SHREE H. N. SHUKLA INSTITUTE OF PHARMACEUTICAL EDUCATION AND RESEARCH

B.PHRAM

(SEMESTER –II)

SUBJECT NAME: ENVIRONMENTAL SCIENCES

SUBJECT CODE: BP205TP

CHAPTER-2 Ecosystems:

Ecosystems:

Concept of an ecosystem.

Structure and function of an ecosystem.

Introduction, types, characteristic features, structure and function of the ecosystems: Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

ECOSYSTEMS

INTRODUCTION:

ECOLOGY:

- The term was first coined by Hons Reiter and Haekel in 1869.
- The term ecology (Okekologie) is originated from two Greek words Oikos (eco) – means "house" (or) place of living and "ology" means "the science of (or) the study of. Hence, ecology is the branch of science that deals with the study of the pattern of relations between the organism and their environment.

(OR)

- Ecology is the study of interactions among organisms (or) group of organisms with their environment.

(OR)

- Ecology is the study of ecosystems.

ECO SYSTEM:

- In 1935, the British ecologist A.G.Tansley coined the term "eco system".

- The term **"eco system"** is made up of two Greek words. "Eco" means ecological sphere (or) house (or) place of living (or) surroundings (or) Environment, w here living organism does exist while **"system"** means "group of organisms joined in regular and interdependent manner. Hence,
- A group of organisms interacting among themselves and with environment is known as ecosystem.

(OR)

- A system of interaction of organisms with their surroundings (i.e., environment) is called as "ecosystem".

Examples: Pond, lake, ocean, forest and desert…. Etc are some of the examples of the ecosystems.

FUNDAMENTAL CHARACTERISTICS OF ECOLOGY

STRUCTURE:

- Living /Biotic
- Non-Living /Abiotitic

PROCESS:

- Energy flow
- Cycling of matter

CHANGE:

- Dynamic (Not static)
- Succession etc.

FUNCTION:

- Food chain
- Food web
- Ecological pyramids
- Energy Flow
- Cycling of matter

CHARACTERISTICS OF ECOSYSTEM

- Eco system is the basic functional unit of ecology.
- It contains both biotic and abiotic components.

- The function of ecosystem is related to the cycling of matter (materials) and flow of energy.
- The amount of energy needed to maintain an ecosystem depends on its structure.
- Ecosystem passes from a less complex state to more complex state, which is called as **"ecological succession".**

CLASSIFICATION OF ECOSYSTEM:

- The ecosystem can be generally classified into two types:
  1. Natural Ecosystem
  2. Artificial Eco system

1. NATURAL ECOSYSTEM:

- A natural ecosystem is developed and governed by nature.
- These are capable of operating and maintaining themselves without any major interference by man.
- The following are the two types of natural ecosystem based on theirhabitat.
  1. Terrestrial Ecosystem.
  2. Aquatic Ecosystem.

1) Terrestrial Ecosystem:

- This ecosystem is related to land.

Examples: Grassland ecosystem.
Forest ecosystem, and
Desert ecosystem etc.

2) Aquatic Ecosystem:

- This ecosystem is related to water, it is further sub divided into two types based on salt content.

i. Fresh Water Ecosystem:

a. Running Water Ecosystems
   Examples: Rivers, streams (small narrow rivers)
b. Standing Water Ecosystems

Examples: Pond, lake & well, etc

ii. Marine Ecosystem:

Examples: seas and sea shores <land along the edges of sea>

2. MAN MADE (OR) ARTIFICIAL ECOSYSTEM:

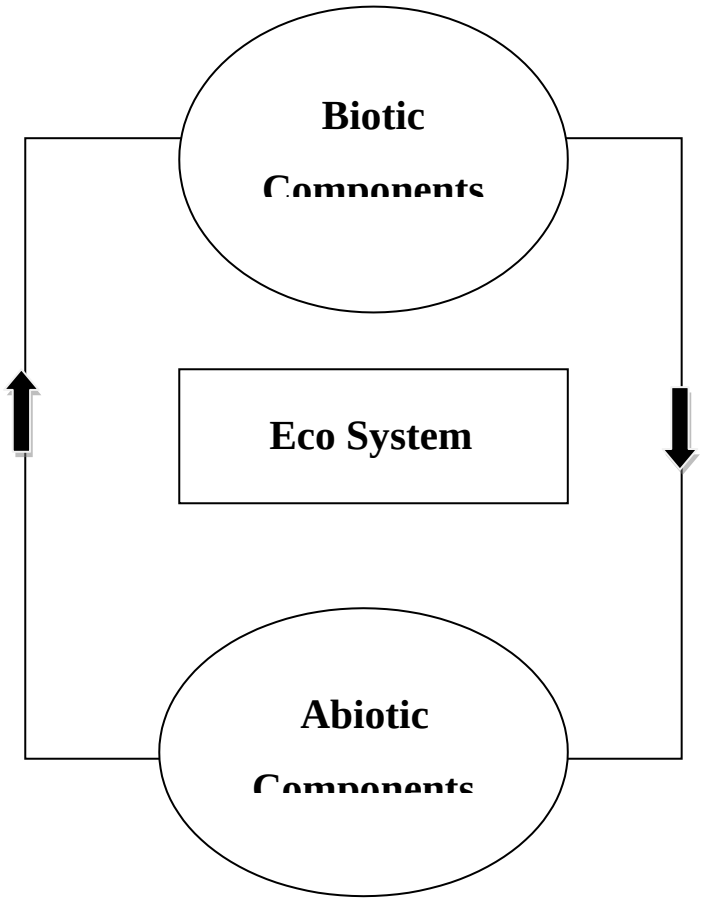
An artificial ecosystem is created and maintained by man for his different needs.

Examples: Reservoirs, Artificial lakes and gardens, etc.

STRUCTURE (OR) COMPONENTS OF ANECOSYSTEM:

- The term structure refers to various components. So, the structure of an ecosystem explains the relationship between the abiotic (non-living) and the biotic (living) components.
  - Each and every ecosystem has two major components are:

1. Biotic (living) components.



2. Abiotic (Non-living) components.

Fig: Components Of Ecosystem

1. **Biotic Components:** The living component of an ecosystem is called **"Biotic component".**

Examples: Plants (Producers)Animals (Consumers) and
Micro Organisms (Decomposers)

- The biotic components of an ecosystem are classified into three types based on how they get their food.

A. Producers (Autotrophs) : Plants
B. Consumers (Heterotrophs) : Animals
C. Decomposers (Saprotrophs) : Micro organisms.

A. Producers (or) Autotrophs (Auto=self, troph=feeder)

- Self food producing organisms are known as autotrophs.
  Examples: All green plants and trees.
- Producers synthesize their food themselves through photosynthesis. Hence they are also called **"Photo autotrophs".** (photo = light)

B. Consumers (or) Heterotrophs (Hetero = other, troph = feeder:

- Consumers are organisms, which cannot prepare their own food and depend directly (or) indirectly on the producers.
  Examples: Plant Eating Species:Insects, rabbit, goat, deer, cow, etc.
  Animals Eating Species:Fish, lions, tigers, etc.
- Depending upon the food habits the consumers are divided into four types.
  i. Herbivores (or) Primary Consumers(Plant Eaters)
  ii. Carnivores (or) Secondary Consumers (Meat Eaters)
  iii. Omnivores (or) Tertiary Consumers(With plant & meat eaters)
  iv. Detritivores(dead organism eaters)

i. Herbivores: (Herbi = the green plant & Vorare = to devour)

- Animals that eat only plants are called Herbivores.
- They directly depend on the plants for their food. So they are called Plant eaters.
  Examples: Insects, goat, deer, cow, horse,etc.

ii. Carnivores: (Carne = flesh meat & Vorare = to devour)

- Animals that eat other animals are called carnivores.

- They directly depend on the herbivores for their food.

