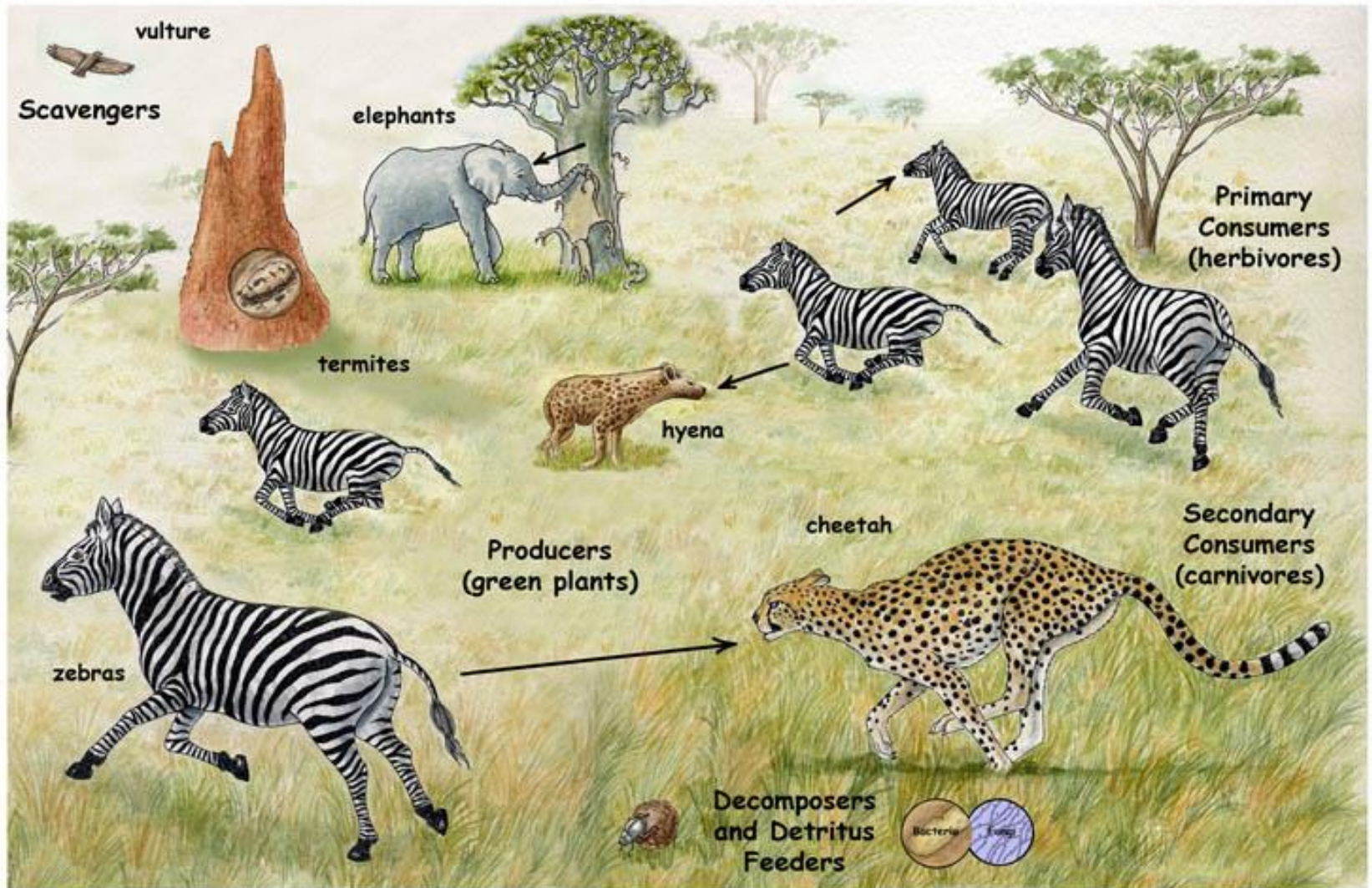
- **There are mainly two types of food chains operating in nature.**
- **a) Grazing food chain**
- **b) Detritus food chain.**

Grazing type food chains-

- which is start from green plants in to herbivores and then into carnivores, then it is called as Grazing food chain. and depend upon solar energy

Type of Ecosystem	Producers	Herbivores	Primary Carnivores	Secondary Carnivores	Tertiary Carnivores
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	Lions Tigers Etc.	

Grassland Food Web



Detritus Food Chain

Which starts from dead organic matter ,moves in microbes and then in to small microorganisms

Mangrove Fallen Leaves and Dead Bodies(Detritus)

Eaten By.....

Fungi, Bacteria and Protozoan's (Detritivores)

Eaten By.....

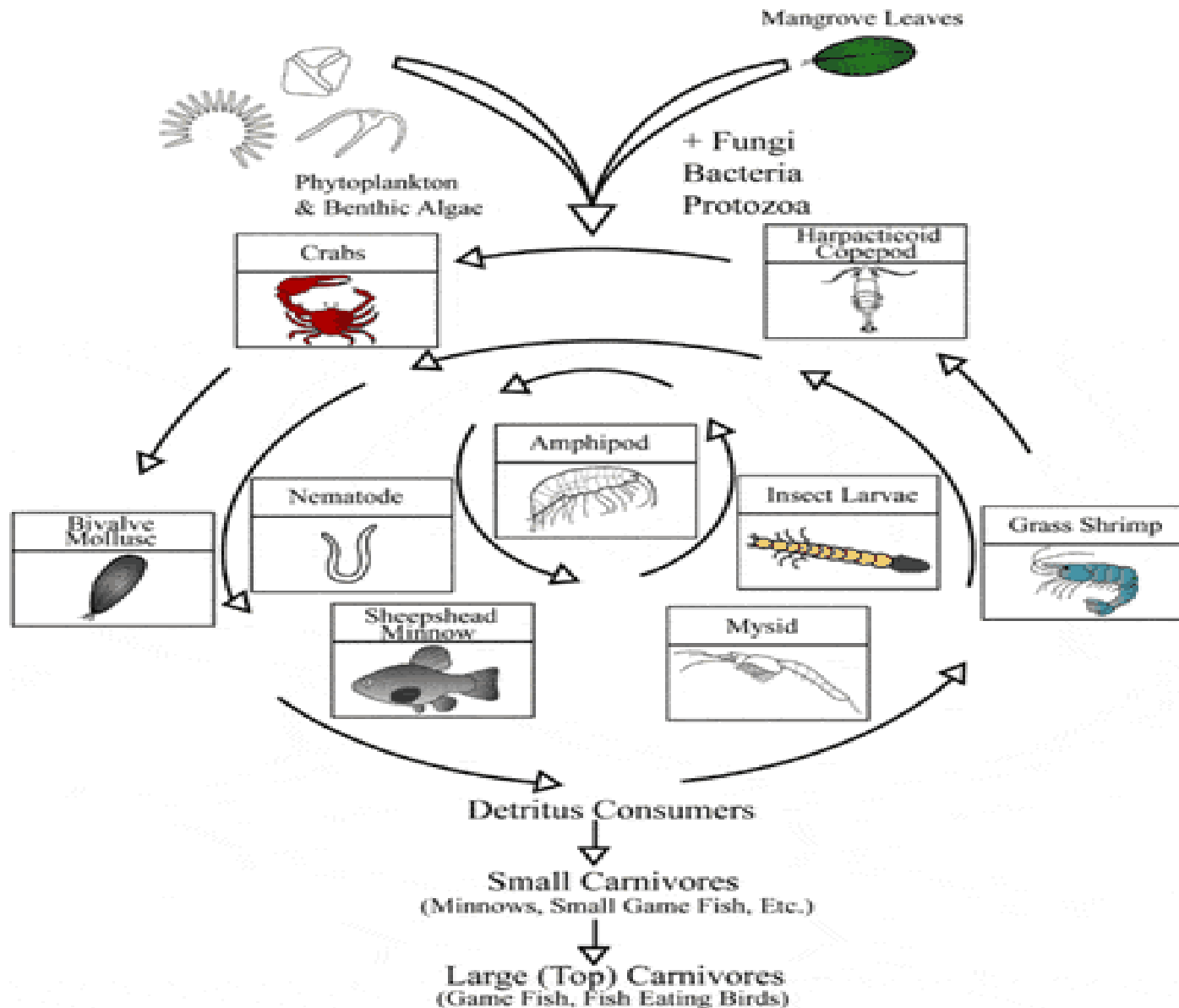
Insect Larvae,Certain Crustaceans,Molluscs and Fishes(Detritivores Consumers)

Eaten By.....

Minnows Small game fish etc.(Small Carnivores)

