

# The Environment and Ecosystem

UNIT 1

## Environment and Environment Studies

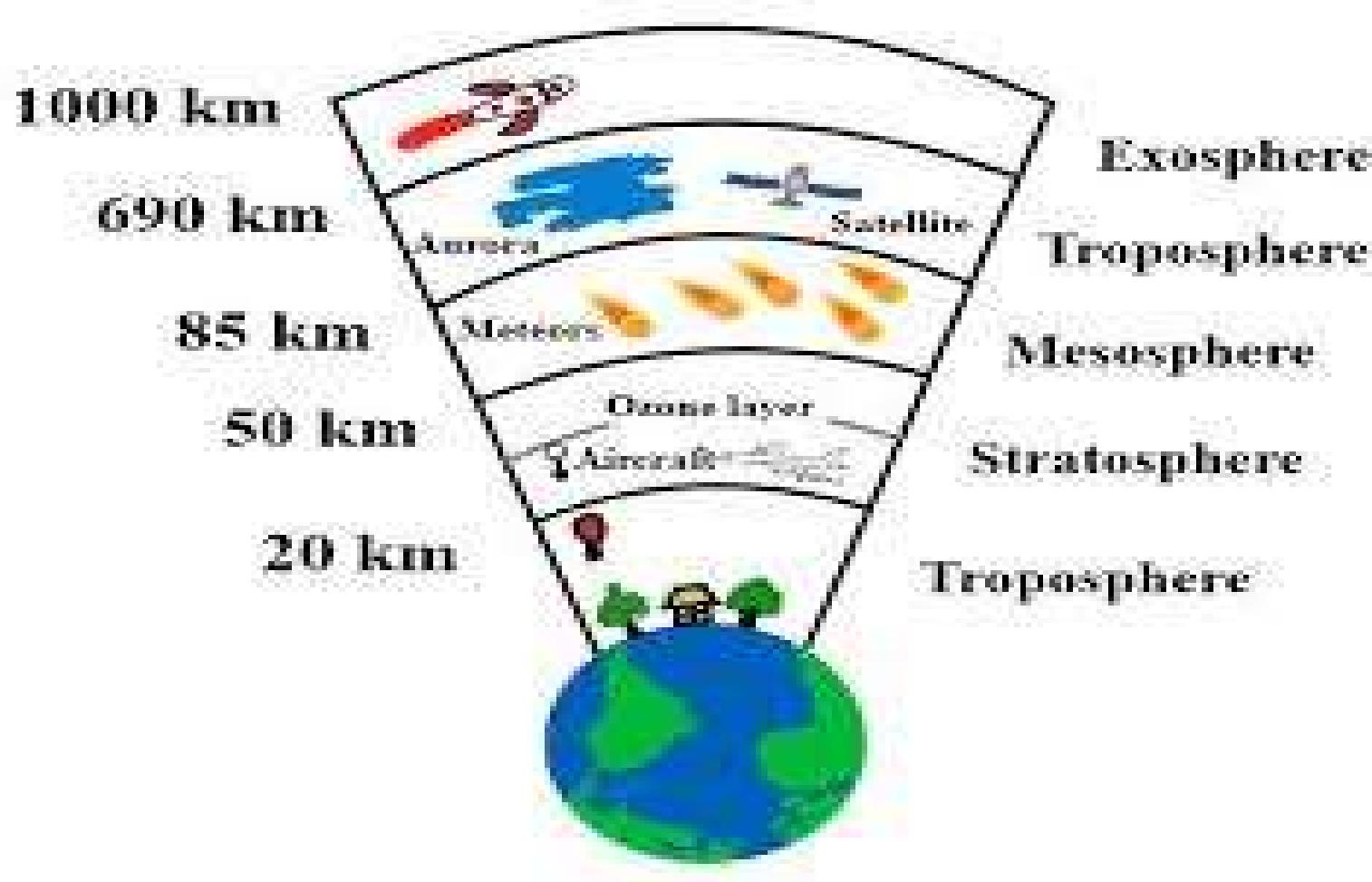
- ▶ The word Environment is derived from the French word “Environ” which means “surrounding”.
- ▶ Our surrounding includes biotic factors like human beings, Plants, animals, microbes, etc and
- ▶ abiotic factors such as light, air, water, soil, etc. Environment is a complex of many variables, which surrounds man as well as the living organisms.

- ▶ The natural environment consist of four interlinking systems namely, the atmosphere, the hydrosphere, the lithosphere and the biosphere.
- ▶ These four systems are in constant change and such changes are affected by human activities and vice versa.
- ▶ Components of Environment Environment has been classified into four major components:
  - ▶ 1. Hydrosphere,
  - ▶ 2. Lithosphere,
  - ▶ 3. Atmosphere,
  - ▶ 4. Biosphere.

- ▶ Hydrosphere includes all water bodies such as lakes, ponds, rivers, streams and ocean etc. Hydrosphere functions in a cyclic nature, which is termed as hydrological cycle or water cycle.
- ▶ Lithosphere means the mantle of rocks constituting the earth's crust.
- ▶ The earth is a cold spherical solid planet of the solar system, which spins in its axis and revolves around the sun at a certain constant distance.
- ▶ Lithosphere mainly, contains soil, earth rocks, mountain etc. **Lithosphere is divided into three layers-crusts, mantle and core (outer and inner).**

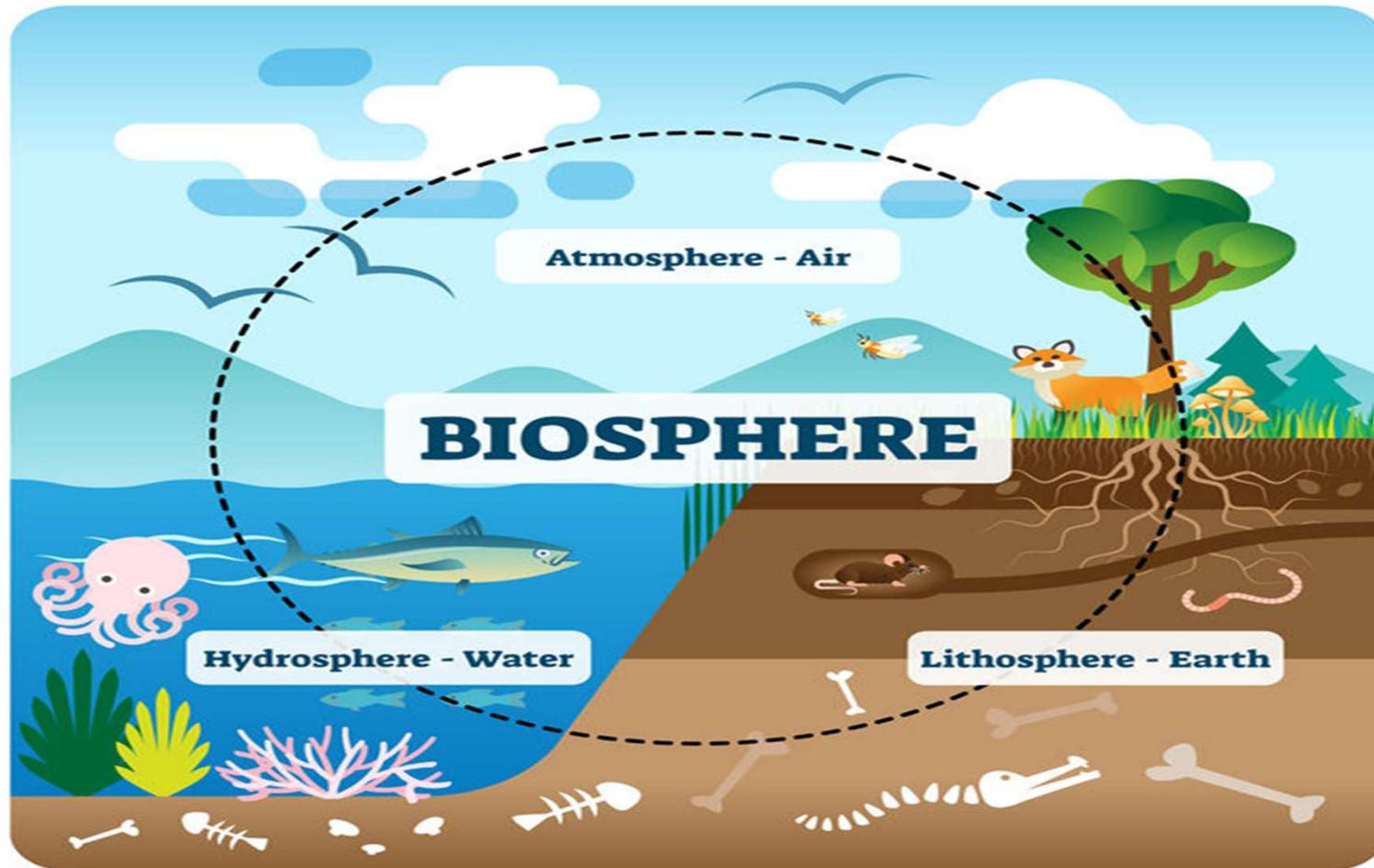
- ▶ Atmosphere The cover of the air, that envelope the earth is known as the atmosphere.
- ▶ Atmosphere is a thin layer which contains gases like oxygen, carbon dioxide etc. and which protects the solid earth and human beings from the harmful radiations of the sun.
- ▶ There are **five concentric layers within the atmosphere**, which can be differentiated on the **basis of temperature** and each layer has its own characteristics.
- ▶ These include the **troposphere**, the **stratosphere**, the **mesosphere**, the **thermosphere** and the **exosphere**.

# Layers of the Atmosphere



- ▶ Biosphere it is also known as the life layer, it refers to all organisms on the earth's surface and their interaction with water and air.
- ▶ It consists of plants, animals and micro-organisms, ranging from the tiniest microscopic organism to the largest whales in the sea.
- ▶ Biology is concerned with how millions of species of animals, plants and other organisms grow, feed, move, reproduce and evolve over long periods of time in different environments.

# BioSphere



## BioDome

- ▶ A biodome is a self-contained, human-made environment designed to mimic a natural ecosystem. It typically houses plants, animals, fungi, and other living organisms within a transparent dome structure. Biodomes can serve as educational tools, research facilities, or even potential habitats for humans in extreme environments.