  Examples: Frog, cat, snake & foxes, etc.

iii. Omnivores: (Omni = whole comes from "ohm" & Vorare = to devour)

- Animals that eat both plants and animals are called omnivores.
- They depend on both herbivores and carnivores for their food.

  Examples: humans, tigers, lions, rats and fox etc.

iv. Detritivores: (Detritifeeder)

- Animals that eat dead organisms and waste of living are called detritivores.

  Examples: beetles, termites, ants, crabs, earthworms,etc.

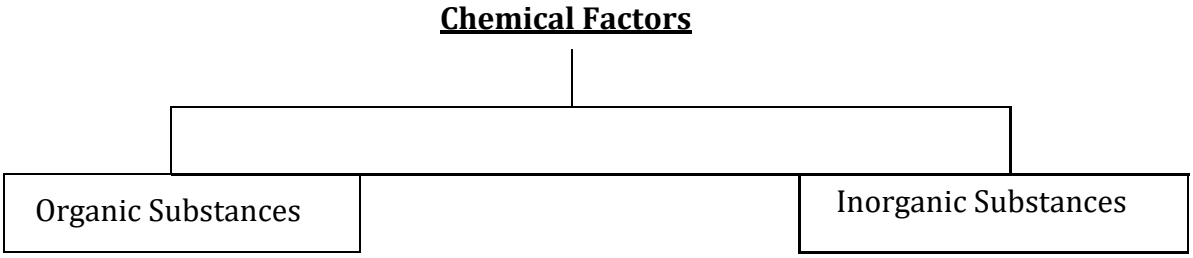
C. Decomposers (or) Saptrotrophs: (Sapros = Rotten, trophos = feeder)

- Decomposers attack the dead bodies of producers and consumers and decompose them into simple compounds. During the decomposition inorganic nutrients are released.
- The organisms which break down the complex compounds into simple products are called decomposers (or) reducers.

  Examples: micro-organisms such as bacteria and fungi, etc.

2. Abiotic Components:

- The non-living component of an ecosystem is called "abiotic component"
- These non-living components enter the body of living organism, take part in metabolic activities and then return to the environment. The abiotic component of the ecosystems divided into three portions.
  1. Climate factors : Solar radiation, temperature, wind, water current, rainfall, etc.
  2. Physical factors : light, fire, soil, air, etc.
  3. Chemical factors : Organic and Inorganic substances.



FUNCTION OF AN ECOSYSTEM:

- The function of an ecosystem is related to the cycling of materials (matter) and flow of energy.

Types of functions:

- Functions of an ecosystem are of threetypes:
  1. **Primary Function:** The producers (plants) can make their food themselves through photosynthesis. This process is called primary function of eco system.
     Examples: All green plants and trees.
  2. **Secondary Function:** The consumers (animals and humans) cannot make their own food. They are always depending upon the producers for their energy. This is called secondary function of eco system.
  3. **Tertiary Function:** Decomposers attack the dead bodies of consumers and producers and decompose them into simpler compounds. During the decomposition inorganic nutrients are released.

Examples: Micro organisms like bacteria and fungi, etc.

The functioning of an ecosystem may be understood by studying the following terms:

A. Food chains
B. Food webs
C. Food pyramids (or) Energy pyramids
D. Energy and material flow.

A. Food Chain:

- Anything which we eat to live is called food.
- Food contains energy.
- Food can be transferred from one organism to the other.
- The process of transfer of food (energy) from one organism to a series of organisms is called as **"food chain".**
- A food chain always starts with a plant life and end with animal life. Thus, a food chain is a picture (or) model that shows the flow of energy from autotrophs (producers) to series of organisms in an environment, as shown in the following figure.

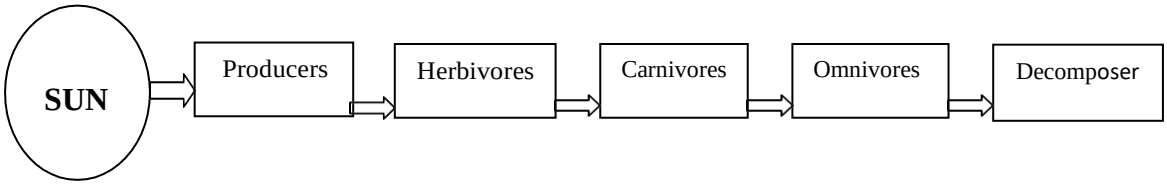


Figure: Schematic representation of food chain.

- Infact, all the food chains starts with the sun. The sun provides energy for plants.
- The producers (plants) can make their food themselves with the help of the sunlight, chlorophyll, water and air. The consumers, including animals and humans, cannot make their own food. They are always depending upon the producers for their energy.
- Decomposers are the micro-organisms that break down the dead animals and plants and release nutrients that become part of the soil, which are re-used by new plants, back to the starting point of the food chain.

Types of food chain:

Three basic types of food **chains** are found in a typical eco system. They are:

1. Grazing food chains.
2. Detritus food chains.
3. Parasitic food chains.

1. Grazing food chains:

- Grazing food chain starts with green plants (producers) and goes to decomposer food chain (or) detritus food chain through herbivores and carnivores.
- It has two types :
  a. Terrestrial food chainand
  b. Aquatic food chain

a. **Terrestrial food chain:** Food chain on land is called terrestrial food chain.

Example: Grassland food chain
Forest land food chain
Desert land food chain

Grass land food chain

Grasses ⟶ Grasshoppers ⟶ Frog ⟶ Snake ⟶ Eagles

Forest food chain

Green plants ⟶ Deer ⟶ Tiger (or) lion

Aquatic food chain : This food chain is slightly different from terrestrial food chain. It is seen in aquatic (water) eco system. Food chain in water is called "Aquatic food chain".

Example: Marine food chain Example: Ocean

Fresh water food chain Example: Pond, lake, streams, etc.