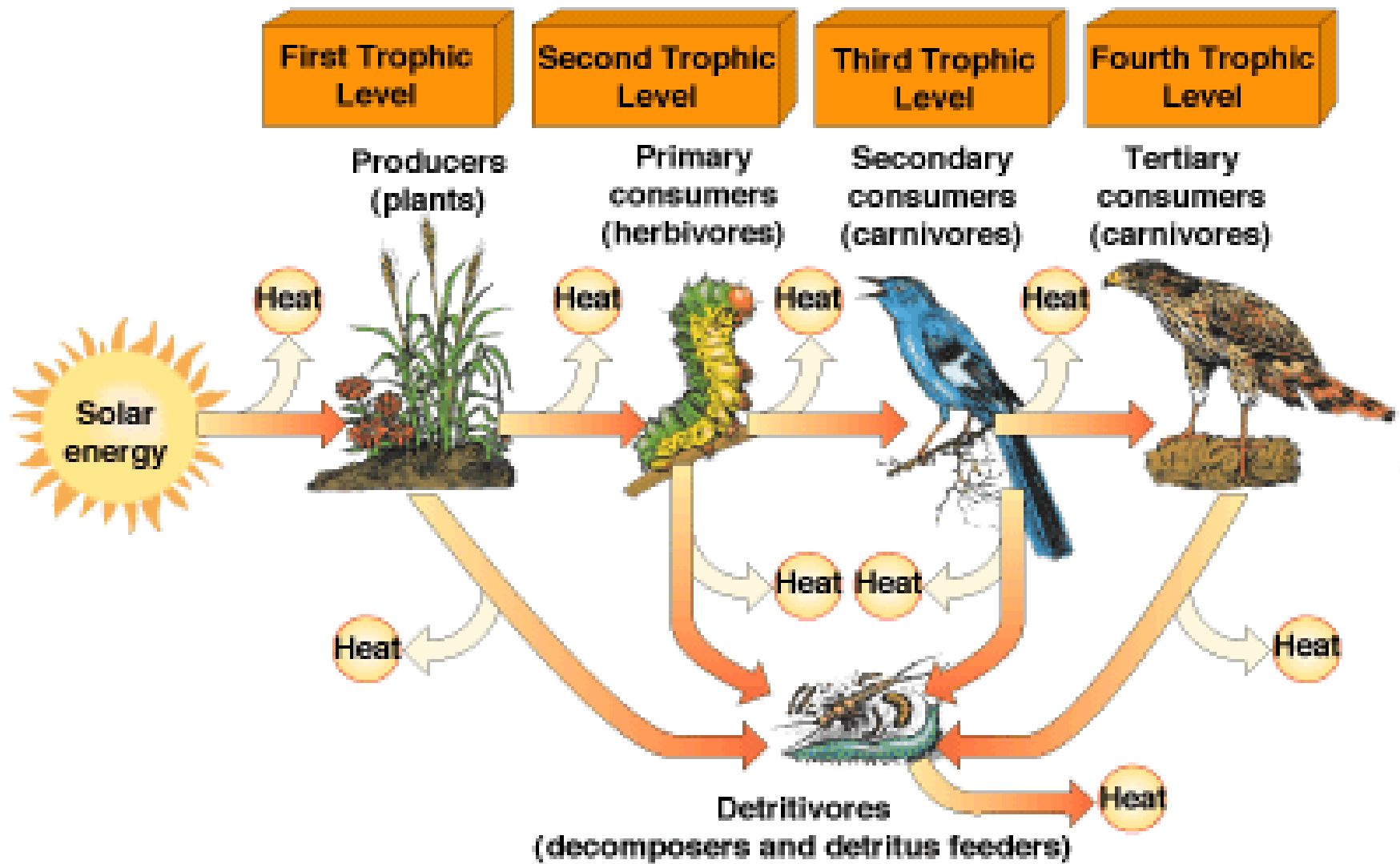
Eaten By.....

Large Fish, Fish eating Birds(Large Carnivores)

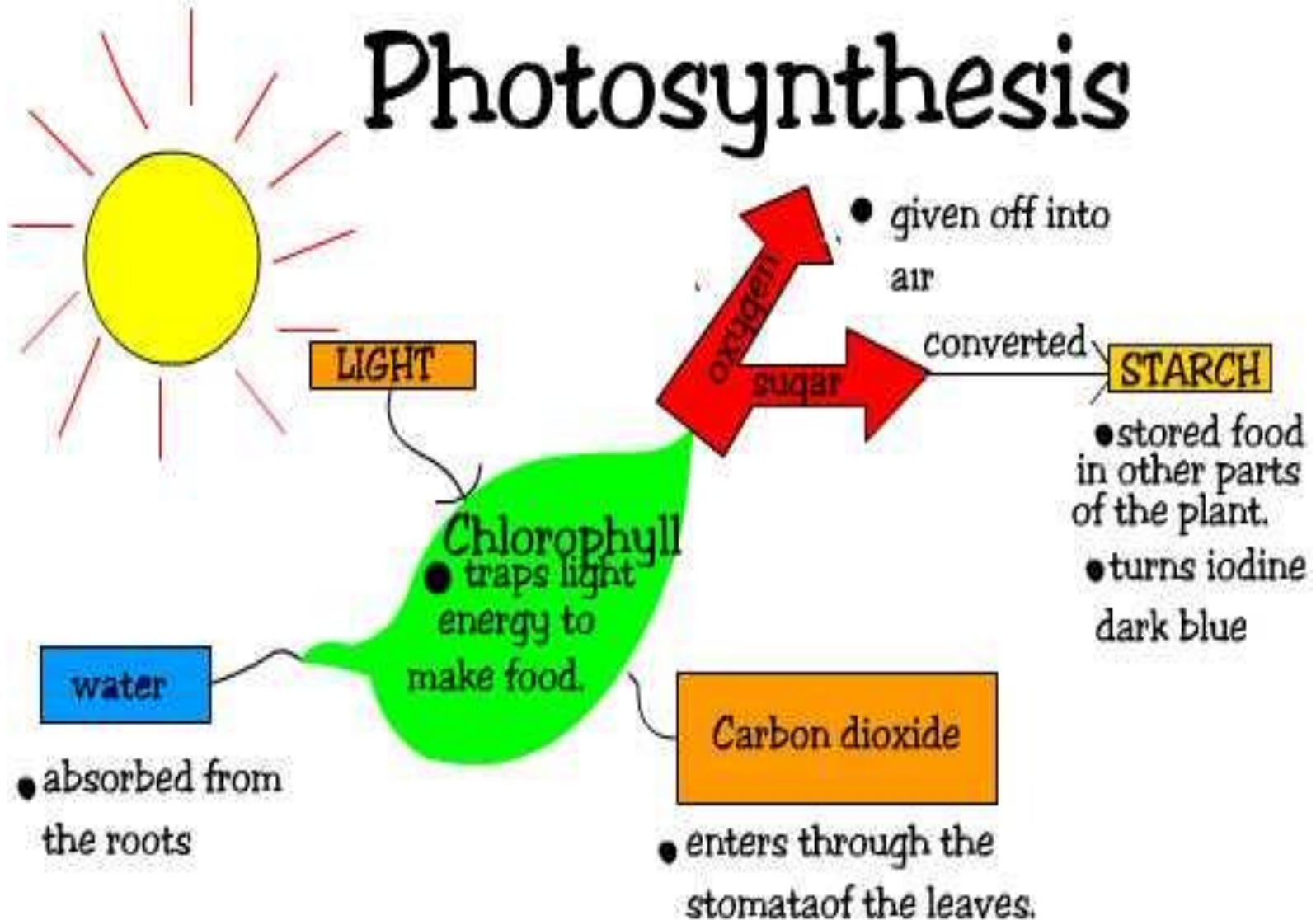


Energy Flow in an Ecosystem:-

- **Energy is the capacity to do work. Solar energy is transformed into chemical energy by the process of photosynthesis, and is stored in plant tissue and then transformed into mechanical and heat forms during metabolic activities.**
- **The energy, in the biological world, flows from the sun to plants and then to all heterotrophic organisms such as microorganisms, animals and man.**