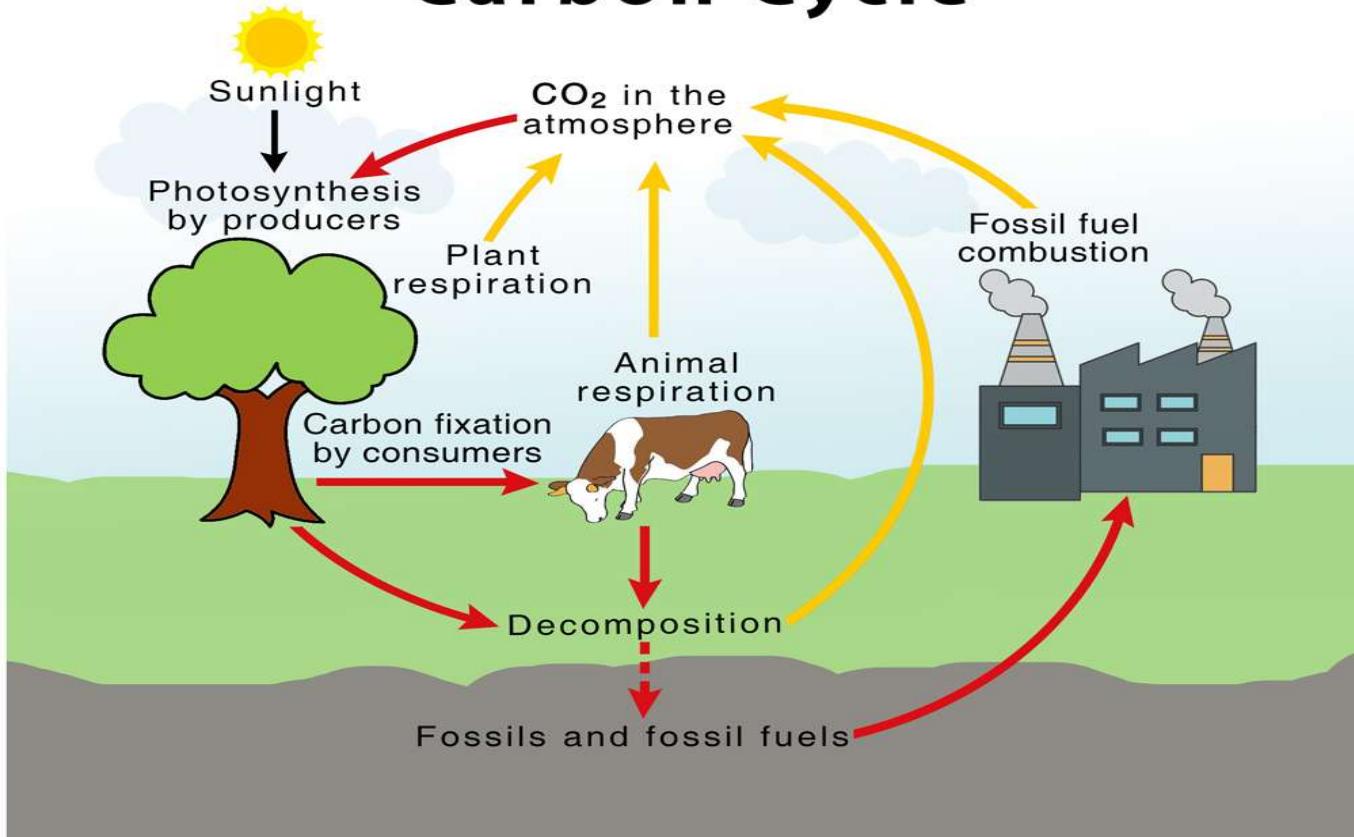
## Carbon Cycle

- ▶ What is the Carbon Cycle?
- ▶ The circulation of carbon on earth in which atmospheric carbon dioxide is converted to organic nutrients through photosynthesis and is again converted back to the inorganic state by respiration, decay, or combustion.
- ▶ The atmosphere, the oceans, vegetation, rocks, and soil forms the major carbon reserve of our planet.

- ▶ Who discovered the Carbon Cycle?
- ▶ Antoine Lavoisier and Joseph Priestley discovered the carbon cycle in the 18th century, which was later popularized by Humphry Davy.

# Carbon Cycle

## Carbon Cycle



- ▶ What are the Major Steps of the Carbon Cycle?
- ▶ 1. Role of Primary Producers (Photosynthesis and Cellular Respiration)
  - ▶ Carbon present in the air as carbon dioxide is absorbed by plants, the primary producers to produce food in the form of carbohydrates by a process called photosynthesis. This forms the foundation of the carbon cycle.
  - ▶ Respiration by plants returns carbon dioxide to the atmosphere, thus once again contributing to the cycle in a different manner.
- ▶ 2. Role of Primary Consumers (Carbon Fixation and Cellular Respiration)
  - ▶ The primary consumers such as cows and horses use plants as their food, and carbon gets accumulated and fixed into their bodies in the form of organic carbon, a process known as carbon fixation.
  - ▶ Respiration by animals release carbon dioxide back to the atmosphere.

- ▶ **3. Role of Detritus Feeders (Decomposition)**
- ▶ Once plants and animals die, the fixed organic carbon is released back into the atmosphere as carbon dioxide gas through decomposition by the **detritus feeders.**(next slide)
- ▶ **4. Role of Fossils and Fossil Fuels (Combustion)**
- ▶ The carbon that is leftover in the body of the dead organisms after decay becomes **fossil fuels over many years**, which on combustion releases the carbon stored in them back to the atmosphere thus completing the cycle.



## Detritivores

are heterotrophic animals that feed on dead, particulate, organic material (chiefly plant matter).



crabs



snails



earthworms



dung  
beetles

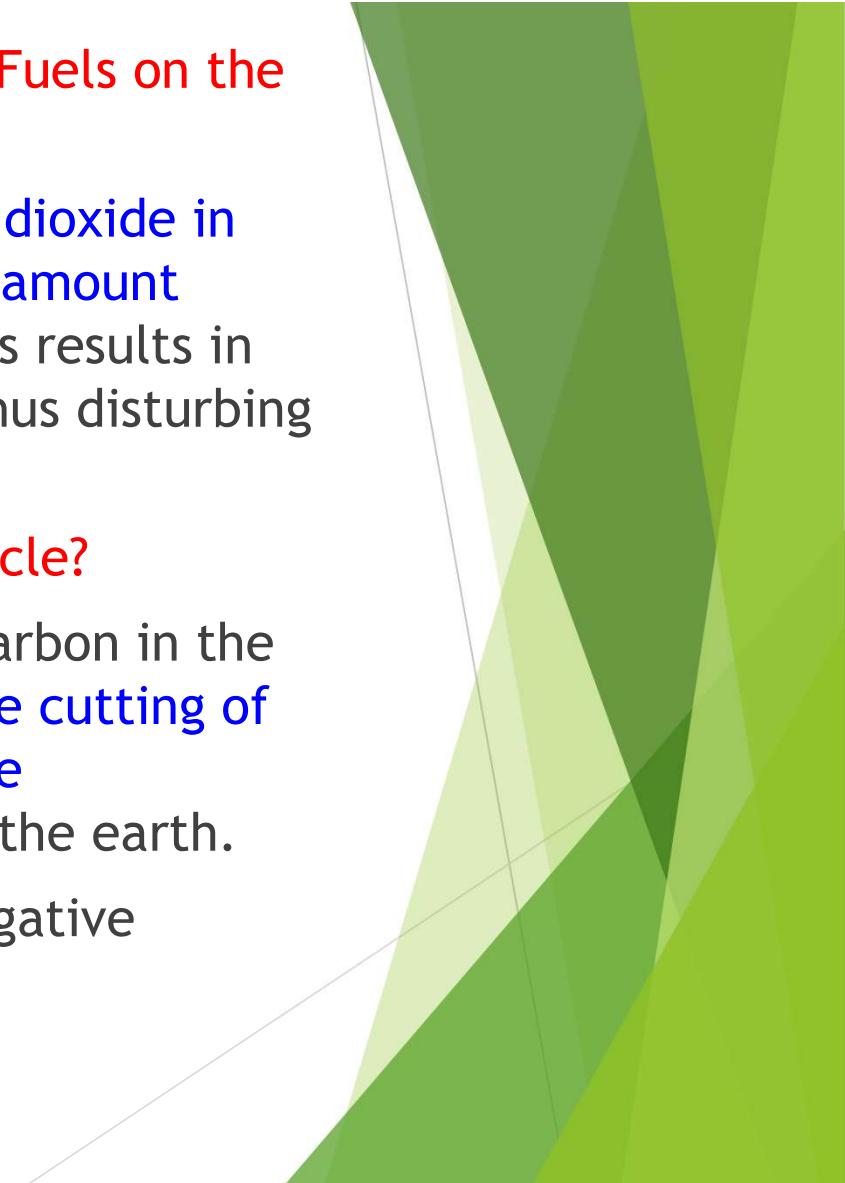


flies

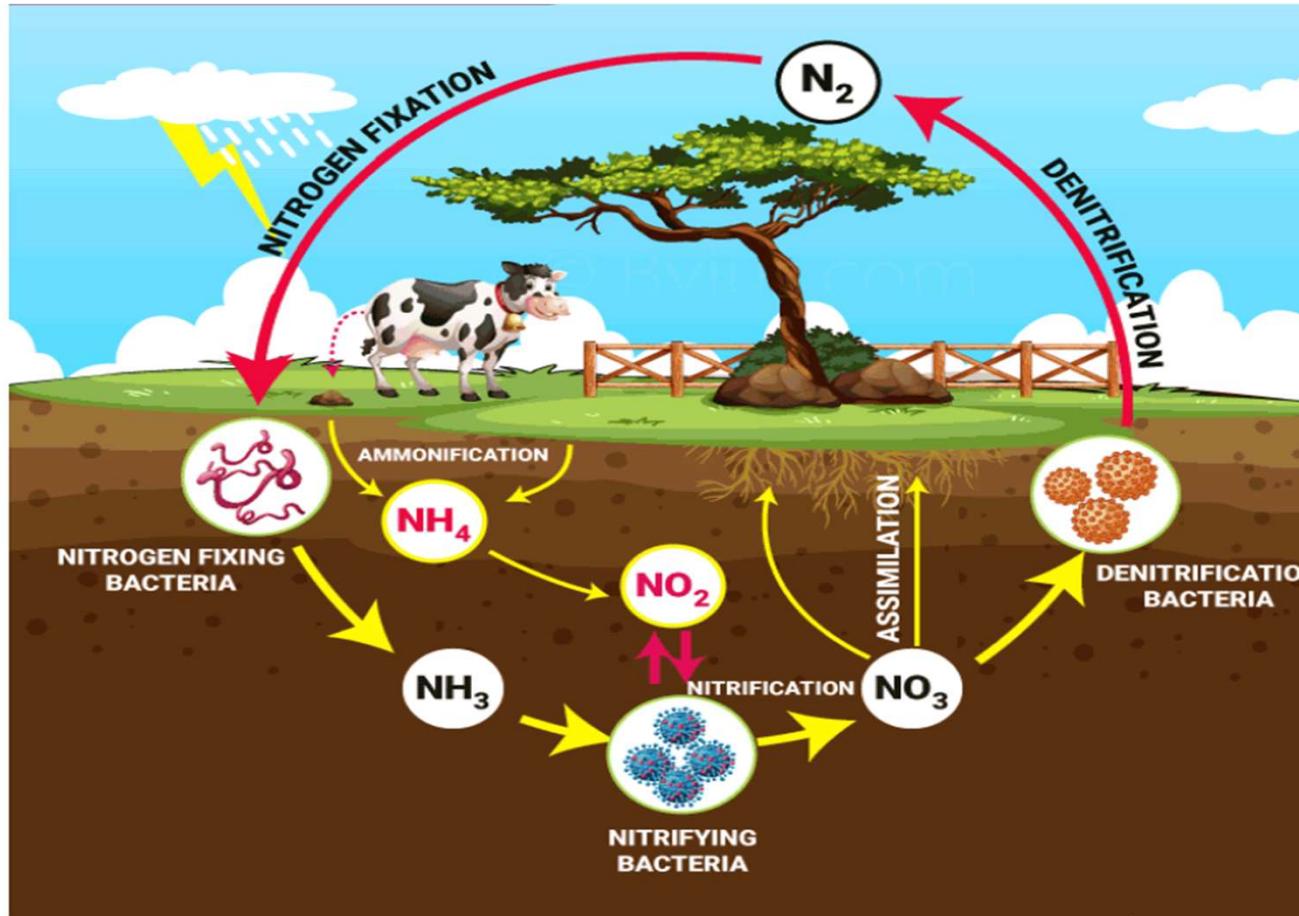
- ▶ Why is the Carbon Cycle Important?
- ▶ Primary Function of the Carbon Cycle: To maintain the balance of carbon in nature.
- ▶ Since atmospheric carbon dioxide determines the rate of photosynthesis by the producers, which acts as the primary source of food production on earth, **the carbon cycle helps to sustain life on earth.**
- ▶ Other Roles in Living Systems and the Environment:
- ▶ Carbon forms an integral component of proteins, lipids, and DNA, the building blocks of all living things.
- ▶ Carbon dioxide traps the long-wavelength radiations from the sun and prevents it from escaping into space, very much like the glass walls of a greenhouse, thus acting as a blanket over the planet and controlling the temperature of the earth.