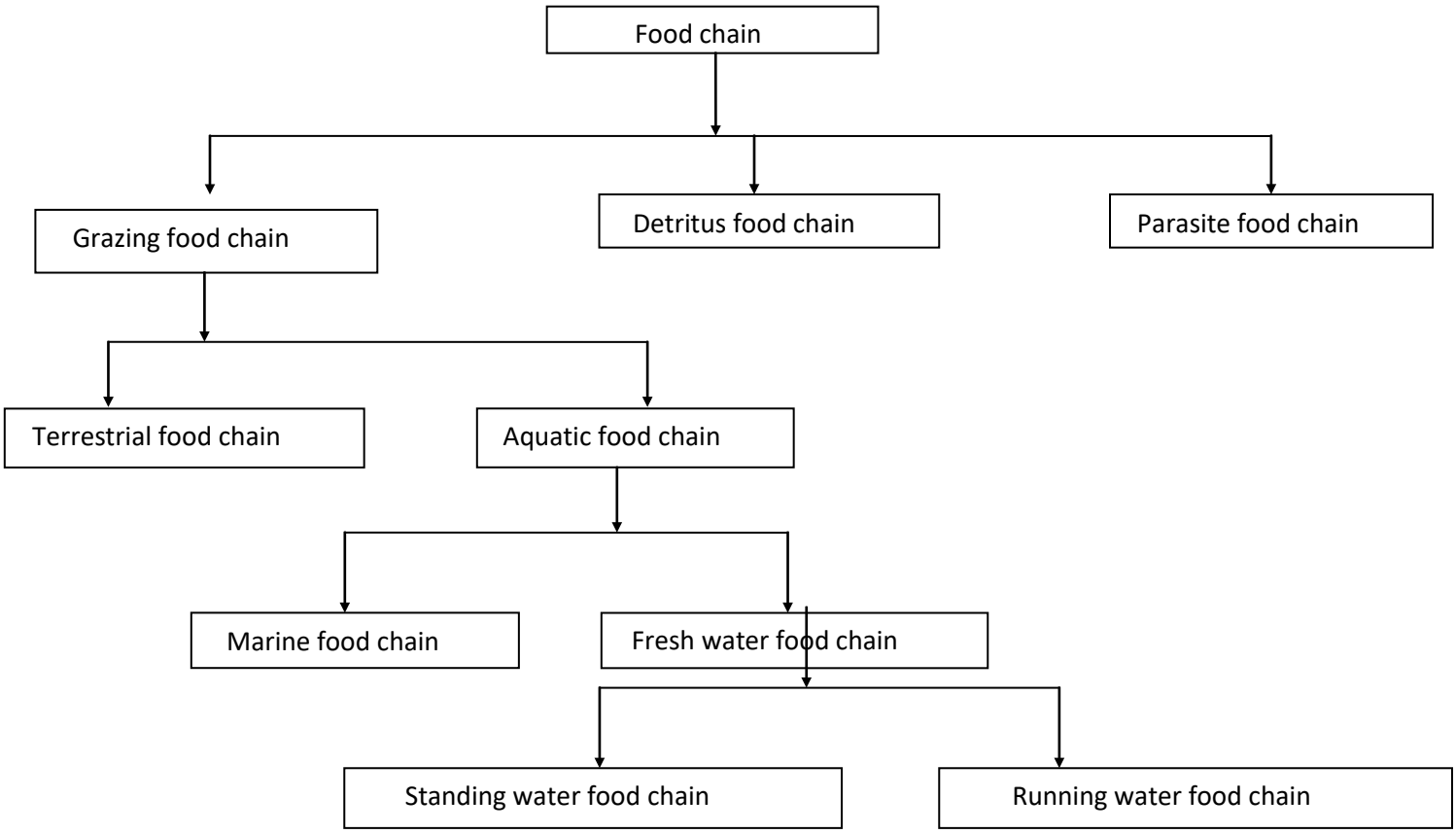
Food chain in a pond

Phytoplankton ⟶ Zoo Plankton ⟶ Small fish ⟶ Large fish ⟶ Man

Marine Food chain:

Sea Weeds ⟶ Small fish ⟶ Large fish ⟶ Sharks and other animals

Figure:



2. Detritus' food chain: Detritus food chain starts with dead organic matter (plants and animals) and goes to decomposer through consumers. Detritus food chains, independent of solar energy, but they depend on influx of dead organic matter.

Example:

Dead Plants → Soil mitts → Algae → Crabs → Small fish → Large fish

3. Parasitic food chain: Parasitic food chain operates in many ecosystems. In this food chain either consumer (or) producer is parasitized and the food passes to smaller organisms. A parasitic food chain involves host parasite hyper parasites' links.

Example: Trees → Fruit eating birds → Lice & Bugs → Bacteria → Fungi

B. Food Web:

- Web means "network" such as spider's web, World Wide Web (WWW) etc.
- So, food web is a network of food chains.
- In a food web many food chains are inter connected, where different types of organisms are connected at different tropic levels, so that there are a number of options of eating and being eaten at each tropic level. Thus, there is a inter connecting of various food chains are called food webs and as shown in following figure.

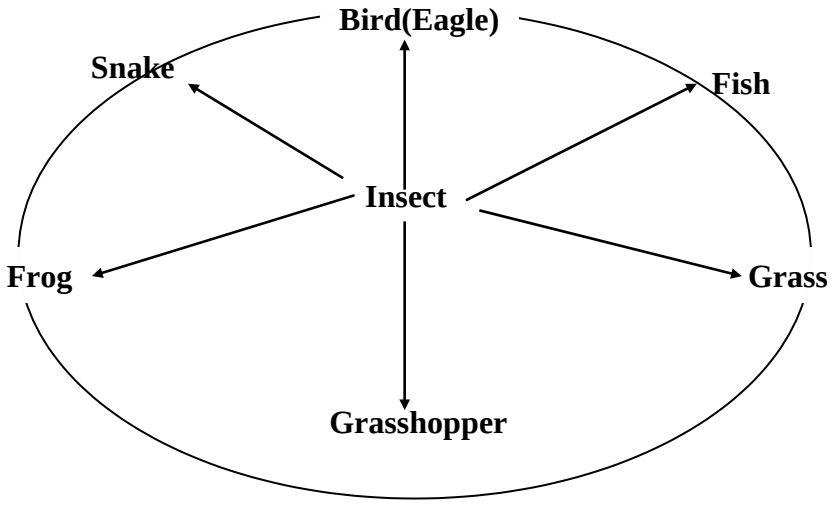
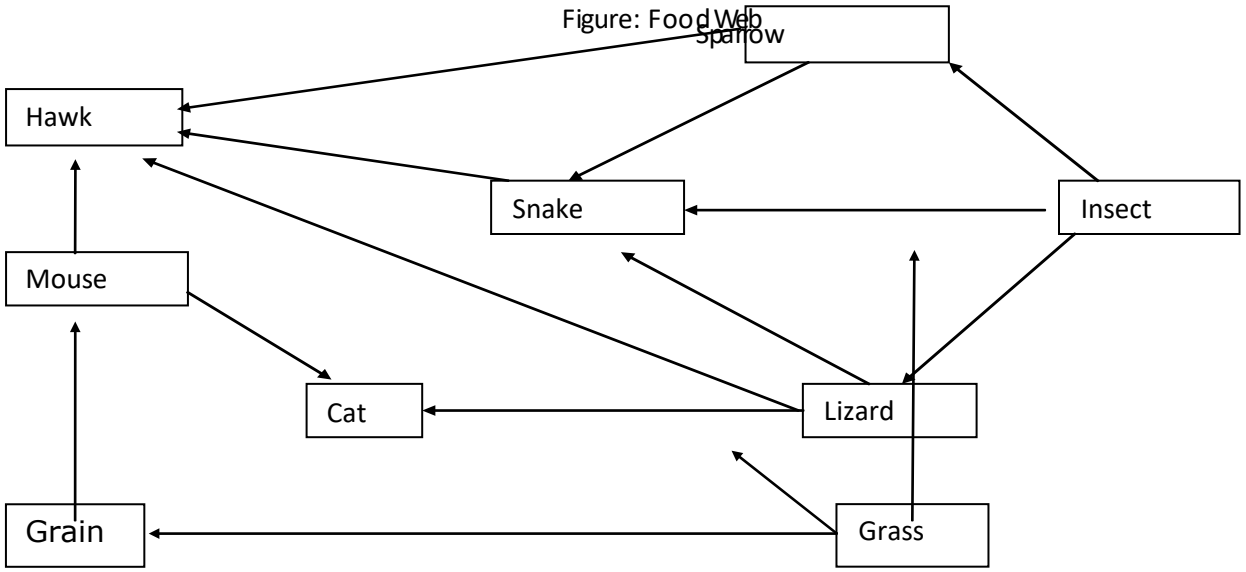


Figure: Food Web



This food web shows many linear food chains <as shown in figure>. These linear food chains are inter connected with other food chains operating in the eco system to form a food web. The grazing food chains are as follows:

- Grains → Mouse → Cat
- Grains → Mouse → Hawk
- Grains → Mouse → Snake → Hawk
- Grains → Insect → Sparrow → Hawk
- Grass → Insect → Lizard → Snake → Hawk
- Grass → Insect → Sparrow → Snake → Hawk

The above food web is a simple one. Much more complex food webs do exist in nature.

C. Ecological Pyramids:

- The concept of ecological pyramids was first developed by British ecologist Charles Elton in 1927.
- Ecological pyramids are the diagrammatic representation of tropic structures in which the tropic levels (i.e., tiers) are depicted in successive stages.
- An ecological pyramid is shown in the following figure.