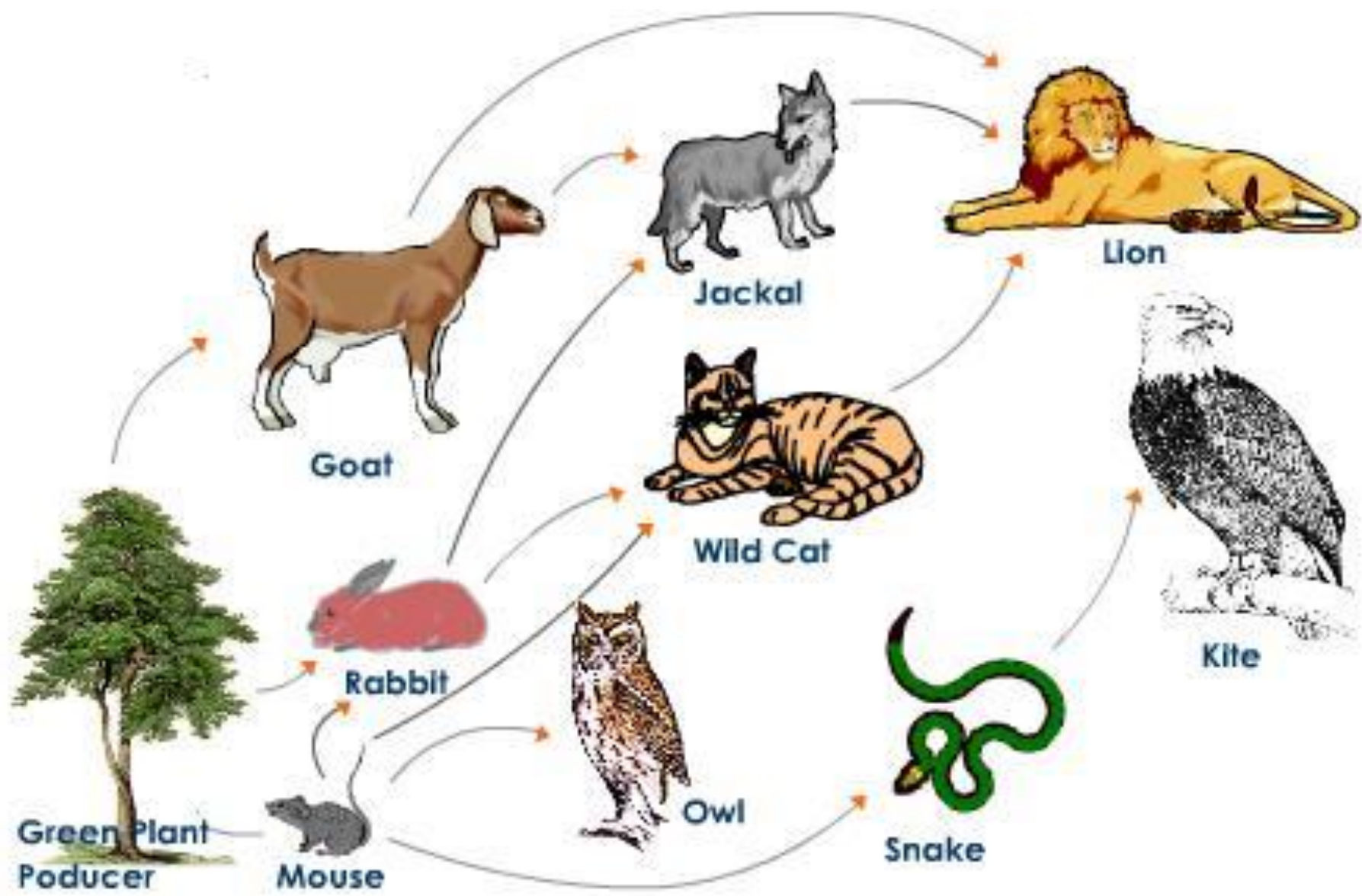


Photosynthesis

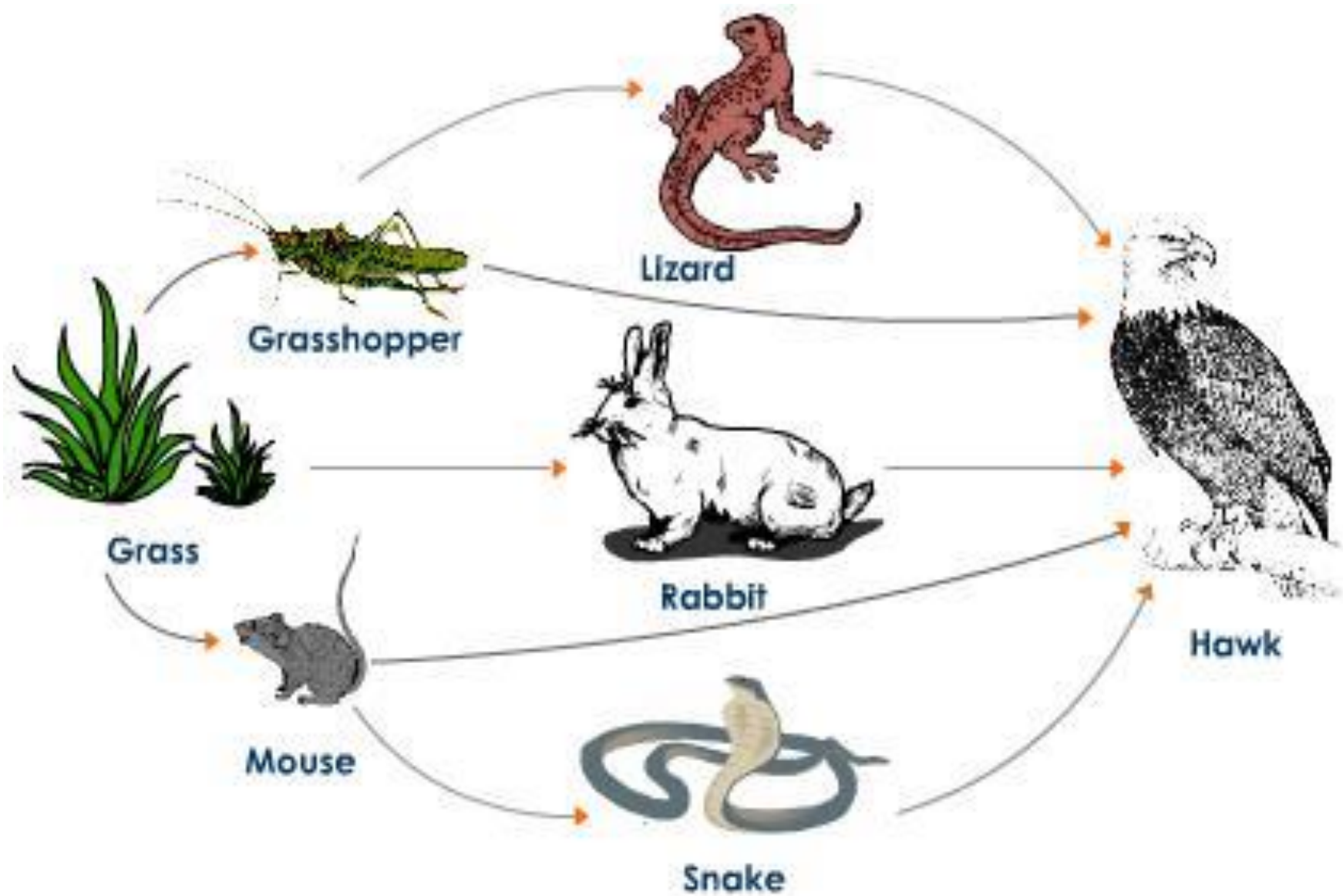


Food Webs

- **“The food web is network of food chain where different types of organisms are connected at different level so that there are number of options and being eaten at each trophic level”**