- ▶ **How do Humans Affect the Carbon Cycle?**
- ▶ Human activities can interfere with the carbon cycle in two possible ways -
  1. Combustion of fossil fuels like coal, petroleum, and natural gases.
  2. Indiscriminate cutting of trees or deforestation

- ▶ What are the Effects of Combustion of Fossil Fuels on the Carbon Cycle?
- ▶ Burning of fossil fuels releases excess carbon dioxide in the atmosphere, which is way more than the amount removed by plants during photosynthesis. This results in an increase in atmospheric carbon dioxide, thus disturbing the balance of the carbon cycle.
- ▶ How Does Deforestation Affect the Carbon Cycle?
- ▶ As trees and forests balance the amount of carbon in the atmosphere through photosynthesis, excessive cutting of trees increases the carbon dioxide level in the atmosphere, thus raising the temperature of the earth.
- ▶ This is one of the primary reasons for the negative greenhouse effects and global warming.



# Nitrogen Cycle



- ▶ Nitrogen Cycle Definition
- ▶ “Nitrogen Cycle is a biogeochemical process which transforms the inert nitrogen present in the atmosphere to a more usable form for living organisms.”

# Nitrogen Cycle Explained - Stages of Nitrogen Cycle

- ▶ Process of the Nitrogen Cycle consists of the following steps - **Nitrogen fixation, Nitrification, Assimilation, Ammonification and Denitrification.** These processes take place in several stages and are explained below:
- 1) **Nitrogen Fixation Process**
- ▶ It is the initial step of the nitrogen cycle. Here, Atmospheric nitrogen ( $N_2$ ) which is primarily available in an inert form, is converted into the usable form -ammonia ( $NH_3$ ).
- ▶ During the process of Nitrogen fixation, **the inert form of nitrogen gas is deposited into soils** from the atmosphere and surface waters, mainly through precipitation.

- ▶ The entire process of Nitrogen fixation is completed by symbiotic bacteria, which are known as **Diazotrophs**. *Azotobacter* and *Rhizobium* also have a major role in this process. These bacteria consist of a nitrogenase enzyme, which has the capability to combine gaseous nitrogen with hydrogen to form ammonia.
- ▶ Nitrogen fixation can occur either by atmospheric fixation- which involves lightening, or industrial fixation by manufacturing ammonia under high temperature and pressure conditions. This can also be fixed through man-made processes, primarily industrial processes that create ammonia and nitrogen-rich fertilisers.

# The phosphorus cycle

- ▶ The phosphorus cycle describes the movement of phosphorus through Earth's rocks (lithosphere), water (hydrosphere), and living organisms (biosphere).
- ▶ Unlike other biogeochemical cycles, phosphorus lacks a significant atmospheric phase, making it a slow, sedimentary cycle primarily driven by geological processes like weathering and erosion.
- ▶ Essential for life, phosphorus forms DNA, RNA, ATP, and bones, and is often a limiting nutrient in ecosystems, especially aquatic ones.
- ▶ Phosphorus is a critical component of **adenosine triphosphate (ATP)**, the "energy currency" of the cell, forming the phosphate groups that store and release energy through high-energy bonds. This chemical energy is essential for all cellular functions, including growth, maintenance, and repair.

## ► Key Stages of the Phosphorus Cycle

- 1. Weathering:
  - Rain and wind gradually break down phosphate-rich rocks, releasing inorganic phosphate into the soil and water.
- 2. Absorption by Plants:
  - Plants absorb these dissolved inorganic phosphates from the soil through their roots, incorporating them into organic compounds.
- 3. Absorption by Animals:
  - Animals obtain phosphorus by eating plants or other animals that have consumed plants, transferring the element through the food chain.

- ▶ 4. Decomposition:
  - ▶ When plants and animals die and excrete waste, decomposers (like bacteria and fungi) break down their organic matter, returning phosphorus to the soil and water for reabsorption by plants.
- ▶ 5. Geological Deposition:
  - ▶ Over very long periods, phosphorus can be carried by rivers and runoff into oceans, where it accumulates in sediments on the ocean floor. Eventually, these sediments may be uplifted by geological processes, exposing new rock formations and starting the cycle anew.

## ► Importance of Phosphorus

- Essential for Life: Phosphorus is a fundamental component of DNA and RNA (genetic material) and ATP (the energy currency of cells).
- Structural Component: It is also vital for forming bones and teeth in animals.
- Limiting Nutrient: In many natural ecosystems, especially aquatic environments, phosphorus is the most scarce nutrient available, limiting plant and phytoplankton growth and overall biomass production.

## ► Human Impact

- Eutrophication: Excessive phosphorus, often from agricultural runoff and wastewater, can lead to eutrophication in lakes and rivers, causing harmful algal blooms and impacting water quality.

# Contents

- Food Chain,
- food web
- Ecological Pyramids

The function of an ecosystem can be studied under the three heads.

1. **Trophic Level Interaction** - gives idea about the energy flow through the ecosystem.

2. **Ecological Succession** - deals with the changes in features/members of an ecosystem over a period of time

3. **Biogeochemistry Trophic Level** - focused upon the cycling of essential materials in an ecosystem.

**Trophic Level Interaction** -. Three concepts

➤ **Food Chain**

➤ **Food Web**

➤ **Ecological Pyramids**

## Food chain

it is the sequence of eating and being eaten in ecosystem is known as food chain.

- A food chain may be defined as, “ the transfer of energy and nutrients through a series of organisms with repeated process of eating and being eaten ”.
- In an ecosystem, all the organisms are linked together with one another by food relationship.
- Each organism living or dead is potential food for some other organism.

## Examples

- Grass → grasshopper → Frog → Snake → Hawk (Grassland ecosystem)
- Phytoplanktons → water fleas → small fish → Tuna (Pond ecosystem)
- Lichens → reindeer → Man (Arctic tundra)

# FOOD CHAIN

OWL  
(Consumer)



FLOWER  
(Producer)



FROG  
(Consumer)



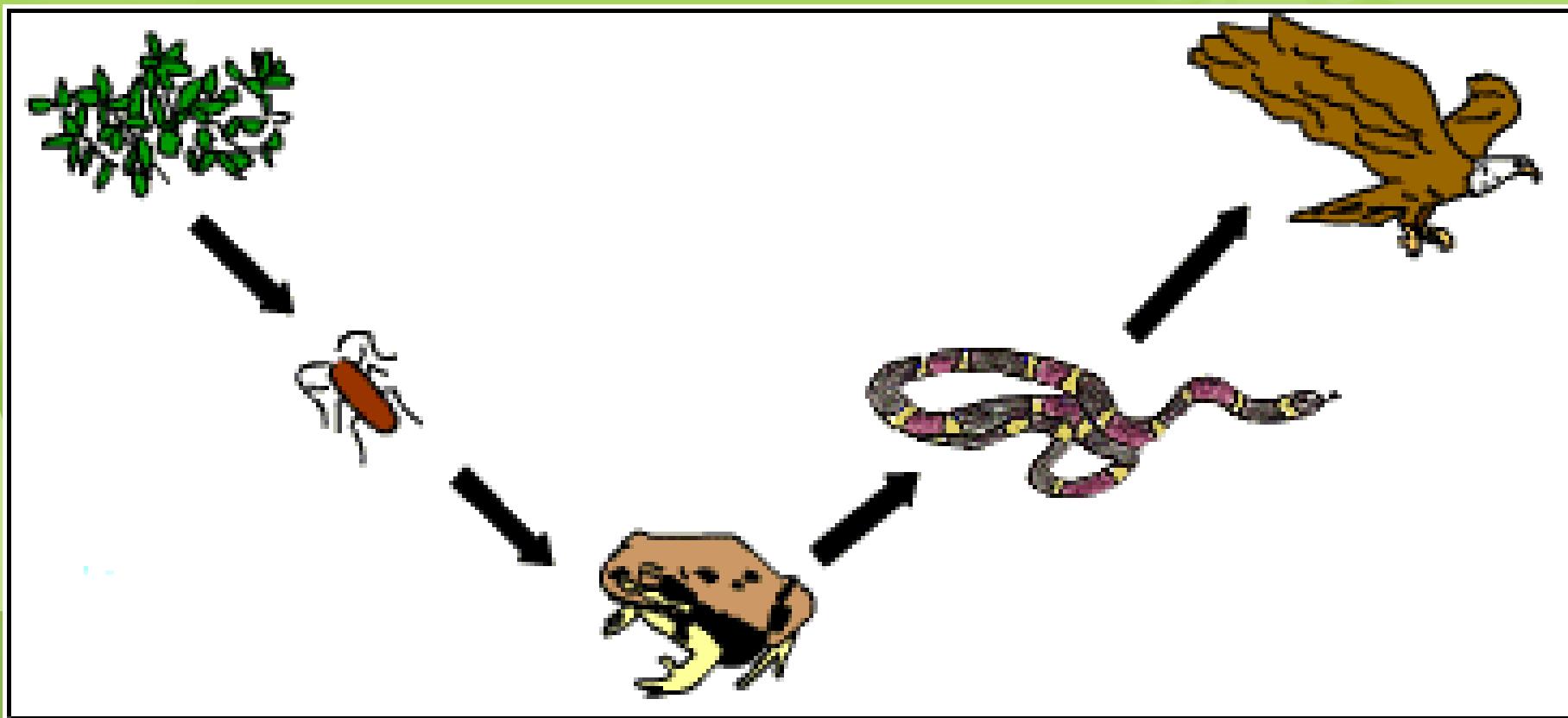
SNAKE  
(Consumer)