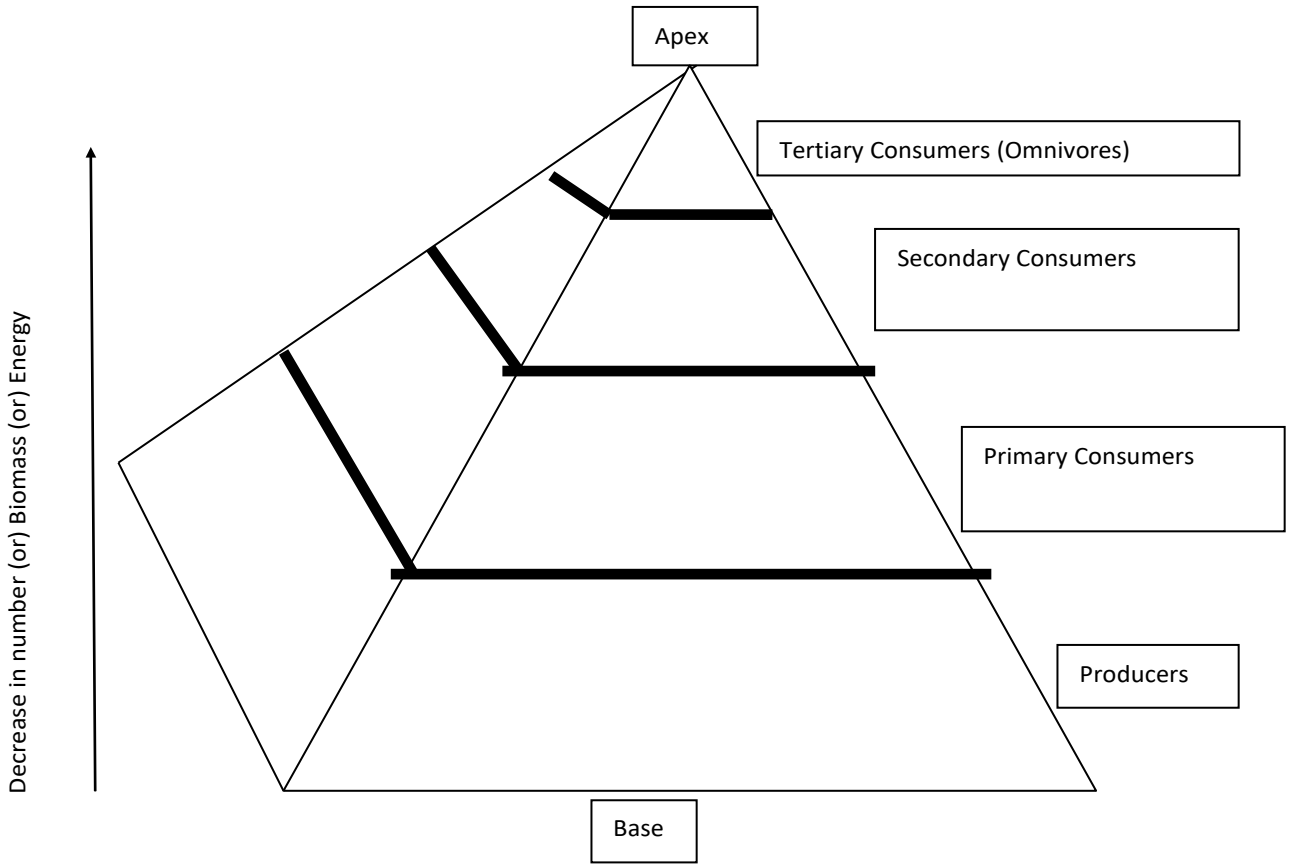


Figure: Formation of an Ecological Pyramid

- In ecological pyramids, tropic levels are shown in the following manner:
    i. The producers represent first tropic level in the ecological pyramid.
    ii. The herbivores (or) primary consumers represent second tropic level in the ecological pyramid.
    iii. The carnivores (or) secondary consumers represent third tropic level in the ecological pyramid.
    iv. The omnivores (or) tertiary consumers represent fourth tropic level in the ecological pyramid.

- On the basis of the number of organisms, the biomass of organisms and energy flow in organist population. Three types of ecological pyramids are:
    1. Pyramid of numbers.
    2. Pyramid of biomass

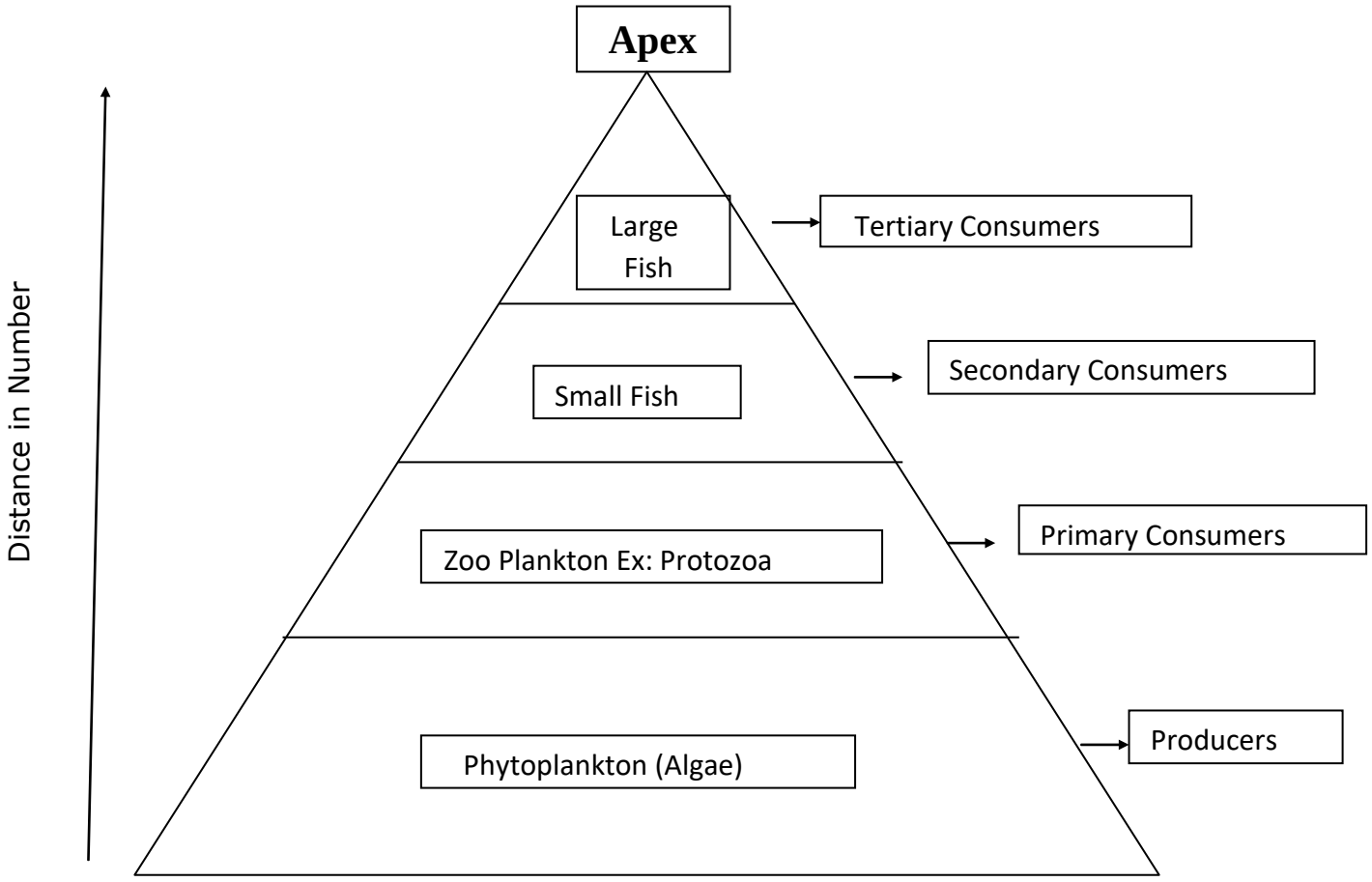
3. Pyramid of energy.