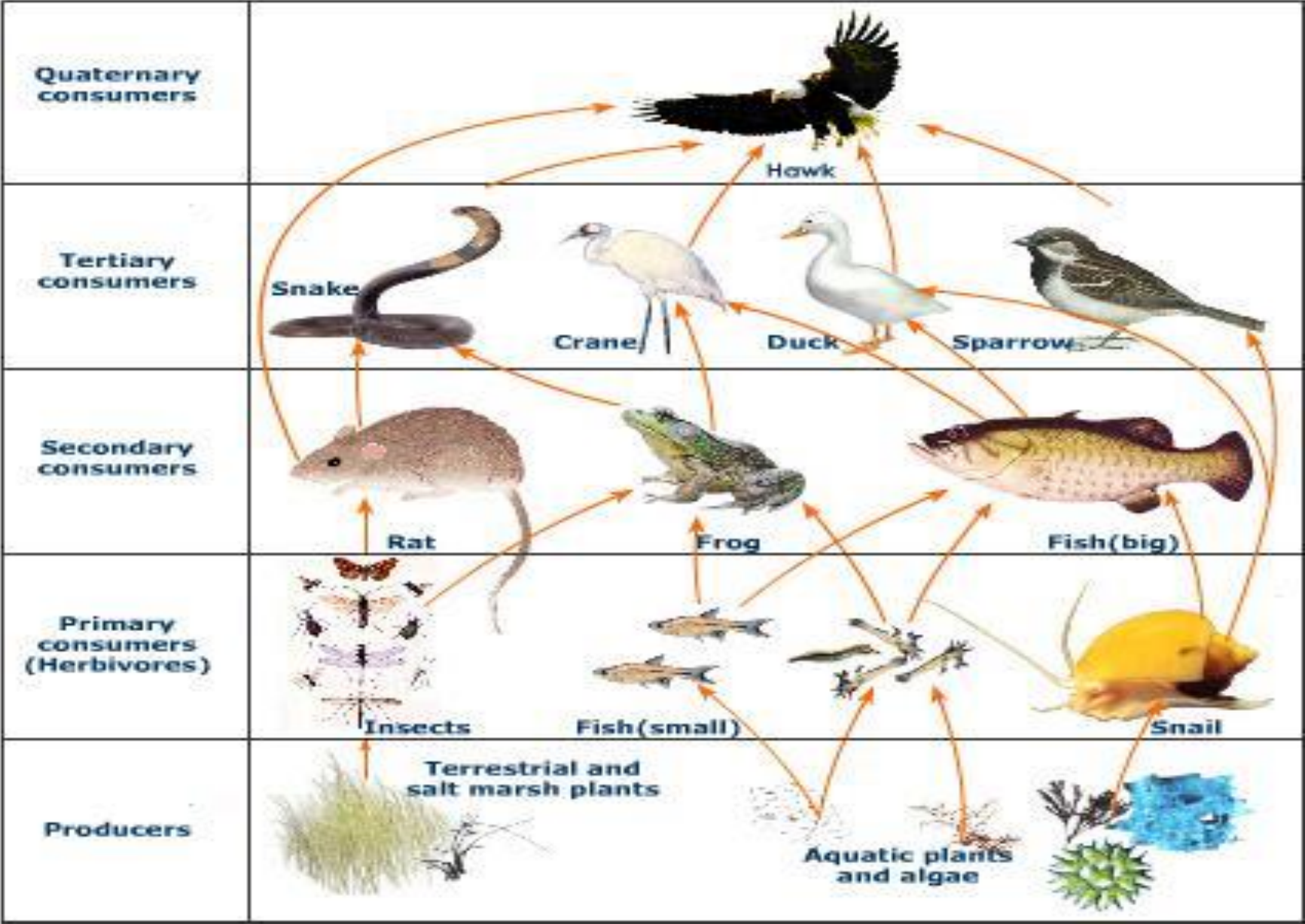


Food Web in a Forest



A Food Web in a Grassland Ecosystem With Five Possible Food Chains

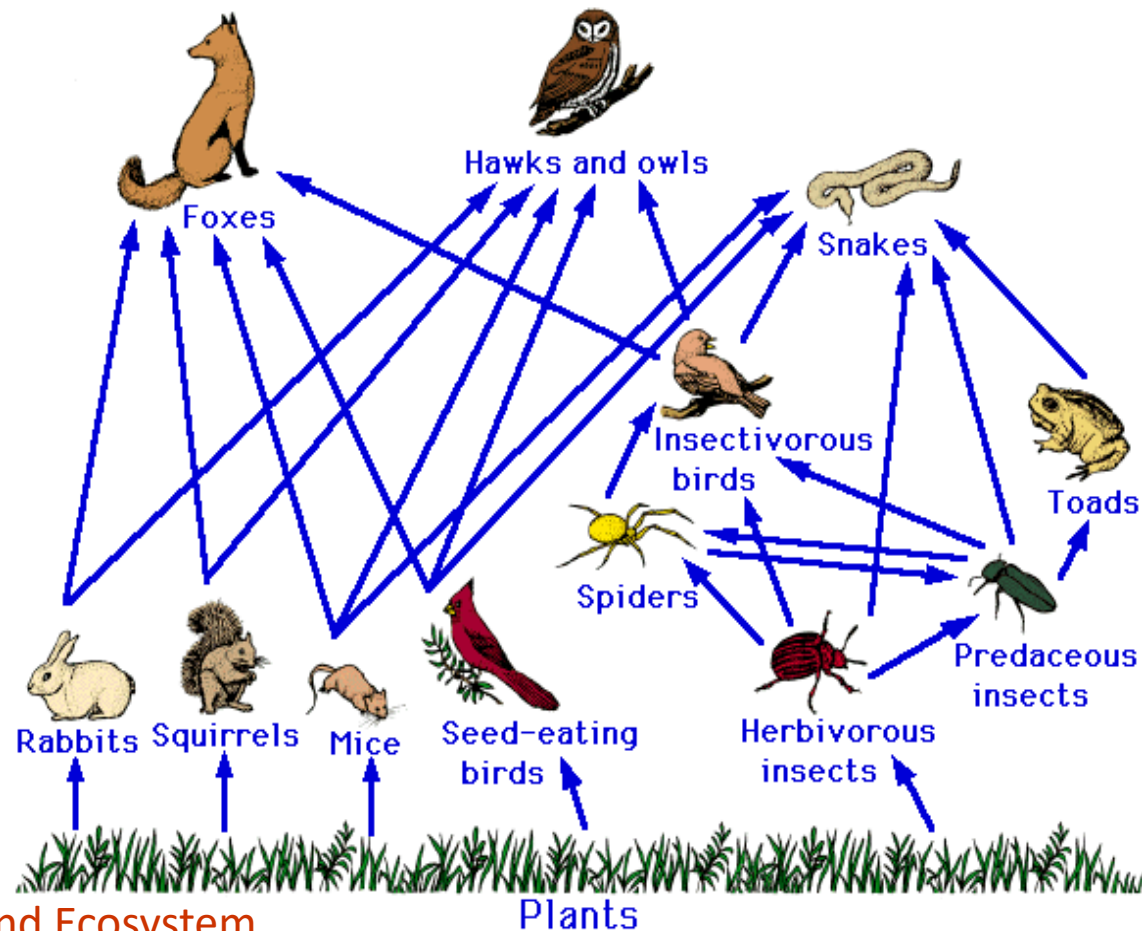
A Food Web in Terrestrial and Aquatic Ecosystem



A Food Web in Terrestrial and Aquatic Ecosystem

Food web:

- ❖ Interlocking pattern of several interlinked food chains is termed as FOOD WEB.
- ❖ Food web which maintain the stability of ecosystem.



Food Web in Grassland Ecosystem

Ecological pyramids

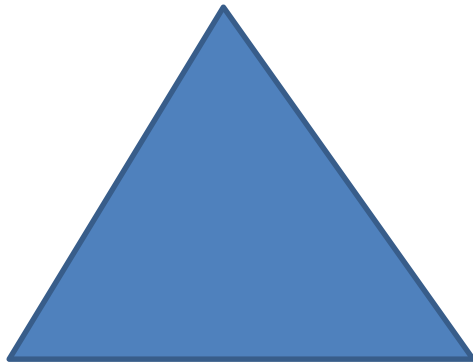
- Ecological pyramids are also called 'Eltonian pyramids' after C. Elton.
- Charles Elton (1927) developed the concept of ecological pyramids who noted that "...the animals at the base of a food chain are relatively abundant while those at the end are relatively few in number..."

Ecological pyramids can be defined as,

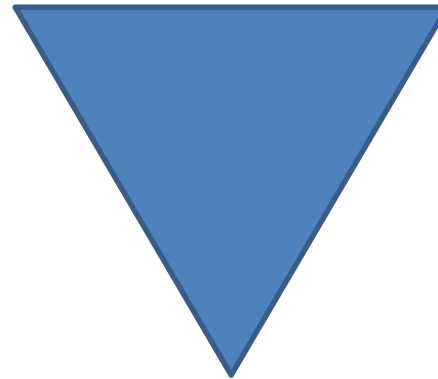
- Graphical representation of the trophic structure and function of an ecosystem ,starting with producers at the base and successive trophic levels forming the apex is know as Ecological pyramids .

Ecological pyramid

An ecological pyramid may be upright (tapering towards the tip or broad base and narrow apex), or inverted (widens towards the tip or narrow base and broad apex) or spindle shaped (broader in the middle and narrow above and below).



Upright in position



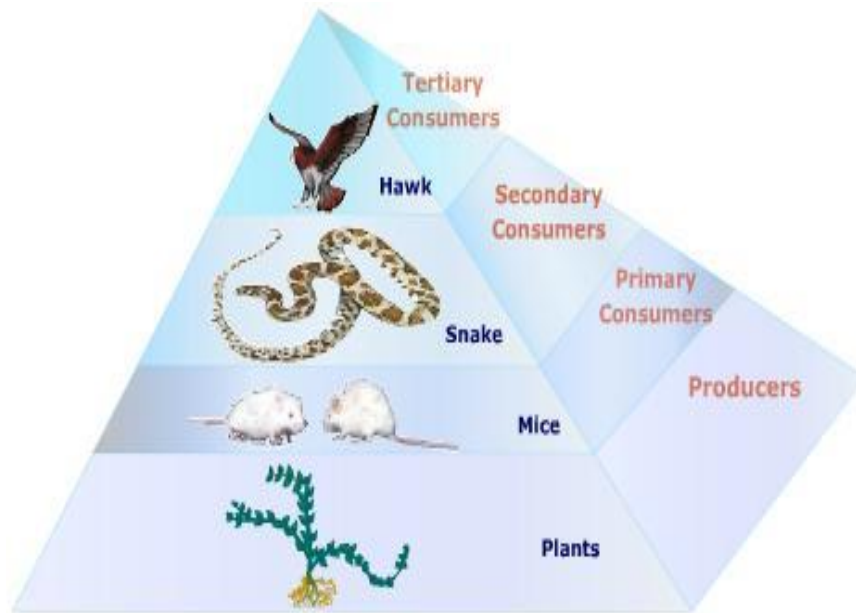
Inverted in position

– On the basis of the parameters used, ecological pyramids are of three types.

- **Pyramid of Numbers**
- **Pyramid of Biomass**
- **Pyramid of Energy**

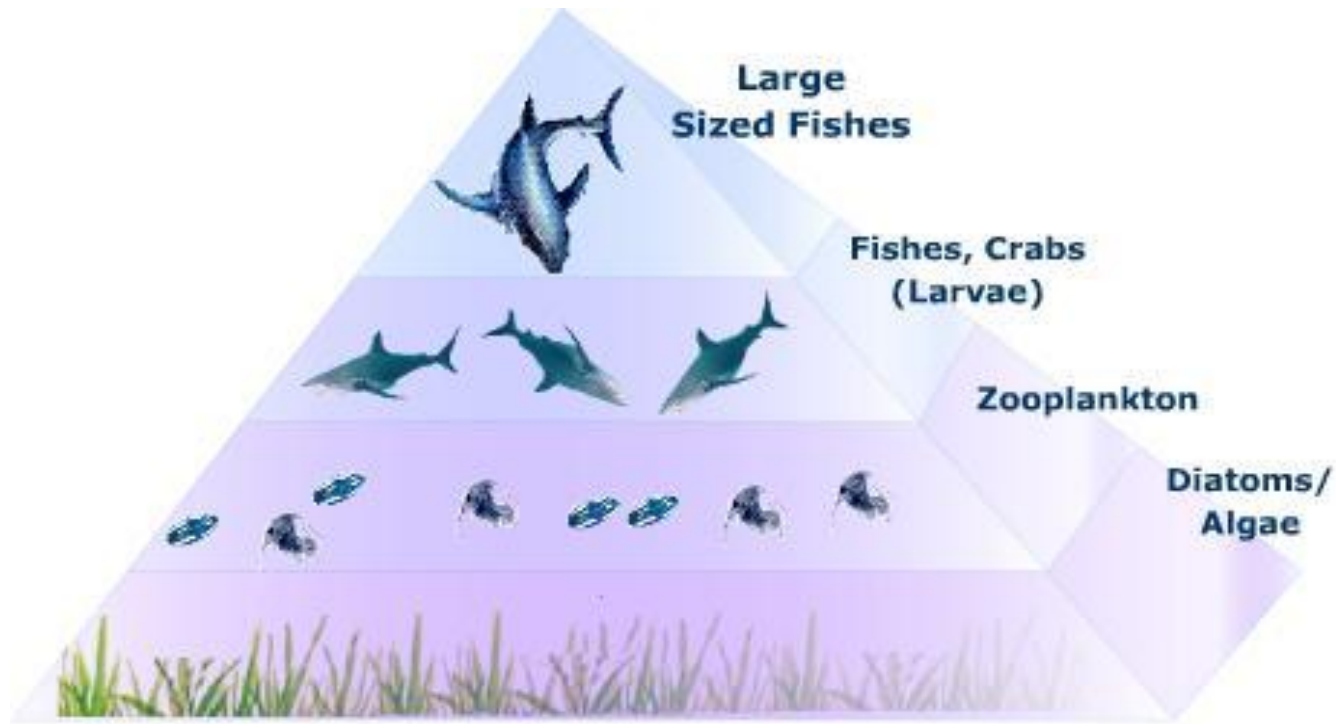
Pyramid of Numbers

- **Definition :- "Pyramid of numbers is the graphic representation of number of individuals per unit area of various trophic levels ".**