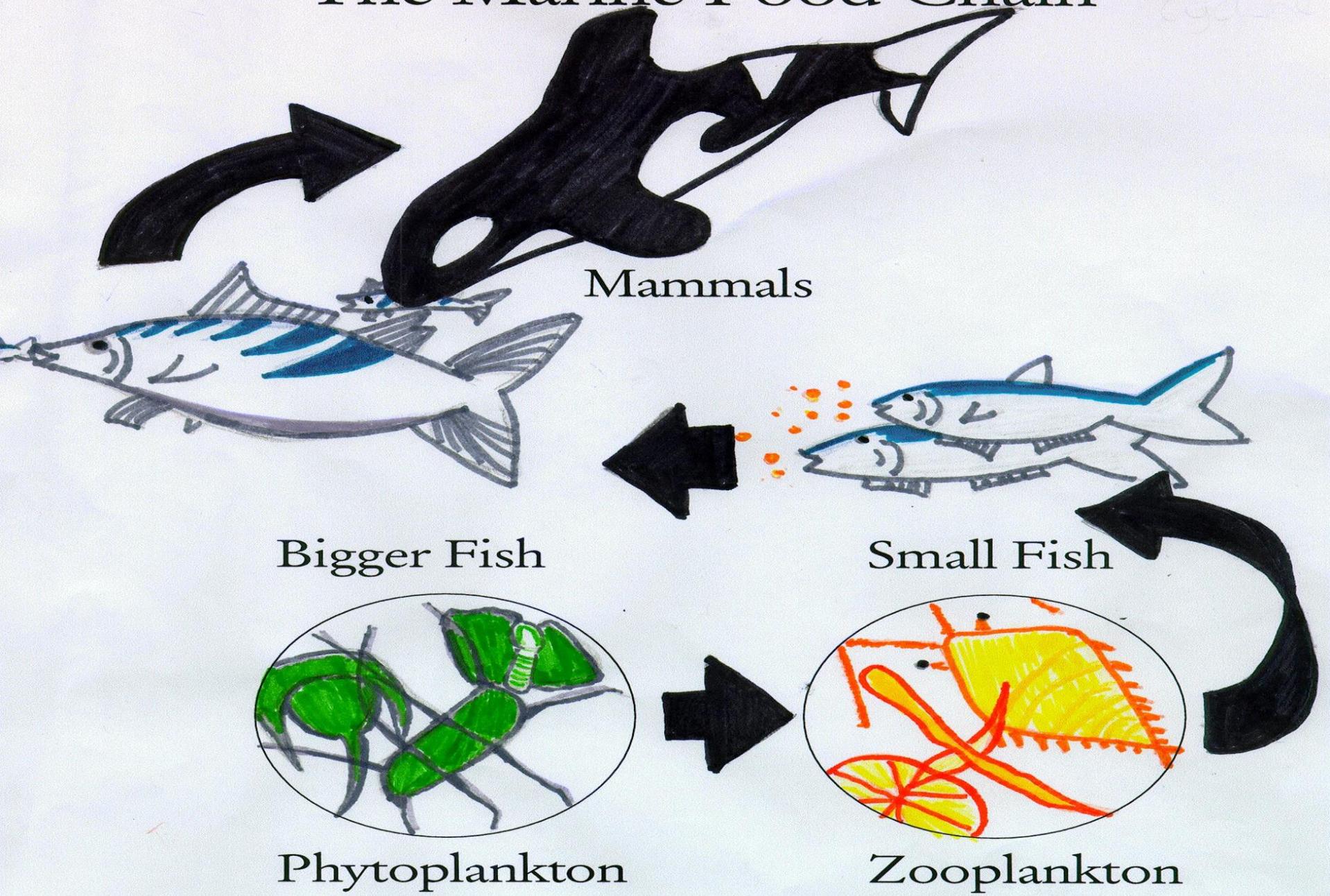
CATERPILLAR  
(Consumer)



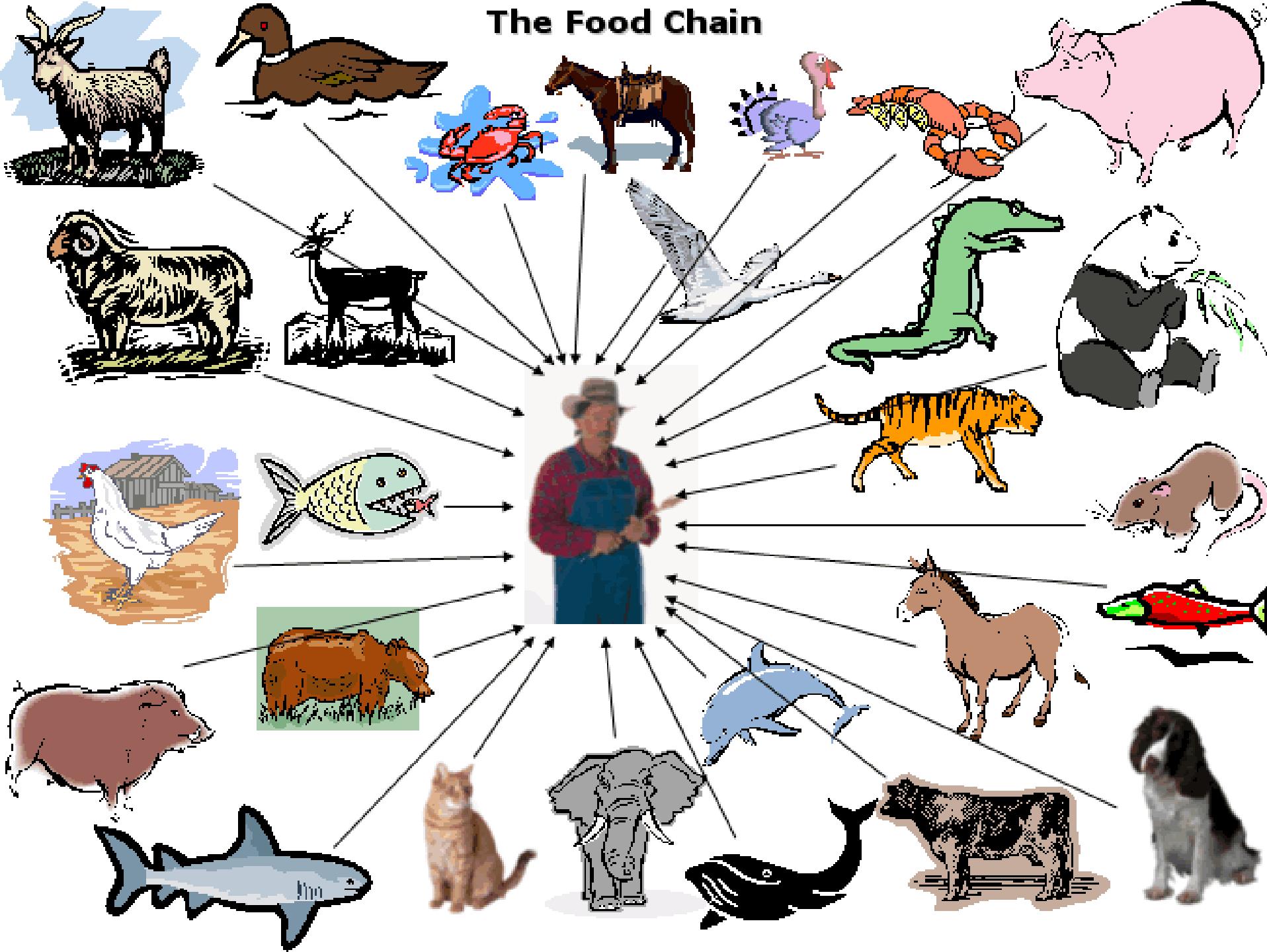
# Food Chains



# The Marine Food Chain



## The Food Chain

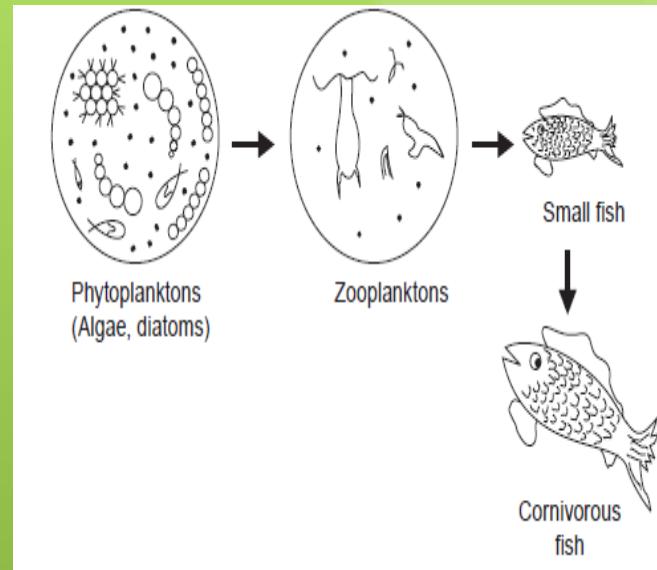


# Types of food chains

- 1. Grazing Food chain
- 2. Detritous Food chain

# Grazing Food chain

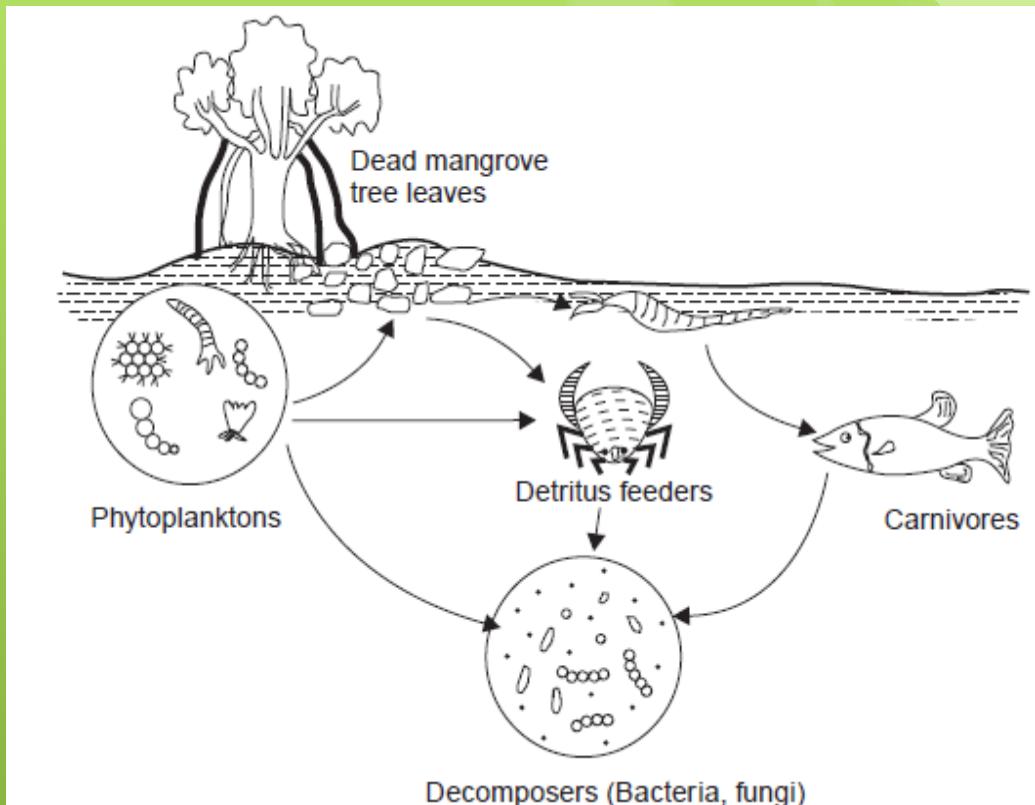
- It starts with green plants and culminates in carnivores.