1. Pyramid of numbers:

- It shows the number of individual organisms present in each tropic level.
- It is expressed in numbers per unit area.
- Depending upon the type of ecosystem, we have three types of pyramid of numbers.
    a. Upright pyramid of numbers.
    b. Partly upright pyramid of numbers.
    c. Inverted pyramid of numbers.

1. Upright Pyramid of numbers:

- The number of individual organisms gradually decreases from lower tropic level to higher tropic level is called ***"upright pyramid of numbers".*** Example: A grassland ecosystem and a pond ecosystem show an upright pyramid of numbers.
- The producers in the grass lands are grasses, which are small in size and large in numbers. So, producers occupy lower tropic level (1^{st} tropiclevel).
- The primary consumers (herbivores) are rats, which occupy the II tropic level. Since the numbers of rats are lower when compared to the grasses, the size of which is lower.
- The secondary consumers (carnivores) are snakes, which occupy the III tropic level. Since the numbers of snakes are lower when compared to the rats, the size of which is lower.
- The tertiary consumers (omnivores) are eagles, which occupy the IV tropic level. The number and size of the last tropic level is lowest <as shown in figure>.
- Similarly, in the case of pond ecosystem, producers, herbivores and carnivores are decreases from lower tropic level to the higher tropic level. Thus, these pyramids are upright.
- Therefore, the numbers of individual organisms permit area, decreases from lower tropic level to higher tropic level as shown in figure.


Apex
Large Fish
Tertiary Consumers
Small Fish
Secondary Consumers
Zoo Plankton Ex: Protozoa
Primary Consumers
Phytoplankton (Algae)
Producers
Distance in Number

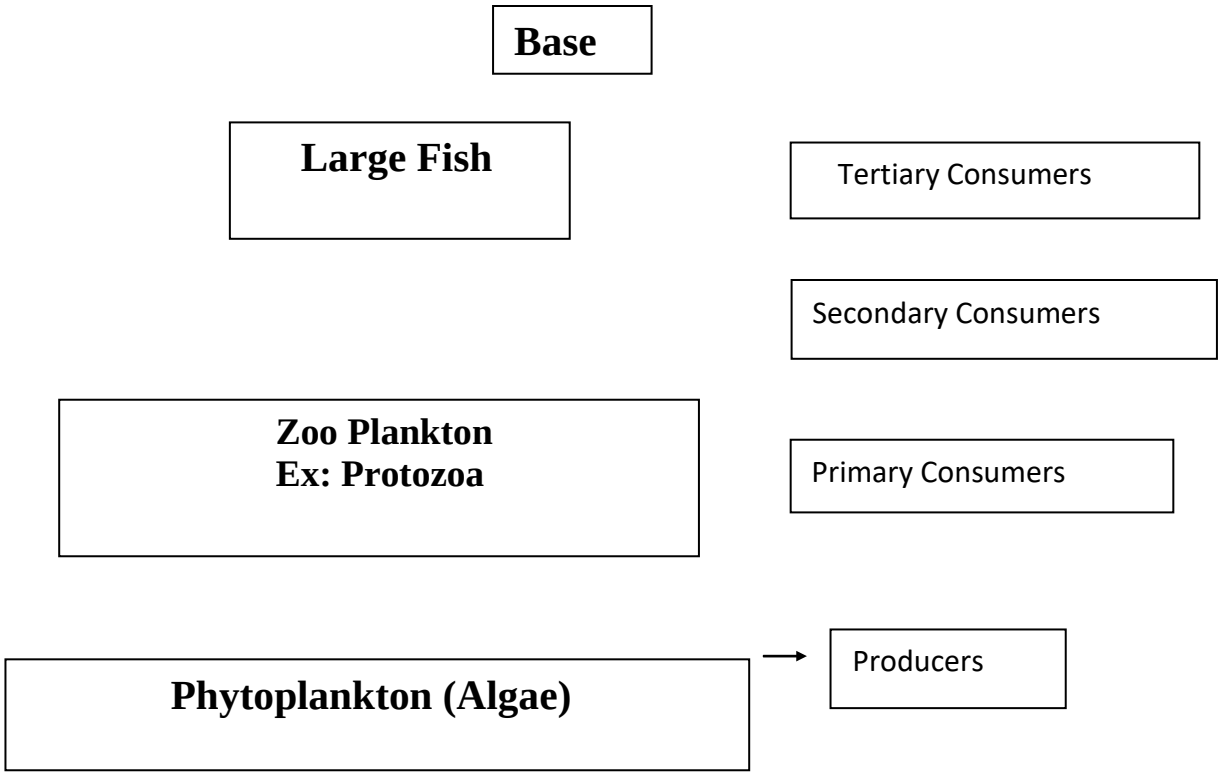
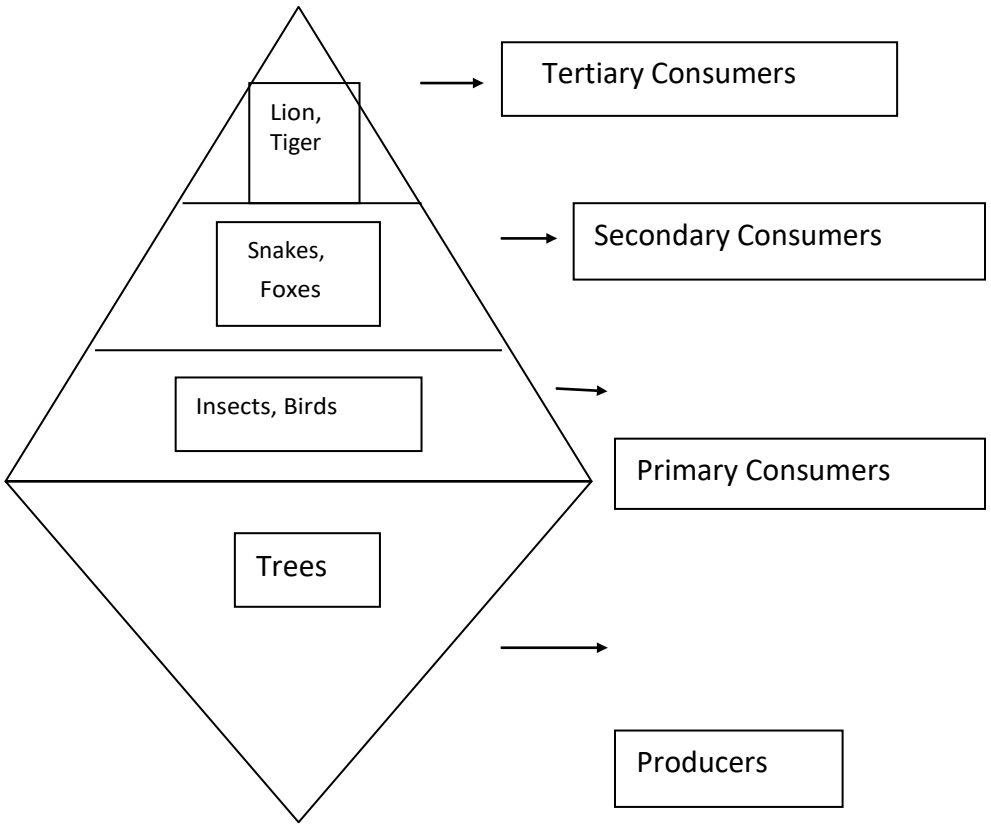


Figure: Pyramid of numbers in an aquatic (pond) ecosystem

2. Partially Upright Pyramid Of Numbers:

- A forest eco system is an example of partially upright pyramid.
- In a forest eco system, big trees are the producers, which are less number. So, these producers occupy the lower tropic level which is narrow base.
- The primary consumers (herbivores) are birds, insects, which occupy the II tropic level. Since the number of birds, insects and other species are higher when compared to the trees, the size of which is broader.
- The secondary consumers (Carnivores) are fox, snakes, lizards, which occupy the third tropic level. Since the number of fox, snakes are lower when compared to the birds, insects the size of which is lower.
- The tertiary consumers (omnivores) are lion, tiger, which occupy the IV tropic level. Since the number of lion, tiger are lower when compared to the fox and snakes the size of which is very (or) narrow lower. So the pyramid is narrow on both sides and broader in the middle and hence it is called partially upright of number as shown in figure.