Pyramid of number in grassland ecosystem

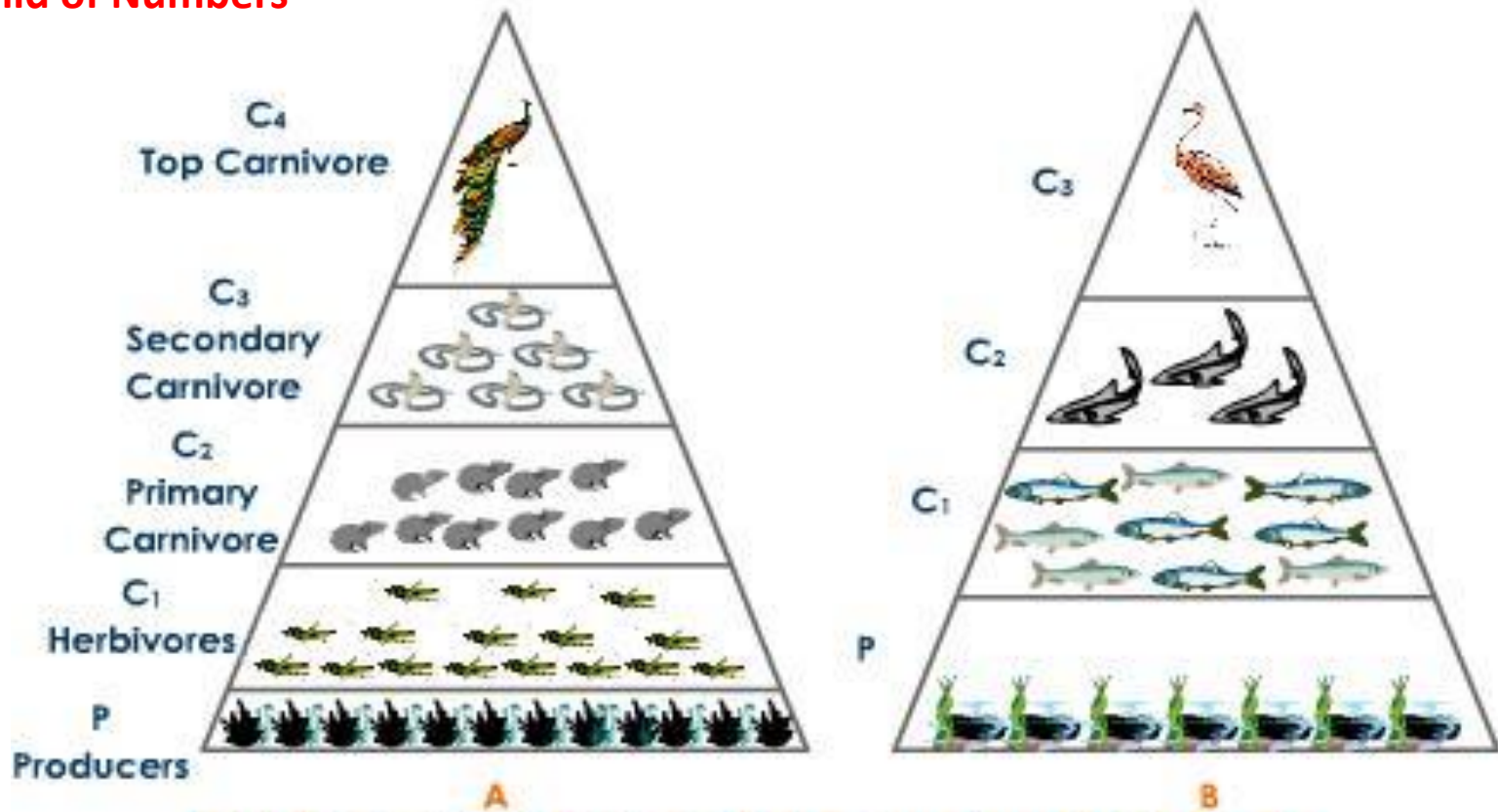
Pyramid of Numbers



- So, the producers are smallest sized but maximum in number while, top carnivores are larger in size but lesser in number, so these cannot be used as prey by another. Hence the pyramid of numbers is upright.

Pyramid of Numbers in a Aquatic Ecosystem

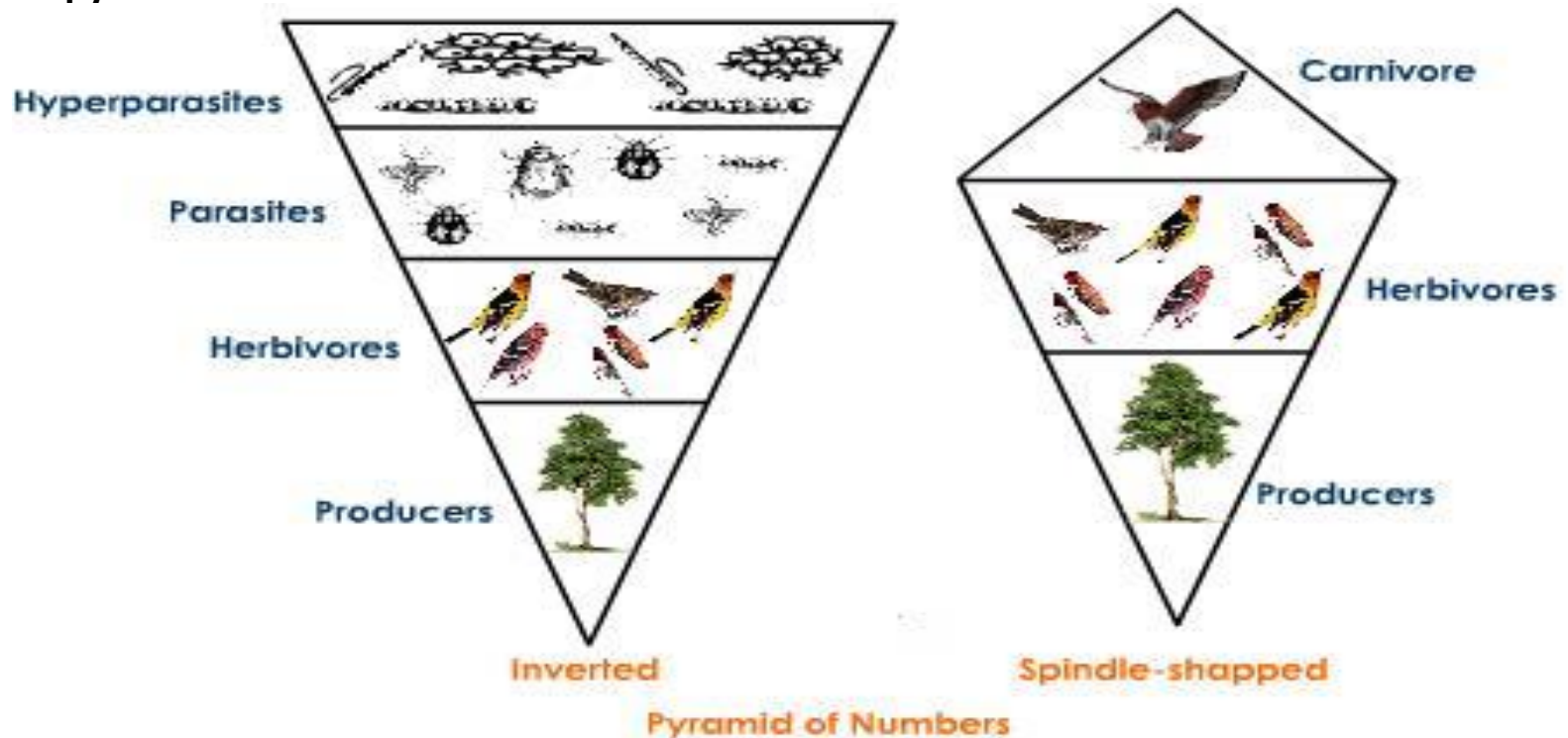
Pyramid of Numbers



Upright Pyramids of Numbers. (A) In a Grass Land (B) In a Pond

Pyramid of Numbers

- In a parasitic food chain, for e.g., an oak tree, the large tree provides food to several herbivorous birds. The birds support still larger population of ectoparasites leading to the formation of an inverted pyramid.
- When a large tree support larger number of herbivorous birds which inturn are eaten by carnivorous birds like falcon and eagle, which are smaller in number, it forms a spindle shaped pyramid.



Pyramid of biomass:-

- **"Pyramid of biomass is the graphic representation of biomass present per unit area of different trophic levels ".**
- **The total amount of living or organic matter in an ecosystem at any time is called 'Biomass'.**

Pyramid of biomass:-

Upright in Position

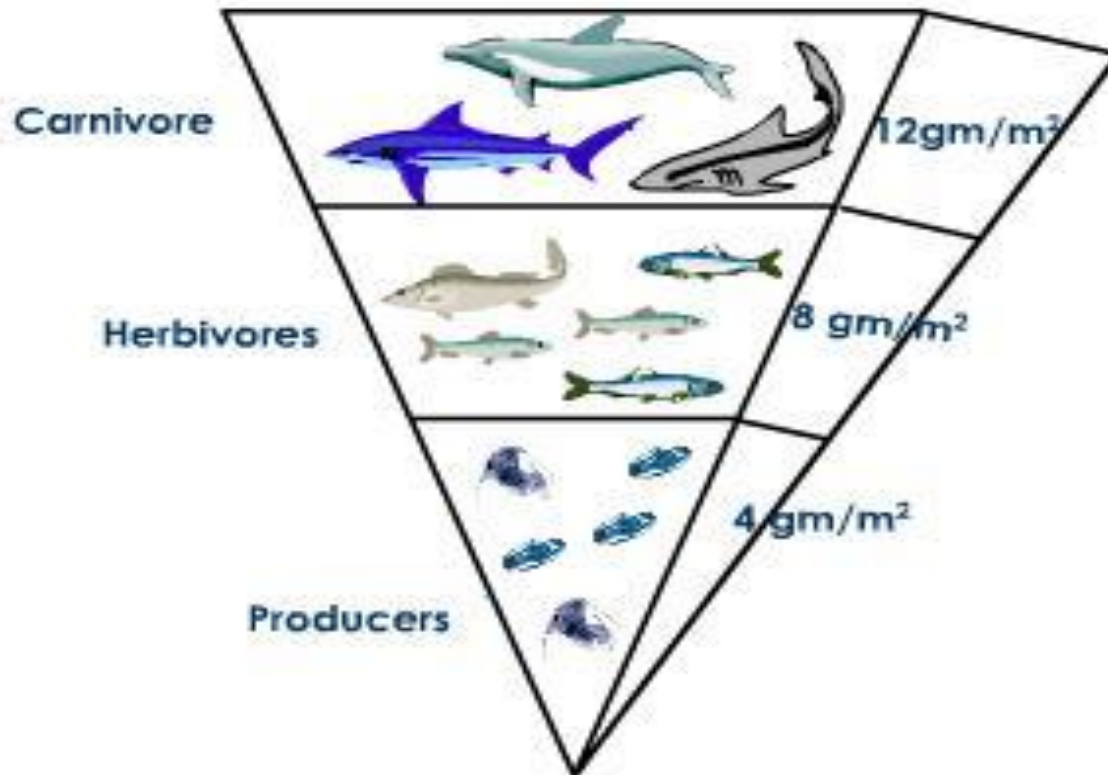
- In a terrestrial ecosystem, the maximum biomass occurs in producers, and there is progressive decrease in biomass from lower to higher trophic levels. Thus, the pyramid of biomass in a terrestrial ecosystem is upright.