Grass → Rabbit → Fox

# Detritous Food chain

- It starts with dead organic matter which the detritivores and decomposers consume. Partially decomposed dead organic matter and even the decomposes are consumed by detritivores and their predators



# Decomposers Vs. Detritivores?

- They actually are different, even though this difference is slight.
- Detritivores are organisms that feed on decomposing organic matter [ex: poop (fecal matter), leaf litter, detritus (marine snow)].
- Decomposers are organisms that consume ONLY dead organisms.

# Decomposers Vs. Detritivores?

- detritivore feeds on large parts of decaying plant, animal matter, and on waste material.
- A decomposer consumes and breaks down dead organisms or waste matter into simple substances.

- They both get nutrition from dead organic matter.
- The difference is that **detritivores** actually eat the **organic matter** (like earthworms eating their way through the soil) e.g. beetles, termites, ants, crabs, earthworms etc

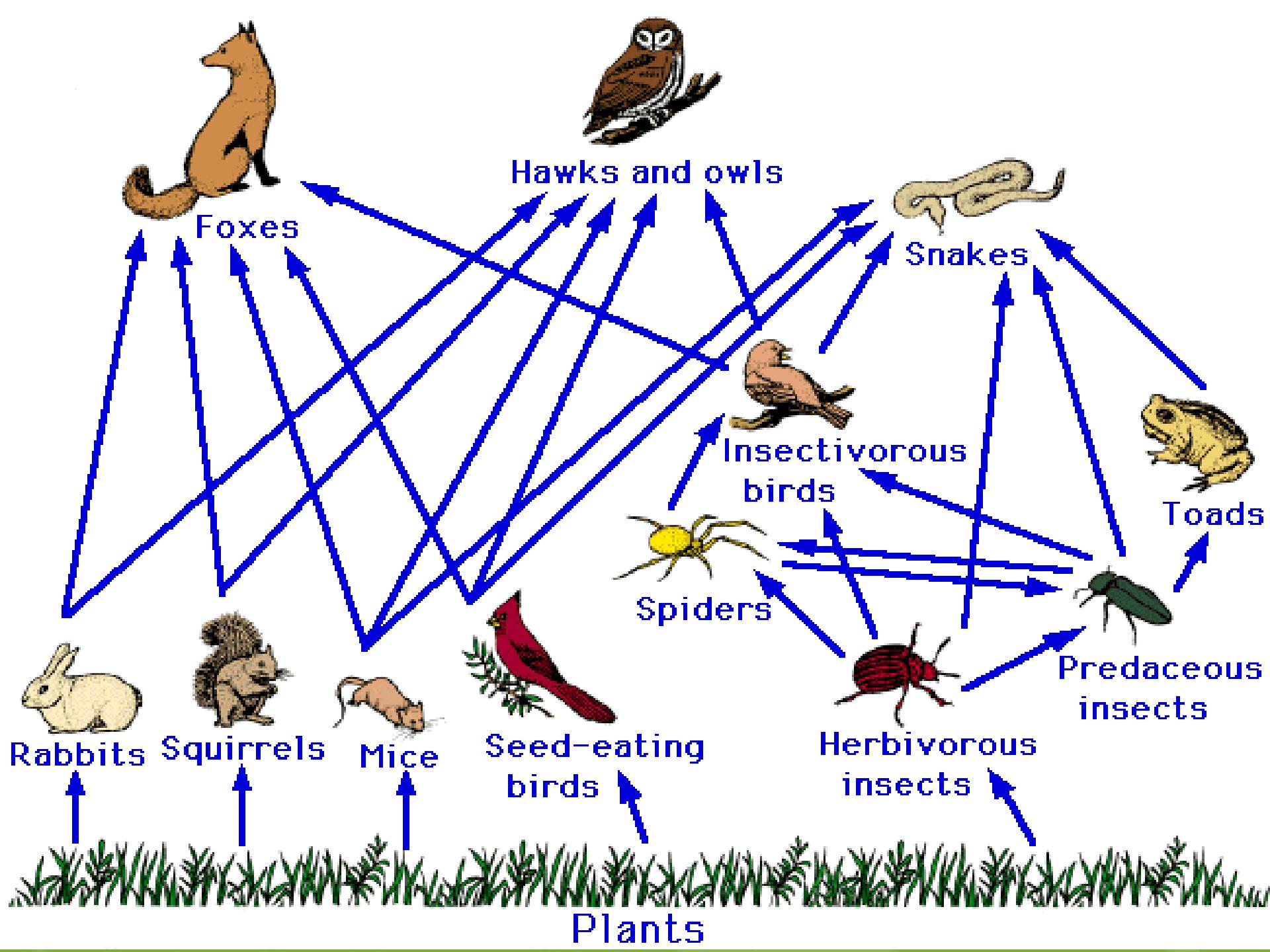
And

- decomposers secrete enzymes to digest the organic matter and then absorb the resulting molecules (like bacteria or fungi do).

- **Decomposers**: absorb nutrients on a molecular scale. They derive their nutrition by breaking down the complex organic molecules to simpler organic compounds and **ultimately into inorganic nutrients**. Various bacteria and fungi are decomposers.
- **Detritivores**: ingesting dead organic matter
  - : might feed on the droppings of scavengers/hunters or on the parts of carcasses/skeleton left behind
- **Scavengers**: generally being larger organisms which consume larger amounts of organic matter

# Food Web

- ❖ Under natural conditions, the linear arrangement of food chains hardly occurs & these remains connected interconnected with each other through different types of organisms.
- ❖ Interlocking pattern of several interlinked food chains is termed as FOOD WEB.
- ❖ A food web is a network of food chains 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.