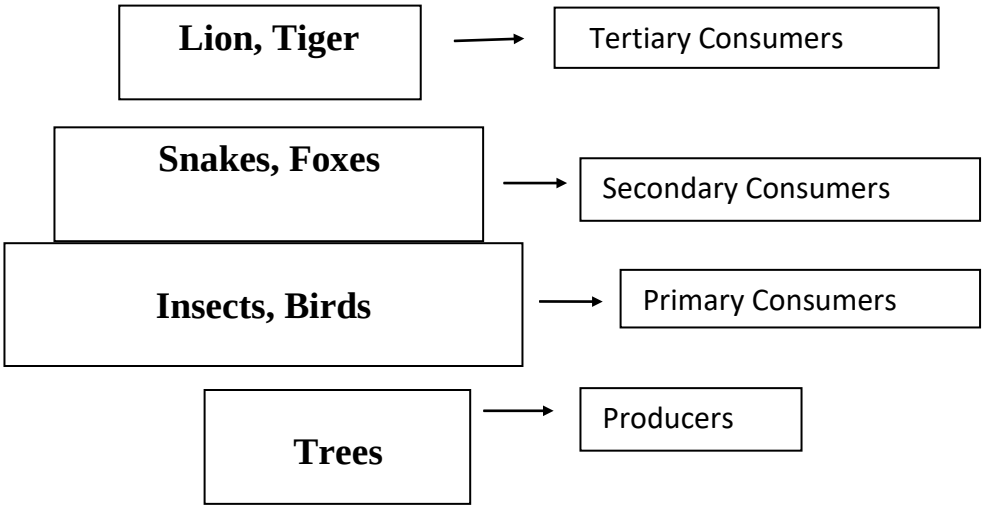
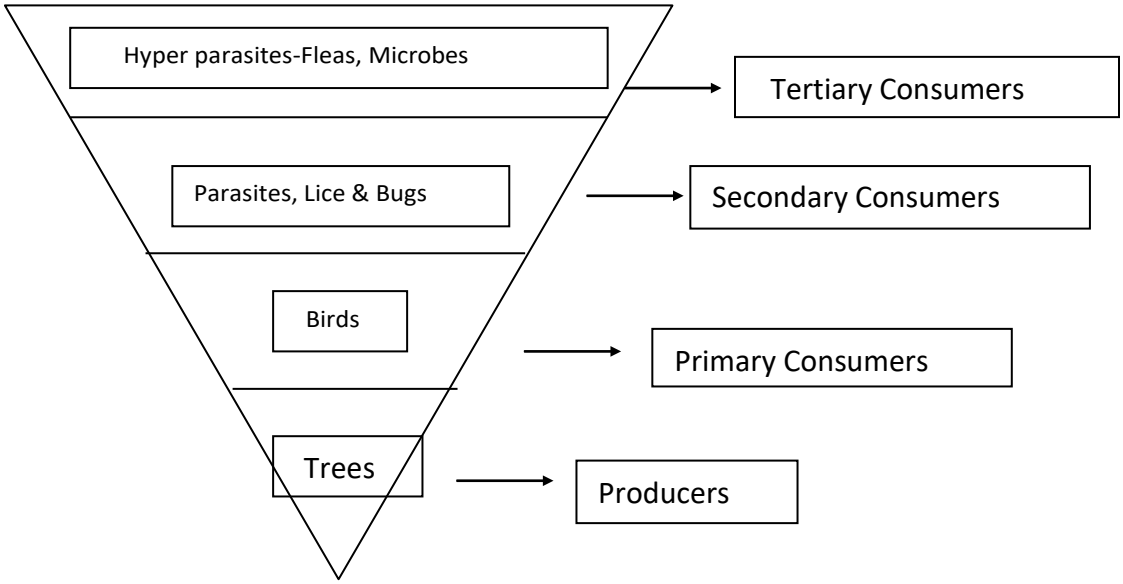


Figure: Pyramid of numbers in the forest ecosystem

3. Inverted Pyramid Of Numbers:

The number of individual organisms gradually increases from lower tropic level to higher tropic level, is known as "**inverted pyramid of numbers".**

Example: Parasitic food chain shows as inverted pyramid of number as shown in the following figure.



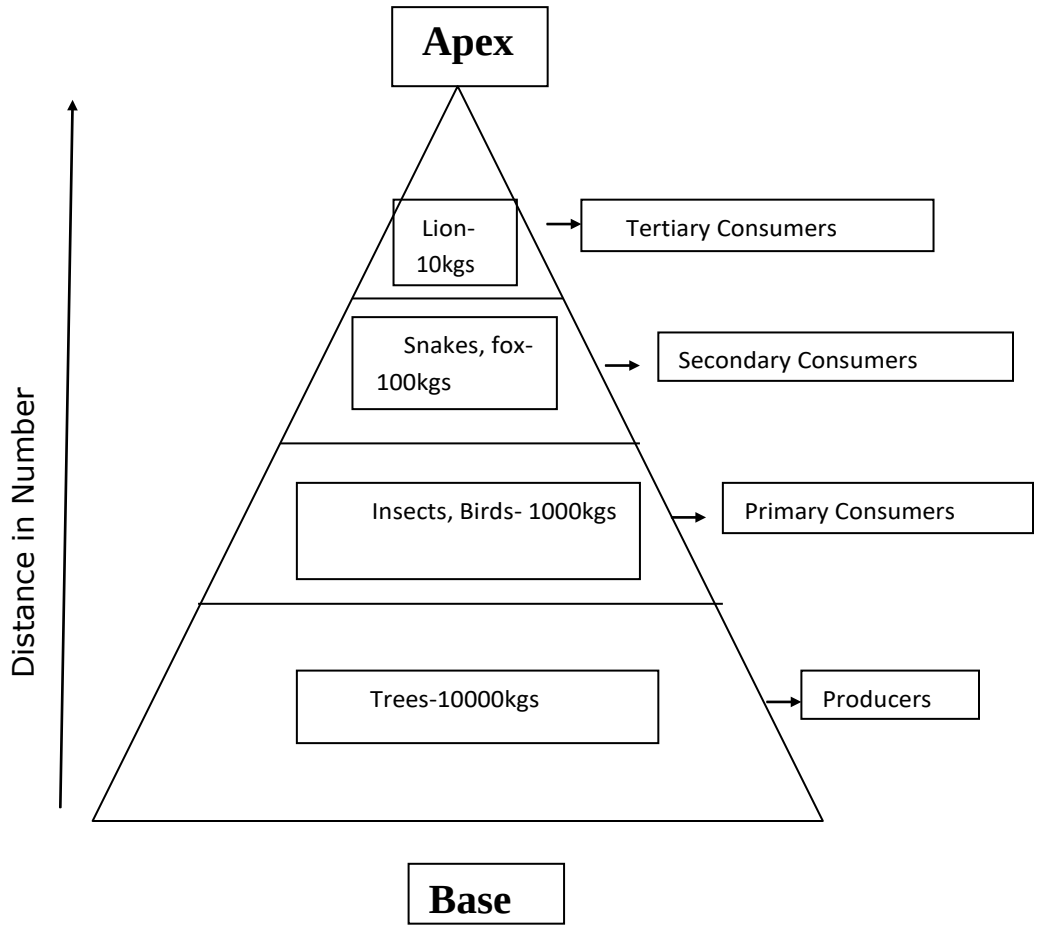
2. Pyramid of Biomass:

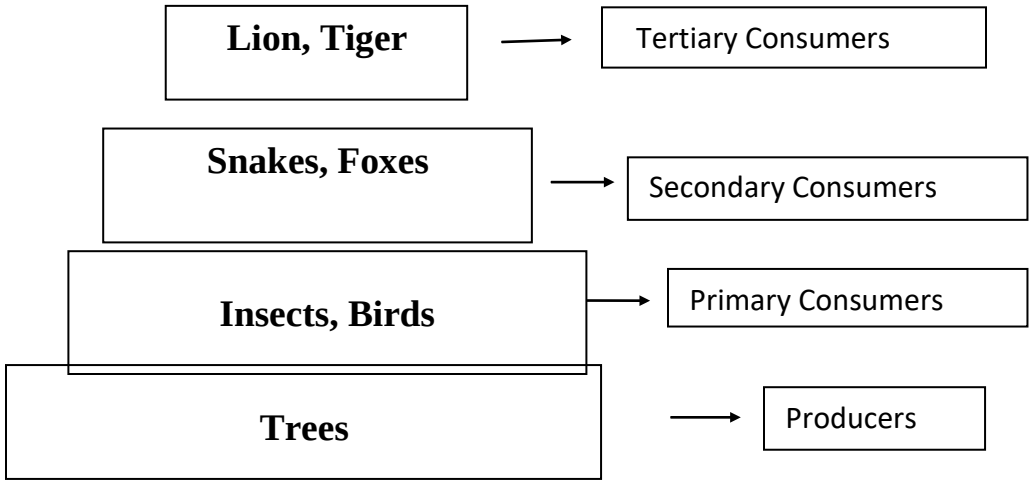
- It represents the total amount of biomass (mass (or) weight of biological material (or) organism) present in each tropic level.
- It is expressed in gram per unitarea.

- Depending upon the type of ecosystem, we have two types of pyramid of biomass.
    i. Upright pyramid of biomass.
    ii. Inverted pyramid of biomass.

i. Upright Pyramid Of Biomass:

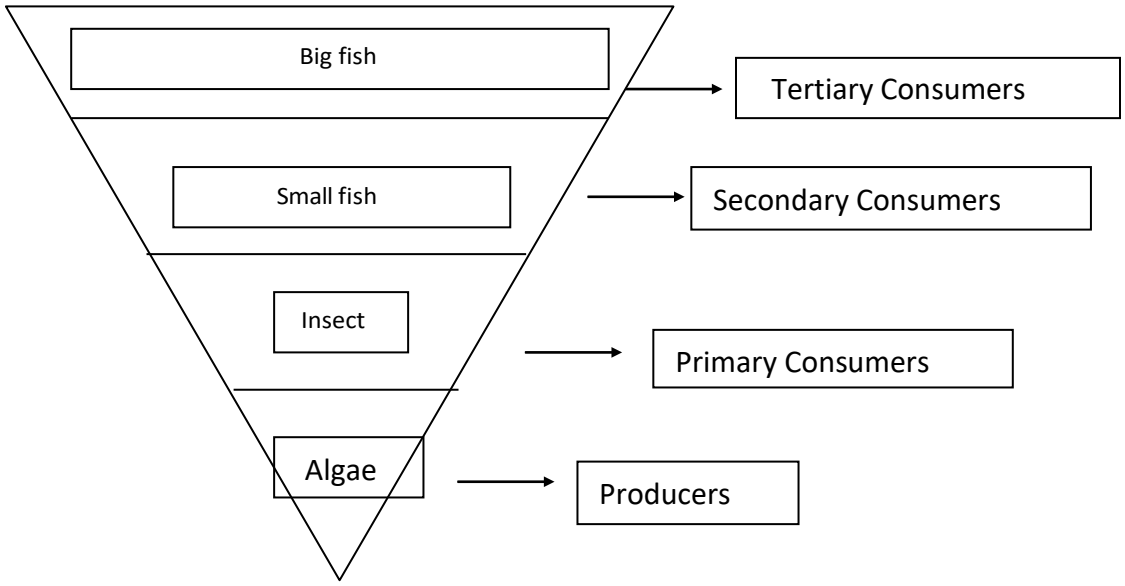
- The pyramid of biomass gradually decreases from the produce level (or) first tropic level to consumer level (higher tropic level) is called "upright pyramid of biomass"
- A forest ecosystem showed an upright pyramid of biomass.
- In this ecosystem, the biomass decreases from the producer level to consumer levels (as shown in figure)





ii. Inverted pyramid of biomass:

- The pyramid of biomass gradually increases from producer level to consumer level are called as Inverted pyramid of biomass.
- Example: The pond ecosystem shows an inverted pyramid of biomass.
- In this, ecosystem, the biomass increases from producer level to consumer levels as shown in the following figure.



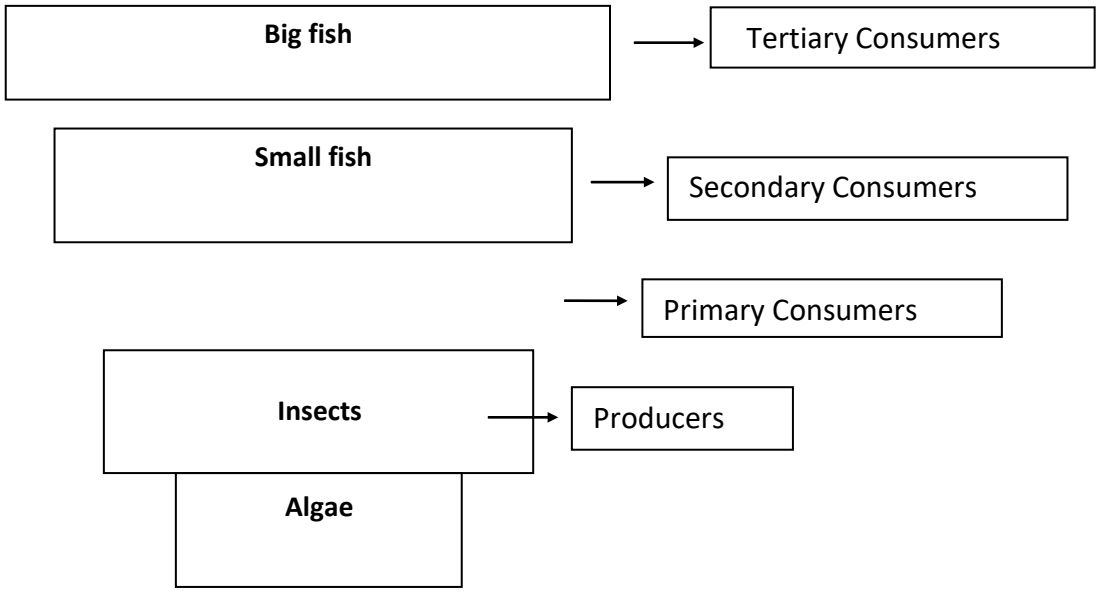
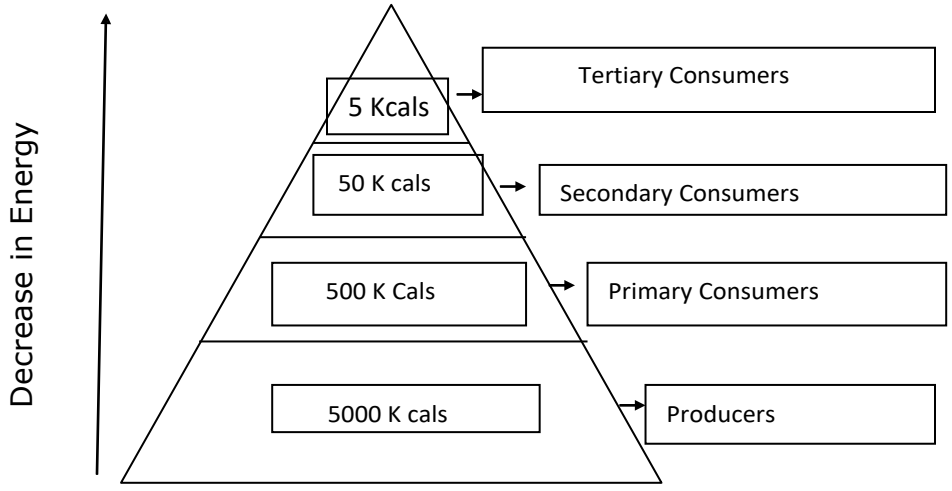
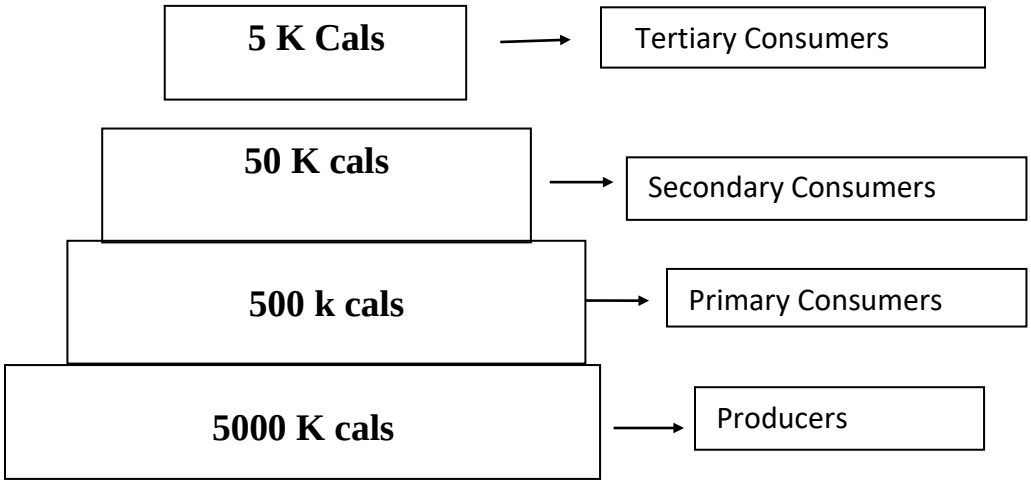