Upright Pyramid of biomass in a Terrestrial Ecosystem

Inverted in Position

- In an aquatic habitat the pyramid of biomass is inverted or spindle shaped where the biomass of trophic level depends upon the



Inverted Pyramid in an Aquatic Ecosystem

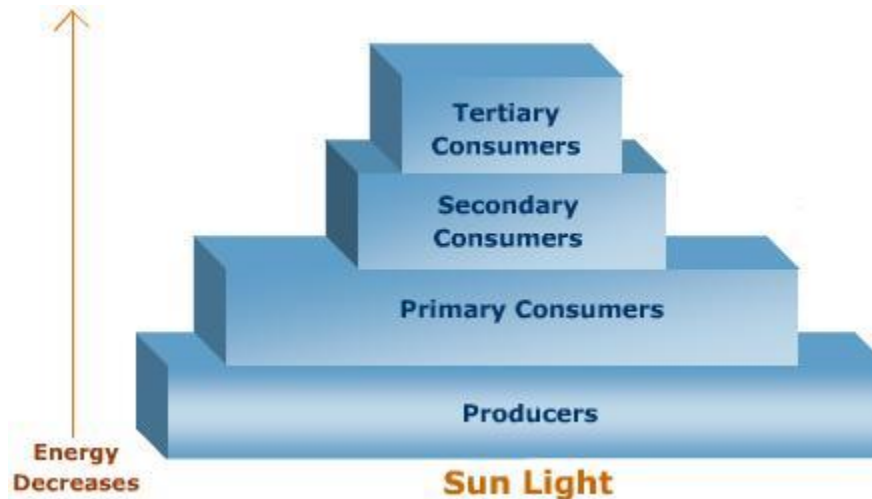
Pyramid of energy:-

- **"Pyramid of energy is a graphic representation of the amount of energy trapped per unit time and area in different trophic level of a food chain with producers forming the base and the top carnivores at the tip".**

Pyramid of energy:-

Representation of Pyramid of Energy

Pyramid of energy is always upright. It is so because at each transfer about 80 - 90% of the energy available at lower trophic level is used up to overcome its entropy and to perform metabolic activities. Only 10% of the energy is available to next trophic level (as per Lindeman's ten percent rule).



Forest Ecosystem (Terrestrial Ecosystem)

❖ Forest Ecosystem:

- ❖ A forest is an area with a high density of trees.
- ❖ **World's total land area** is 13,076 million hectares - (Source: FAO; 1989)
- ❖ Of which total forests account for about 31% of the world's land area.
- ❖ **In India**, the forest cover is roughly 19% of the total land area.
- ❖ The forest ecosystem are of great concern from the environmental point of view.
- ❖ It provides numerous environmental services like;
 - Nutrient cycling,
 - Maintaining biodiversity
 - Providing wildlife habitat
 - Affecting rainfall patterns
 - Regulating stream flow
 - Storing water
 - Reducing flooding
 - Preventing soil erosion
 - Reclaiming degraded land & many more....



Forest Ecosystem

❖ Forest Ecosystem:

❖ Apart from environmental values, forest ecosystems have some traditional values as well.

❖ Examples are:

➤ Fire Wood & Timber.

➤ Fruits.

➤ Gums.

➤ Herbs & drugs.

❖ The various components of a Forest Ecosystem are:

❖ Biotic components: The various biotic components, representatives from the three functional groups, of a forest ecosystem are:

1) Producer Organisms:

❖ In a forest, the producers are mainly trees.

❖ Trees are of different kinds depending upon the type of forest developed in that climate.

- ❖ Apart from trees, climbers, epiphytes, shrubs and ground vegetation.
- ❖ Dominant species of trees in major types of forest ecosystems are:
 - ❖ *Tectona grandis*, Acer, Betula, Picea, Pine, Cedrus.

2) Consumers:

- ❖ In a forest, consumers are of three main types;

a) Primary Consumers:

- ❖ These are Herbivores which feed directly on producers. E.g.
 - ❖ Ants, Beetles, Bugs, spiders etc. feeding on tree leaves.
 - ❖ Larger animals such as Elephants, Deer, giraffe etc. grazing on shoots and/or fruits of trees.

b) Secondary Consumers:

- ❖ These are carnivores and feed on primary consumers.
 - ❖ These include Birds, Lizards, Frogs, Snakes, Foxes, etc.

c) Tertiary Consumers:

- ❖ These are secondary carnivores and feed on secondary consumers
 - ❖ These include top carnivores like Lion, Tiger, etc.

3) Decomposers:

- ❖ These include wide variety of saprotrophic micro- organism like;
 - ❖ Bacteria (*Bacillus Sp.*, *Clostridium sp.*, *pseudomonas*, etc.)
 - ❖ Fungi (*Aspergillus sp.*, *Ganoderma sp.*, *Fusarium*, etc.)
 - ❖ Actinomycetes (*Streptomyces*, etc).
- ❖ They attract the dead or decayed bodies of organisms & thus decomposition takes place.
- ❖ Therefore, nutrients are released for reuse.

❖ Abiotic components:

- ❖ These include basic inorganic & organic compounds present in the soil & atmosphere.
- ❖ In addition dead organic debris is also found littered in forests.

Components of Forest Ecosystem:



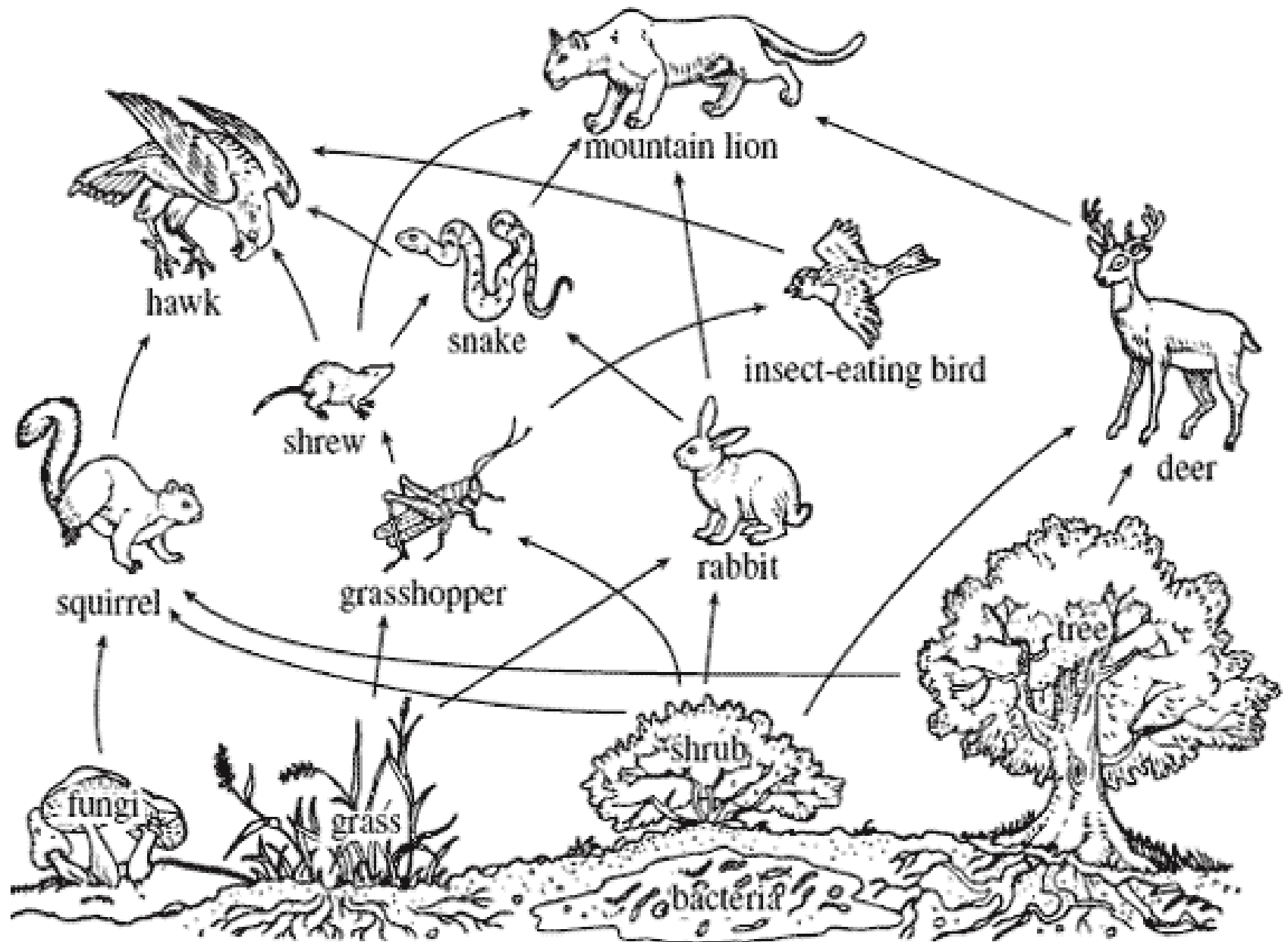
■ Producers: Different tree species



■ Consumers in a Forest Ecosystem



■ Decomposers in a Forest ecosystem



Grassland

Ecosystem

❖ Grassland Ecosystem:

- ❖ Grasslands (also called Greenswards) are areas where the vegetation is dominated by grasses and other herbaceous (non-woody) plants.
- ❖ Grasslands occupy about 24% of the earth's surface.
- ❖ Grasslands occur in regions too dry for forests and too moist for deserts
- ❖ The annual rainfall ranges between 25- 75 cm, Usually seasonal
- ❖ The principal grasslands include:
 - Prairies (Canada, USA)
 - Pampas (South America)
 - Steppes (Europe & Asia)
 - Veldts (Africa)



Grassland ecosystem.