*Fox*



*Rat*



*Gull*



## A common food web

*Puffin*



*Kittiwake*



*Auklet*



*Salmon*



*Cephalopod*



*Sand lance*



*Decomposers*



*Zooplankton*

*Phytoplankton*

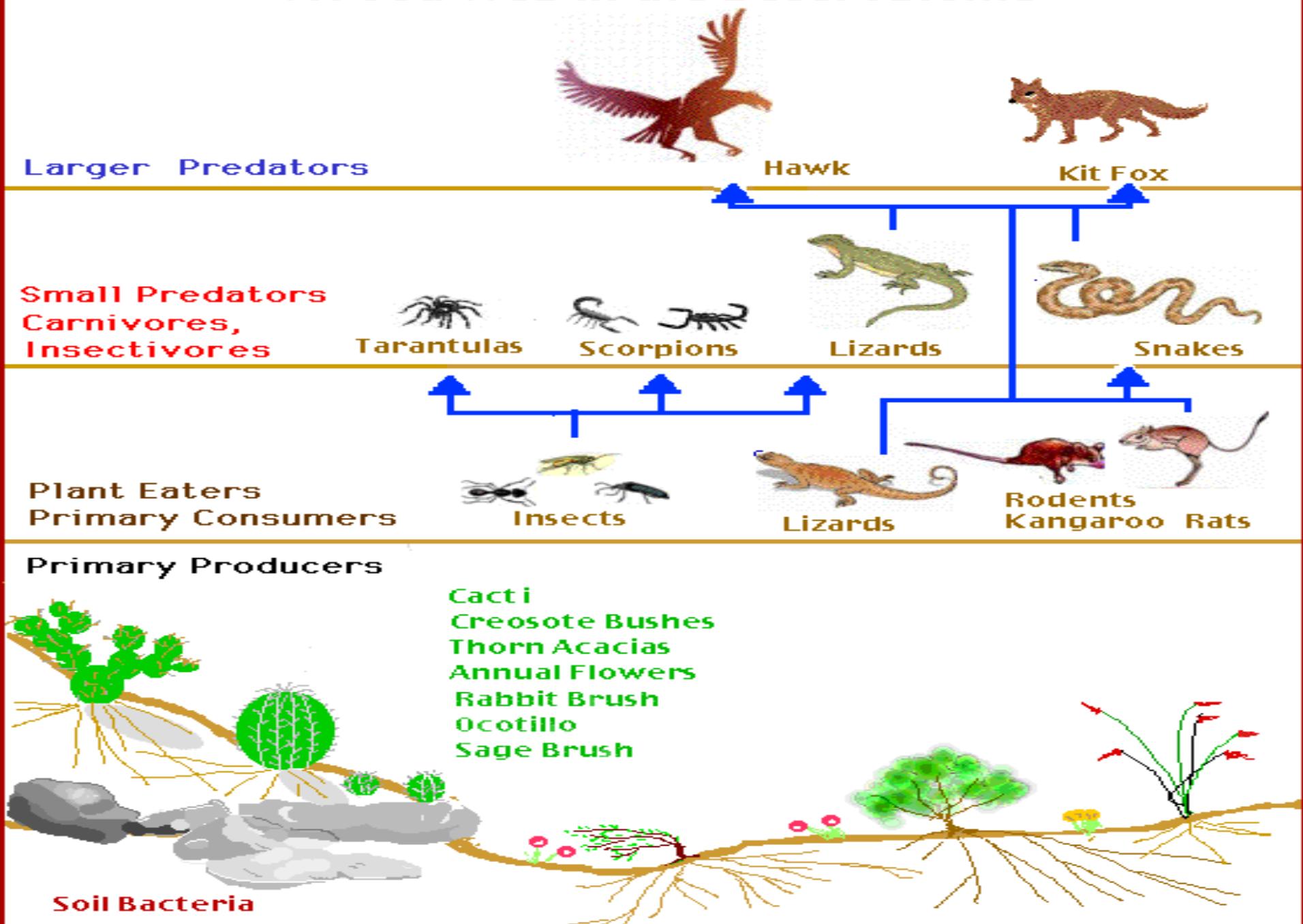


*Water & Nutrients*

*Sun*

*Air*

# A Food Web in the Desert Biome



What is food chain and  
food web

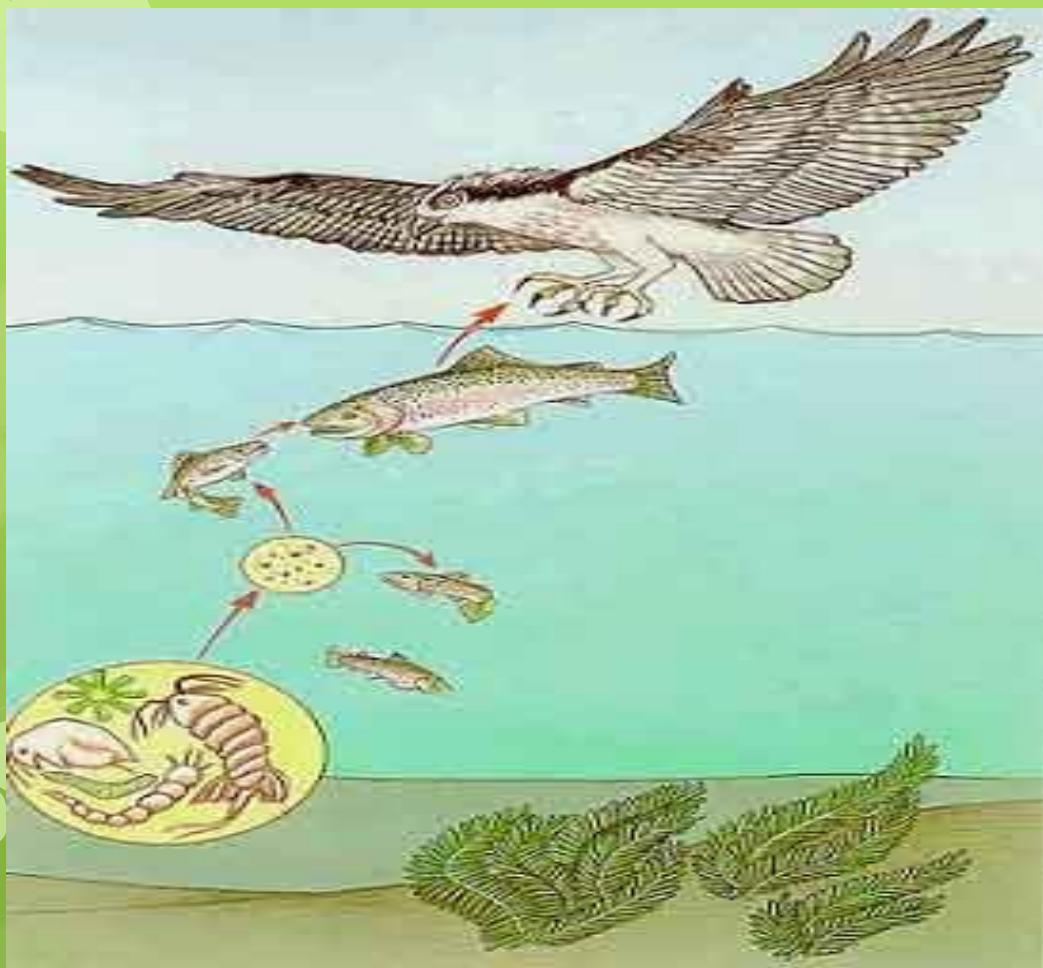
# Significance of food chains and Food webs

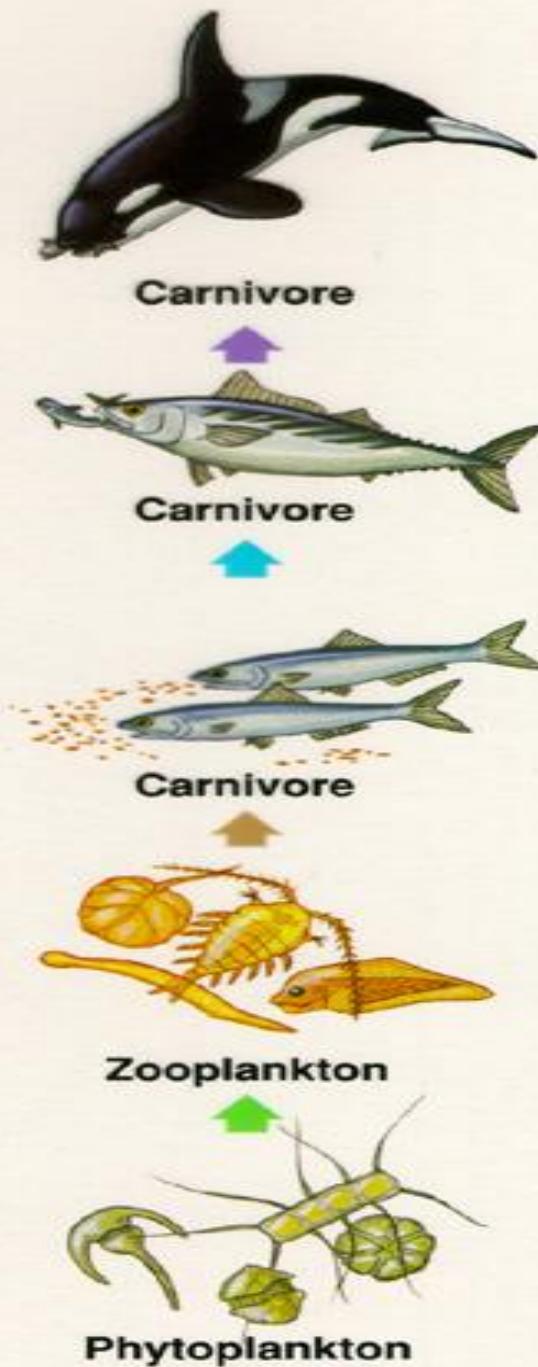
- FC & FB play a very significant role in the ecosystem because the two most important functions of energy flow and nutrient cycling takes place through them.
- The fC also help in maintaining and regulating the population size of animals and thus, he maintain the ecological balance.

# Trophic level

- The producers and consumers are arranged in the ecosystem in a definite manner and their interaction along with population size are expressed together as trophic level.

# Trophic level





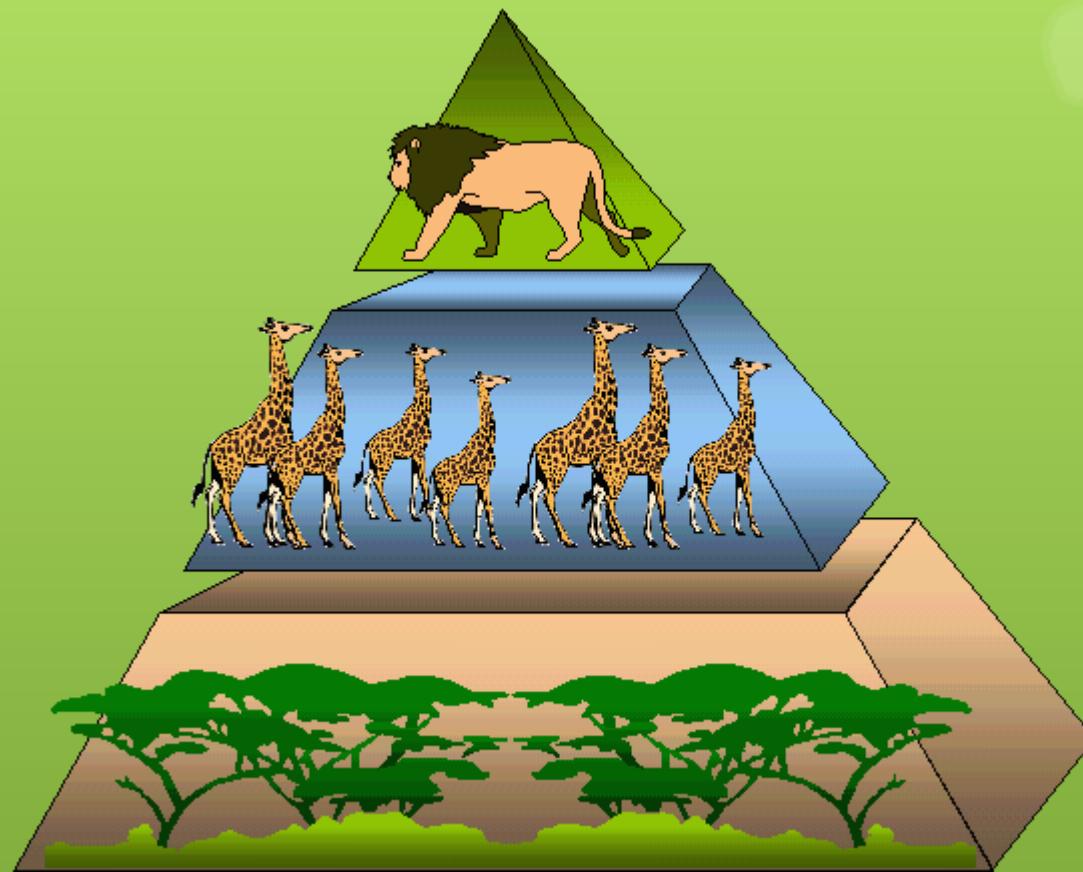
## Ecological Pyramids:

- ❖ An "*Ecological pyramid*" is a graphical representation that shows the relative amounts of energy or matter contained within each trophic level in a food chain or food web.
- ❖ An ecological pyramid shows the relationship between consumers and producers at different trophic levels in an ecosystem
- ❖ There are **three ecological pyramids** recognized by ecologists:

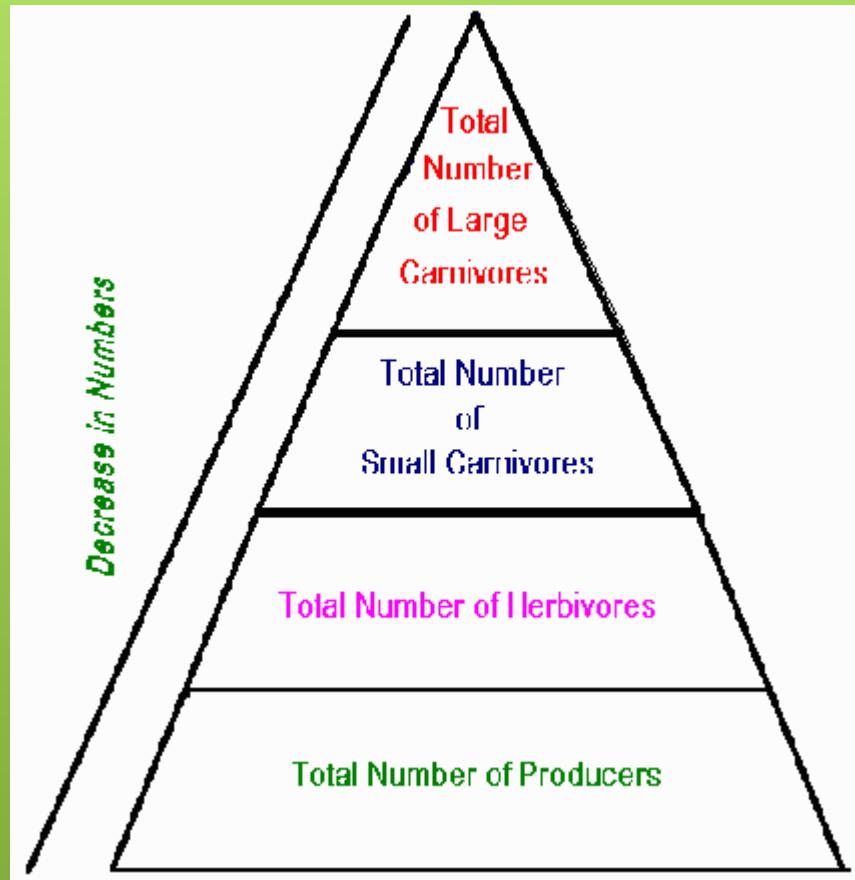
# ECOLOGICAL PYRAMID

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

# ECOLOGICAL PYRAMID

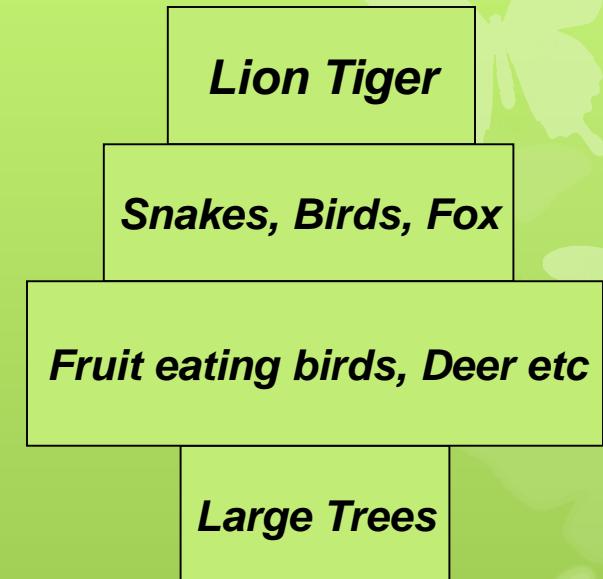


# Number pyramid



## 1) Pyramid of Numbers:

Shows the relative number of individual organisms at each trophic level.