Figure: Pyramid of biomass in pond (eco system)

3. Pyramid of Energy:

- It represents the amount of flow of energy in each tropic level.
- It is expressed in calories per unit area peryear.
- In an eco system, the energy flows from producer level to the consumer level. At each successive tropic level, there is a huge loss of energy (about 90%) in the form of heat, respiration, etc. Thus, at each next higher level only 10% of the energy passes on. Hence, there is a sharp decrease in energy at each and every producer to omnivores (or) top carnivores. Therefore, the pyramid of energy is always upright as shown in figure.





MAJOR TYPES OF ECOSYSTEMS

FOREST ECOSYSTEM

Definition: It is a natural ecosystem consisting of dense growth of trees and wild animals

Types:

1. Tropical – deciduous, evergreen, wet green
2. Littoral and swamps
3. Sub tropical

Characteristics:

Abiotic: soil, sun light, temperature etc

Biotic : forest trees, shrubs and animals

Structure:

Producer	:	Trees and shrubs
Consumer	:	Primary – elephants, deer etc.
		Secondary – snakes, birds, lizards etc
		Tertiary – lions, tigers etc
Decomposers	:	fungi, bacteria

AQUATIC ECOSYSTEM

Definition:

Deals with water bodies and biotic communities present in them-Classified as fresh water and marine ecosystems. Fresh water systems are classified as lentic and lotic ecosystems.

Types:

A. Pond ecosystem: Small fresh water ecosystem – seasonal in nature – organisms: algae, aquatic plants, insects, fishes etc. Ponds are very often exposed to anthropogenic pressure like cloth washing, bathing, cattle bathing, swimming etc.

B. Lake ecosystem: Big fresh water ecosystem – Zonation or stratification, especially during summer is a common one.

Top layer – shallow, warm, prone to anthropogenic activities – Littoral zone **Second layer –** enough sunlight, high primary productivity – Limnetic zone **Third layer –** very poor or no sunlight – Profundal zone

Eg. Dal lake in Srinagar, Naini lake in Nainital

Organisms:

1. Planktons – phytoplankton eg. Algae – zooplankton eg. Rotifers
2. Nektons – that swims in water eg. Fishes
3. Neustons – that float on the surface of water Benthos – that attached to sediments eg. Snails

Types of lakes : Many types

1. Oligotrophic lakes – with less nutrient content
2. Eutrophic lakes – with very high nutrient content due to fertilizer contamination
3. Desert salt lakes – that contains high saline water due to over evaporation
4. Volcanic lakes – formed by water emitted from magma due to volcanic eruptions
5. Dystrophic lakes – that contains highly acidic water (low pH)
6. Endemic lakes – lakes that contain many endemic species, etc.

C. Streams: fresh water ecosystem where water current plays a major role. Oxygen and nutrient content are uniform. Stream organisms have to face extreme difference in climatic conditions but they do not suffer from oxygen deficiency as pond and lake organisms. This is because large surface area of running water provides more oxygen supply. The animals have very narrow

range of tolerance towards oxygen deficiency. Thus stream are worst victims of industrial pollution.

D. River ecosystem: large streams flowing from mountain highlands are rivers.

- Three phases:
    1. Mountain highlands – rushing down water fall of water – large quantity of dissolved oxygen – plants attached to rocks and fishes that require more oxygen are found.
    2. Second phase – gentle slopes of hills – warmer – supports the growth of plants and fishes that require less oxygen are seen.
    3. Third phase: river shapes the land – lots of silts, nutrients are brought – deposited in plains and delta – very rich in biodiversity.

E. Oceans: Gigantic reservoirs of water covering >70% of earth surface – 2,50,000 species – huge variety of sea products, drugs etc. – provide Fe, Mg, oils, natural gas, sand etc. – major sinks of carbon di oxide – regulate biochemical cycles.

- Two zones:
    1. coastal zone – warm, nutrient rich, shallow – high sunlight – high primary productivity.
    2. Open sea – away from continental shelf – vertically divided in to 3 zones.
        - Euphotic zone – abundant sunlight
        - Bathyal zone – dim sunlight
        - Abyssal zone – dark zone – world's largest ecological unit.

F. Estuary: coastal area where river meet ocean – strongly affected by tidal actions – very rich in nutrients – very rich in biodiversity also – organisms are highly tolerant – many species are endemic – high food productivity – however to be protected from pollution.

Characteristics:

Structural Components:

Abiotic: pH, nutrients, D.O, temp, climatic conditions, etc.

Biotic: Phytoplankton, fishes, snails insects, birds, etc.

GRASSLAND ECOSYSTEM:

Dominated by grass – few shrubs and trees are also found – rainfall average but erratic – overgrazing leads to desertification.

Three types – depending on the climate

a. **Tropical grass lands –** found near the boarders of tropical rain forests. Eg. Savannas in Africa. Animals – Zebra, giraffes etc. – fires are common in dry seasons – termite mounds produce methane – leads to fire – high in photosynthesis – deliberate burning leads to release of high CO_2 – global warming.

b. **Temperate grasslands –** flat and gentle slopes of hills. Very cold winter and very hot summer - dry summer fires do not allow shrubs and trees to grow – soil is quite fertile – cleaned for agriculture.

c. **Polar grasslands –** found in arctic polar region – organism – arctic wolf, fox, etc. – A thick layer of ice remains frozen under the soil surface throughout the year – known as permafrost – summer insects and birds appear.

Components:

Structural Components:

Abiotic: soil pH, nutrients, soil moisture, temp, climatic conditions, etc. Biotic: grass, caterpillar, butterfly, worms, insects, birds, etc.