- ❖ The highest abundance & greatest diversity of large mammals are found in these ecosystems.
- ❖ The dominant animal species include
 - ❖ Wild horses, asses & antelope of Eurasia,
 - ❖ Herds of Bison of America; and
 - ❖ The antelope & other large herbivores of Africa
- ❖ The various components of a grassland Ecosystem are:
 - ❖ Biotic components: Three functional groups which are:
 - 1) Producer Organisms:
 - ❖ In grassland, producers are mainly grasses; though, a few herbs & shrubs also contribute to primary production of biomass.
 - ❖ Some of the most common species of grasses are:
 - ❖ *Brachiaria sp.*, *Cynodon sp.*, *Desmodium sp.*, *Digitaria sp.*

2) Consumers:

❖ In a grassland, consumers are of three main types;

a) Primary Consumers:

❖ The primary consumers are herbivores feeding directly on grasses. These are grazing animals such as

❖ Cows, Buffaloes, Sheep, Goats, Deer, Rabbits etc.

❖ Besides them, numerous species of insects, termites, etc are also present.

b) Secondary Consumers:

❖ These are carnivores that feed on primary consumers (Herbivores)

❖ These include;

❖ Frogs, Snakes, Lizards, Birds, Foxes, Jackals etc.

c) Tertiary Consumers:

❖ These include hawks etc. which feed on secondary consumers.

3) Decomposers:

- ❖ These include wide variety of saprotrophic micro-organism like:
Bacteria; Fungi; Actinomycetes
- ❖ They attract the dead or decayed bodies of organisms & thus decomposition takes place.
- ❖ Therefore, nutrients are released for reuse by producers.
- ❖ Abiotic components:
- ❖ These include basic inorganic & organic compounds present in the soil & aerial environment.
- ❖ The essential elements like C, H, N, O, P, S etc. are supplied by water, nitrogen, nitrates, sulphates, phosphates present in soil & atmosphere.

Components of Grassland Ecosystem:



Producers: Different grass species



Consumers of Grassland ecosystem



Decomposers in a Grassland ecosystem



Desert Ecosystem

❖ Desert Ecosystem:

- ❖ A desert is a landscape or region that receives almost no precipitation
- ❖ Deserts are defined as areas with an average annual precipitation of less than 250 millimeters per year.
- ❖ It occupy about 17% of the earth's surface.
- ❖ Deserts are characterized by hot days & cold nights.
- ❖ The deserts of the world are mainly located in the South- western United States, Mexico, North America, Asia (Thar, Gobi, Tibet) & west Asia.
- ❖ Deserts are characterized by scanty flora & fauna.
- ❖ Soils of deserts often have abundant nutrients but little or no organic matter.



❖ The various components of a Desert Ecosystem are:

❖ Biotic components:

1) Producer Organisms:

- ❖ In a desert, producers are mainly shrubs/bushes; some grasses & a few trees.
- ❖ Dominant plant species include: Succulents (water - retaining plants adapted to arid climate or soil conditions) & hardy grasses.
- ❖ Besides some lower plants such as lichens & xerophytic mosses are also present.

2) Consumer Organisms: These include animals such as insects, reptiles which are capable of living in xeric conditions

❖ Besides some nocturnal rodents, birds & some mammals like camel etc are also found.

3) Decomposers:

❖ Due to poor vegetation with very low amount of dead organic matter, decomposers are poor in desert ecosystem.

❖ The common decomposers are some bacteria & fungi, most of which are thermophilic.

❖ **Abiotic components:**

Due to high temperature & very low rainfall, the organic substances are poorly present in the soil.

Components of Desert Ecosystem:



Producers of Desert Ecosystem



Consumers of Desert Ecosystem

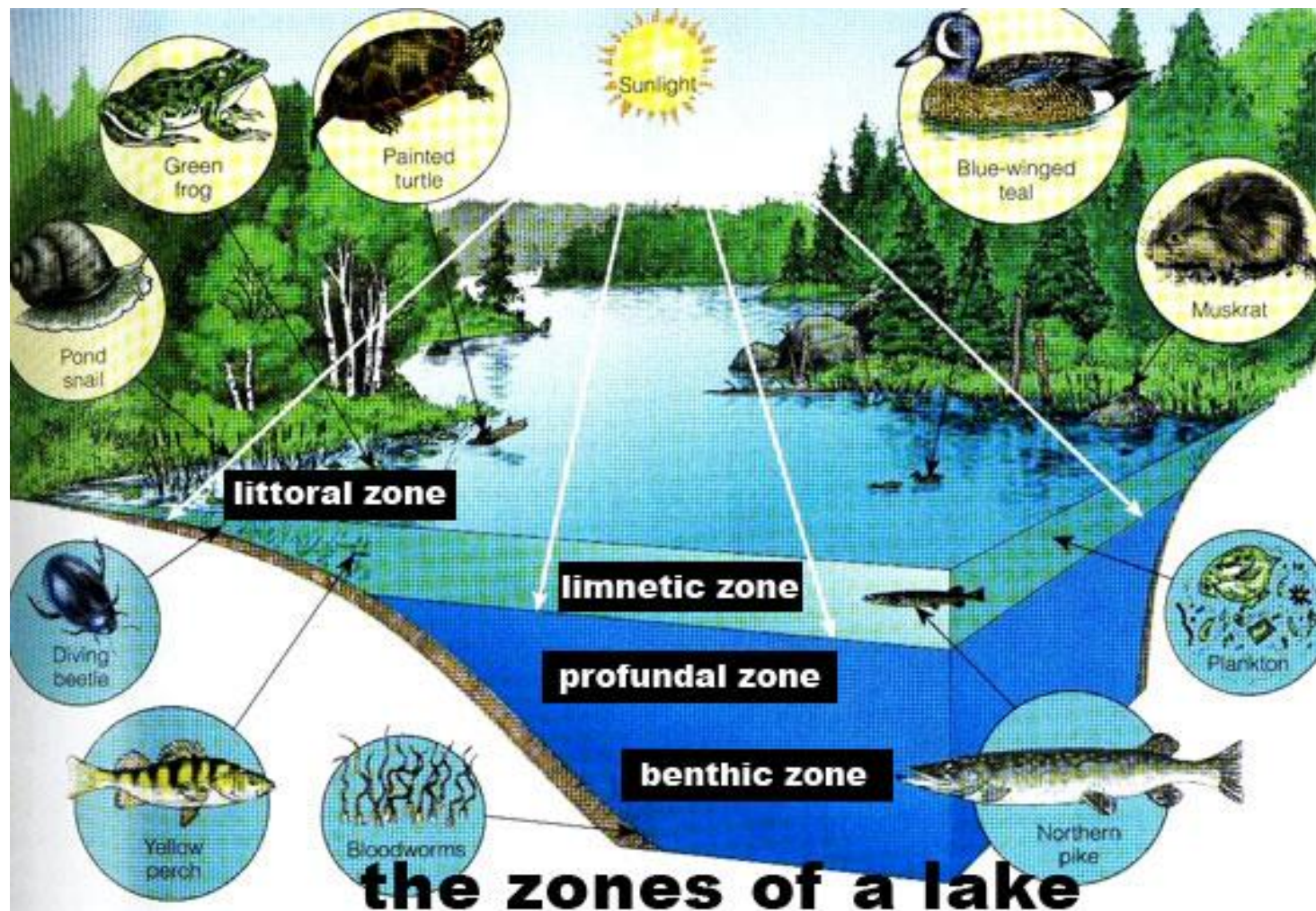
Aquatic Ecosystems

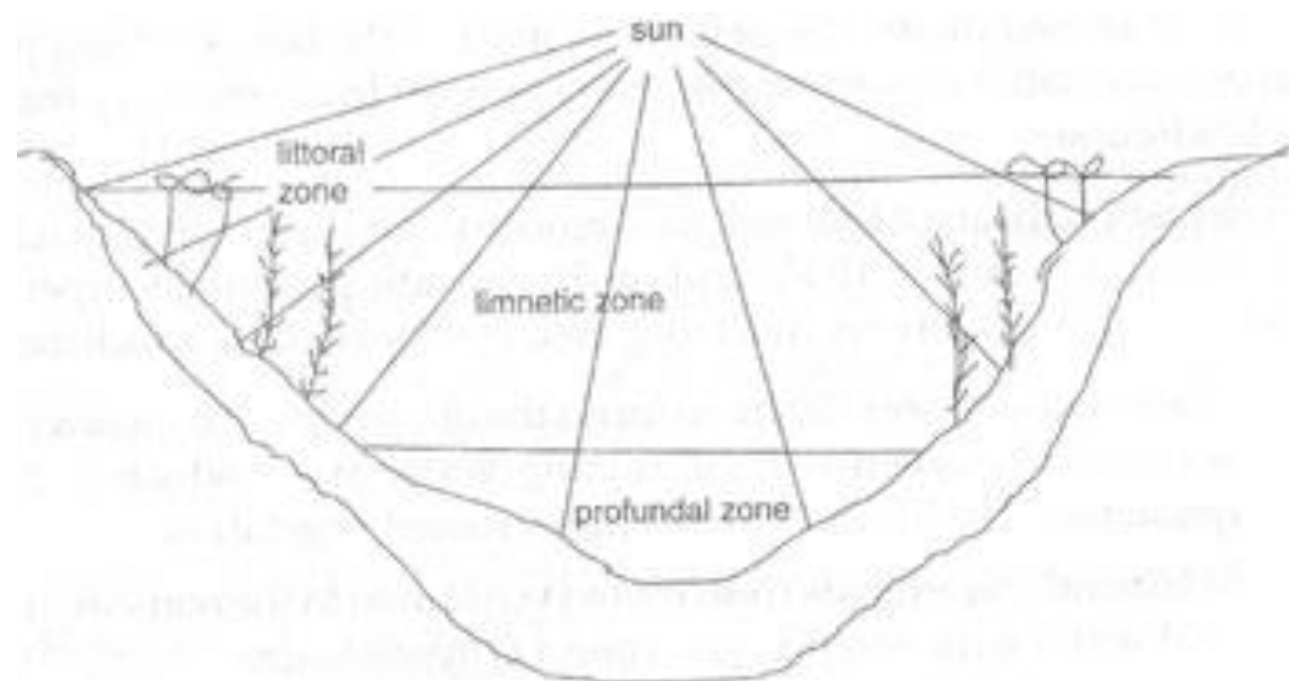
Aquatic Ecosystems:

- ❖ Aquatic ecosystems deal with biotic community present in water bodies.
- ❖ In terrestrial ecosystem, carbon dioxide & oxygen are present in gaseous form whereas in aquatic ecosystem, these are available in dissolved state.
- ❖ Depending upon the quality and nature of water, the aquatic ecosystem are categorized into:
 - ❖ Freshwater Ecosystem and
 - ❖ Marine Ecosystem.