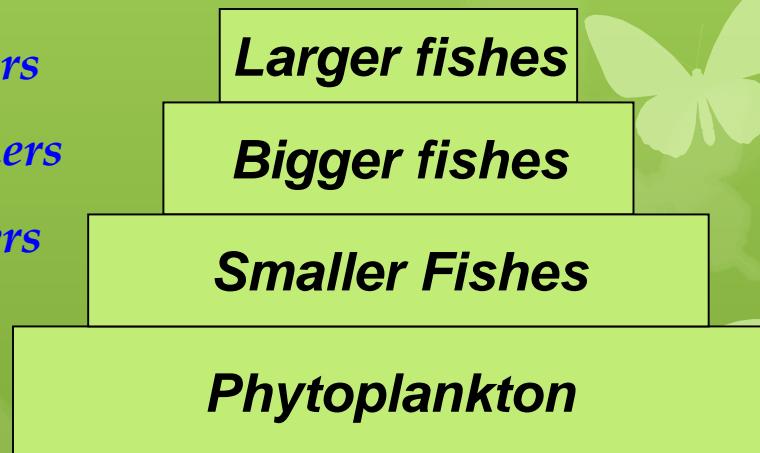


**Forest Ecosystem**



**Grassland Ecosystem**

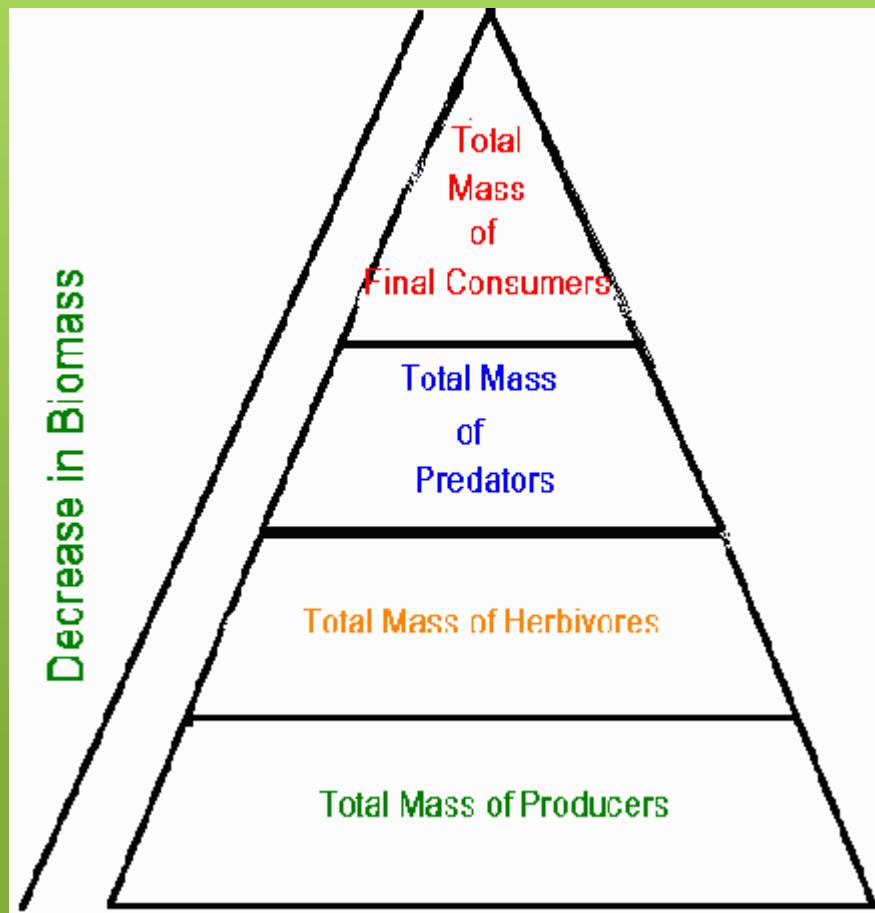
*Producers*  
*Primary Consumers*  
*Secondary Consumers*  
*Tertiary Consumers*



**Pond Ecosystem**

## 2) Pyramid of Biomass:

- ❖ A pyramid of biomass represents the total dry mass (in grams per square metre of area) of all the organisms in each trophic level at a particular time.