Freshwater Ecosystems:

- ❖ Freshwater ecosystems cover **0.8%** of the Earth's surface and contain **0.009%** of its total water.
- ❖ Freshwater ecosystems contain **41%** of the world's known fish species.
- ❖ Aquatic ecosystems perform many important environmental functions.
For example:
 - They recycle nutrients, purify water, attenuate floods, recharge ground water and provide habitats for wildlife.
 - Aquatic ecosystems are also used for human recreation, and are very important to the tourism industry, especially in coastal region.
- ❖ There are three basic types of freshwater ecosystems:
 - ❑ **Lentic:** slow-moving water, including **Pools, Ponds, and Lakes**.
 - ❑ **Lotic:** rapidly-moving water, for example **Streams and Rivers**.
 - ❑ **Wetlands:** areas where the soil is saturated with water or inundated for at least part of the time





Different zones of a freshwater pond

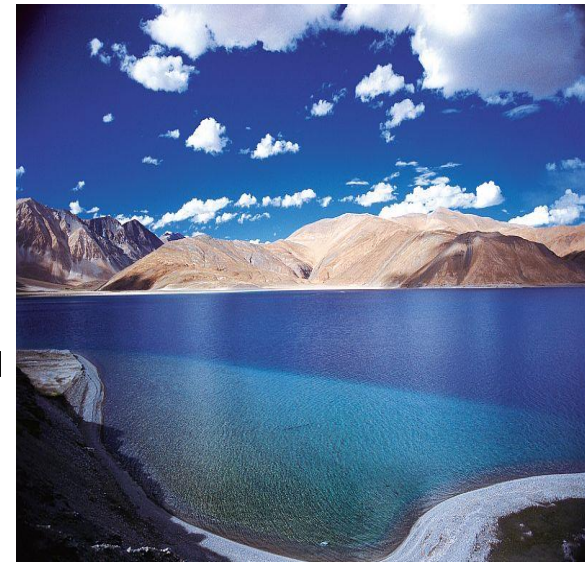
Lakes & pond Ecosystem:

- ❖ A pond is a place where living organisms not only live but interact with biotic & abiotic components.
- ❖ Ponds are often exposed to tremendous anthropogenic pressure which significantly affects the system.
- ❖ Lakes are usually big standing freshwater bodies.
- ❖ They have a shallow water zone called *Littoral zone*; an open water zone where effective penetration of solar light takes place, called *Limnetic zone* and a deep water zone where light penetration is negligible, called *Profoundal zone*.



→ *Pond ecosystem*

Lake ecosystem ←



❖ Biotic components:

1) Producer Organisms:

- ❖ It includes submerged, free floating and amphibious macrophytes (like; *Hydrilla*, *Utricularia*, *Wolffia*, *Azolla*, *Typha* etc.) and minute floating and suspended lower phytoplanktons (like; *Ulothrix*, *Spirogyra*, *Oedogonium* etc.)

2) Consumer Organisms:

- a) **Primary consumers:** These are zooplanktons (ciliates, flagellates, other protozoan, small crustaceans) and benthos.
- b) **Secondary consumers:** These are carnivores like insects and fishes feeding on herbivores
- c) **Tertiary consumers:** These are the large fishes feeding on small fishes.

3) Decomposers: Micro – organisms like bacteria, fungi and actinomyces.

❖ Abiotic component:

- ❖ These are the inorganic as well as organic substances present in the bottom soil or dissolved in water. In addition, to the minerals, some dead organic matter is also present.

Marine or Ocean Ecosystem:

- ❖ Marine ecosystems are among the Earth's aquatic ecosystems. They include: **Oceans**, **Estuaries** and **Lagoons**, **Mangroves** and **Coral reefs**, the **Deep sea** and the **Sea floor**.
- ❖ These are the gigantic reservoirs of water covering approximately **71%** of the Earth's surface (an area of some **361 million square kilometers**).
- ❖ These ecosystem is different from freshwater ecosystem mainly because of its salty water.
- ❖ The salt concentration in an open sea is usually **3.5%** (35 parts per thousand (ppt)). Dominant ions are sodium & chloride.
- ❖ Average temperature of Marine ecosystem is **2-3** degree centigrade, devoid of light.



❖ Biotic components:

1) Producers: It includes phytoplanktons (diatoms, dinoflagillates), large seaweeds (mainly algae like chlorophyceae, phaeophyceae & rhodophyceae; angiosperms like Ruppia, Zostera, posidonia etc.), and mangrove vegetation (like Rhizophora, Carapa etc.)

2) Consumers:

a) Primary consumers: These are herbivores and feed directly on producers (Crustaceans, Mollusks, fish etc.)

b) Secondary consumers: These are carnivorous fishes (Herring, and Mackerel)

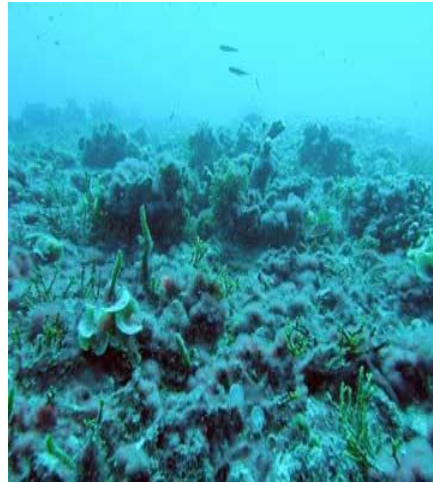
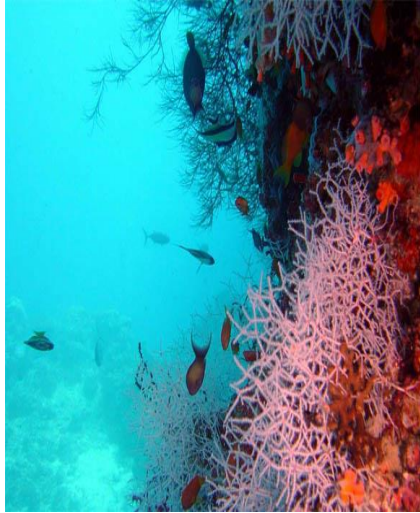
c) Tertiary consumers: These are top carnivorous fishes (Cod, Haddock, etc.)

3) Decomposers: These are micro – organisms like bacteria, fungi

❖ Abiotic components:

❖ High Na, Ca, Mg and K salt concentration, variable dissolved oxygen content, light & temperature make a unique physiochemical conditions in marine water.

Inside Marine or Ocean Ecosystem:



Ecological succession

Ecological succession:-

- The occurrence of relatively definite sequence of communities over a long period of time in the same area resulting in establishment of stable or climax community, is known as ecological or biotic succession".
- The first community which is inhabiting the area will be referred as 'pioneer community' and the last and stable community formed in the area will be referred as 'climax community'. The intermediate communities are called 'transitional or seral communities'. The whole series of changes in community characteristics from pioneer stage to climax stage constitute a 'sere' and the intermediate stages are the 'seral stages'.

Causes of Ecological Succession

Causes of ecological succession are classified under two categories.

- **1) Biotic factors**
- Interactions among the organisms in a community, as called biotic factors, influence the structure, composition and function of a community. In succession, during period of time a community makes the area less favourable for itself and more favourable for the next serial community.
- **2) Physiographic factors**
- Includes physical and chemical factors of the environment such as landslides, erosion, catastrophic factors, etc.

Basic types of succession

1) Primary succession

- Also referred as 'perisere' is a type of biotic succession that occurs on a substratum devoid of life earlier like bare rock, sand dunes, new island exposed out of the sea etc. where there was no previously any sort of life.
- Primary succession takes a very long time (more than thousands of years in case of climax forest on bare rock).



Examples of Primary Succession

2) Secondary succession

- It is the biotic succession that occurs in an area, which had an existing biotic community and have become bare due to destruction by fire, landslide, earthquake etc.
- The sequence of successional stages is called 'subser', and time required for the completion of sere is much shorter than primary succession.

General process of ecological succession (Mechanism of succession)

- Process of primary succession occurs through a number of sequential steps, which follow one another.
- **a) Nudation**
 - is the development of a bare area without any form of life.
 - Causes of nudation may be topographic (soil erosion, landslide, earthquake etc.) or climatic (glaciers, hailstorm, fire etc.) or biotic (human activities, epidemics etc.)
- **b) Invasion**
 - - is the successful establishment of a species in a bare area, which happens in three steps.
 - **i) Migration** - reaching of seed or spores in a bare area through various agencies (wind, water etc.)
 - **ii) Ecesis** - also called 'establishment' involves the adjustment of the migrated species with the prevailing conditions of the area.
 - **iii) Aggregation** - once established, the organisms increase in number through the process of reproduction.

- **c) Competition and co-action**
 - Involves the development of intraspecific and interspecific competitions among the members (as there is natural resistance like limited food and space).
- **d) Reaction**
 - Involves the modification of the environment, influenced by living organisms, and existing community are replaced by next seral community and the process is repeated.
- **e) Stabilization**
 - It is the stage where the final terminal community (climax community) becomes stabilized and can maintain itself in equilibrium with climate of the area.