**Snakes, Frogs,  
Birds etc.**

**Cows Sheep,  
Deer, Rabbit**

**Grasses**

## **Grassland Ecosystem**

*Carnivores*

*Herbivores*

*Producers*

**Lion, Tiger,  
etc.**

**Elephant, Deer etc.**

**Trees**

## **Forest Ecosystem**

**Fish, Water beetles etc.**

**Zooplanktons**

**Phytoplankton's**

## **Pond Ecosystem**

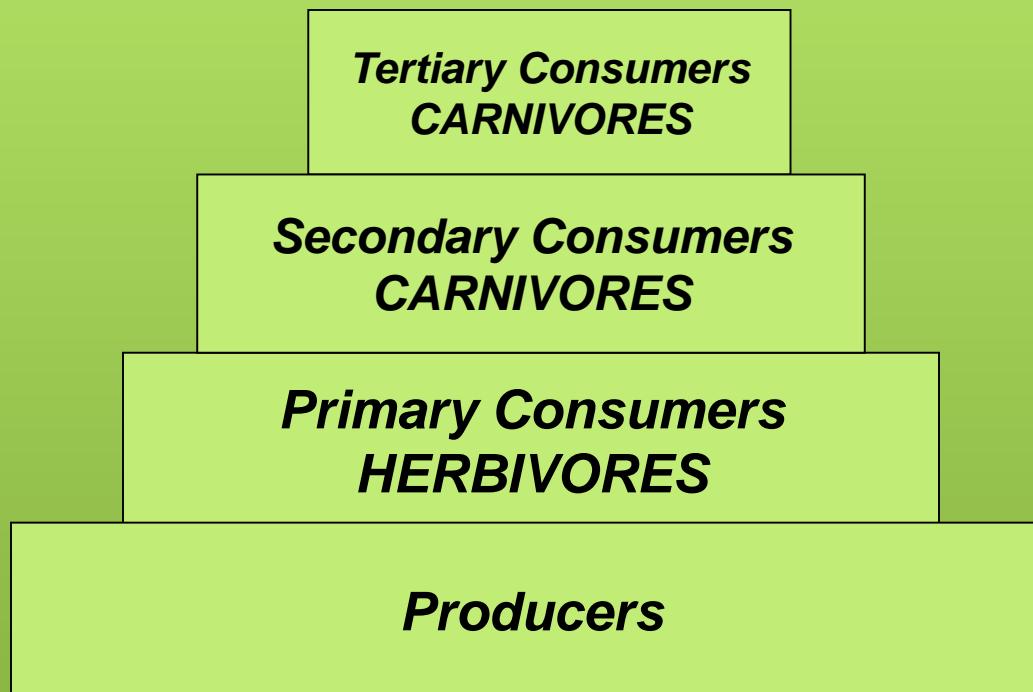
*Carnivores*

*Herbivores*

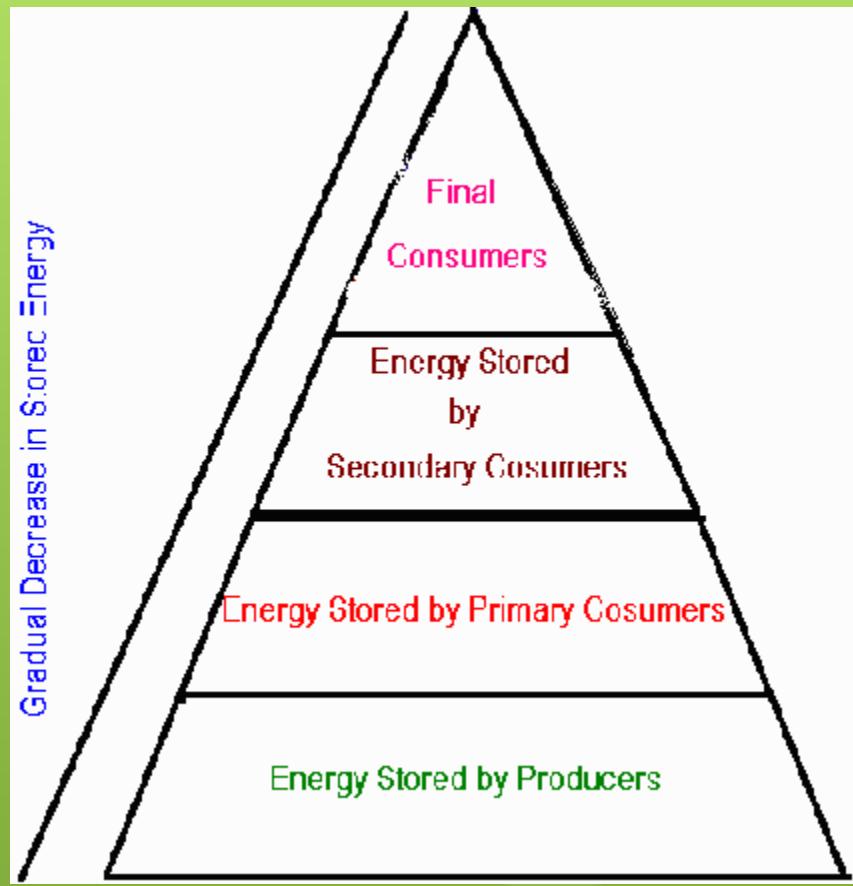
*Producers*

### 3) Pyramid of Energy:

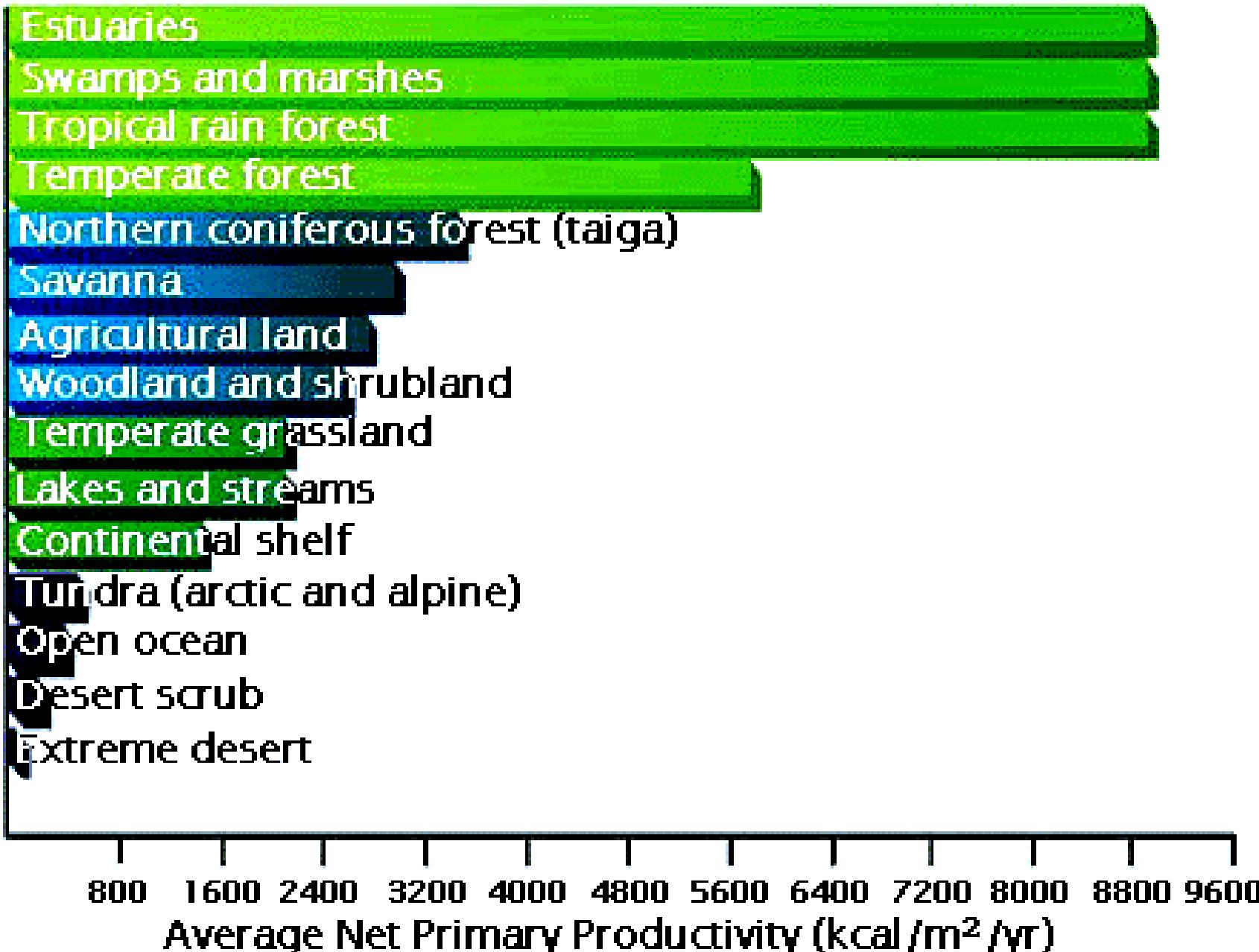
- ❖ A pyramid of Energy represents the rate of energy flow and/or productivity at successive trophic levels. The pyramid of energy are always upright.



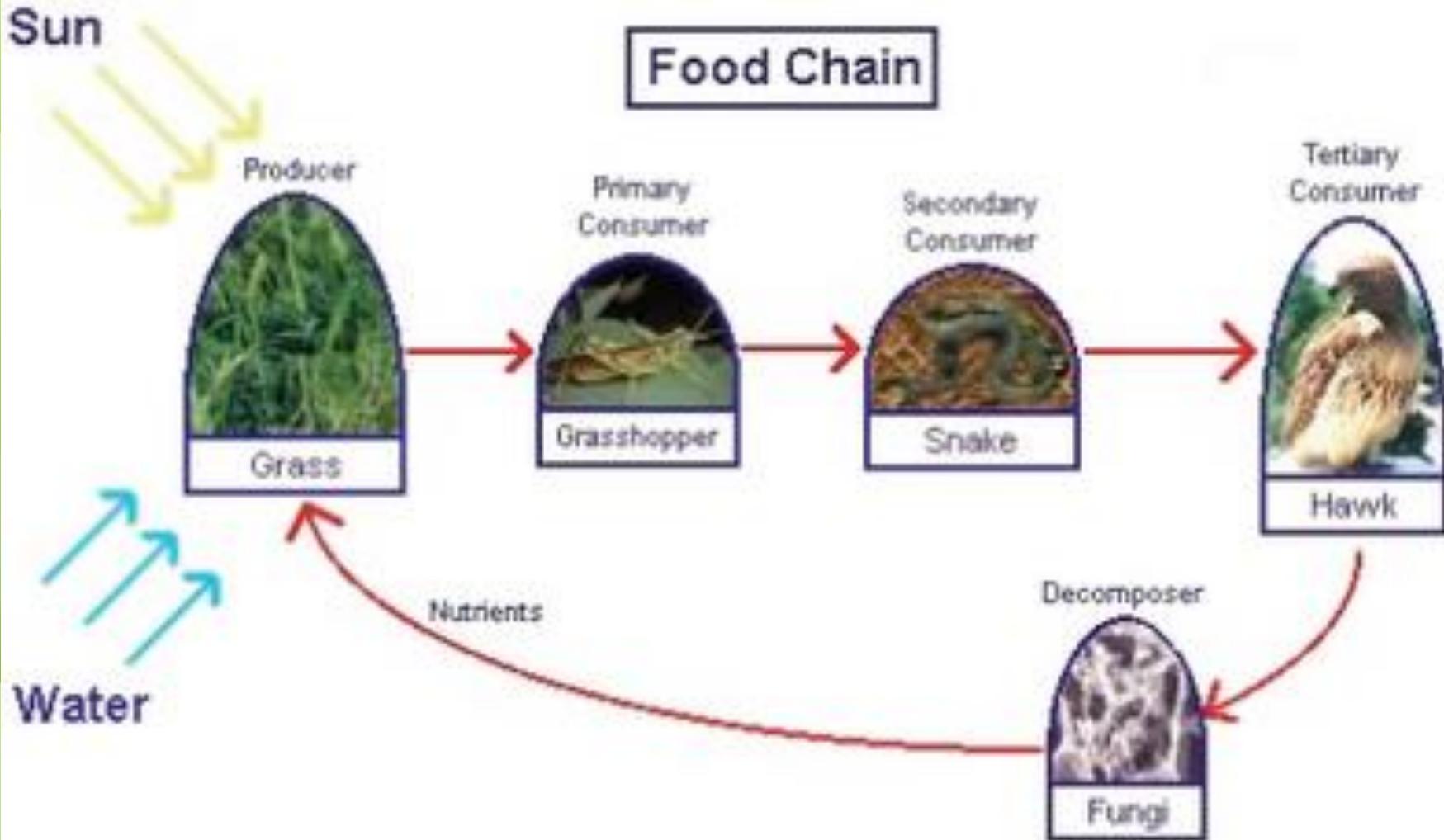
# Energy pyramid



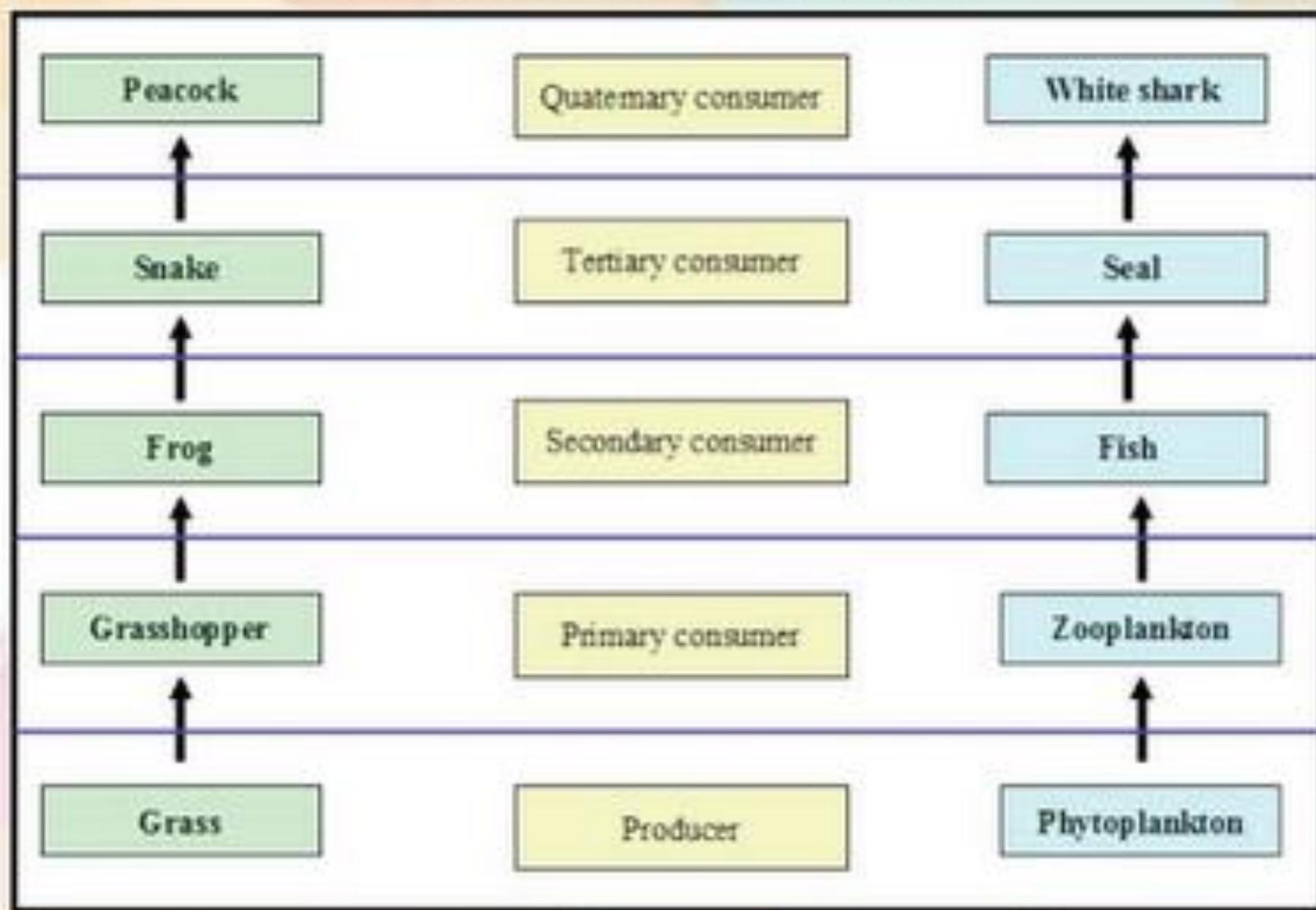
# Type of Ecosystem



## Food Chain



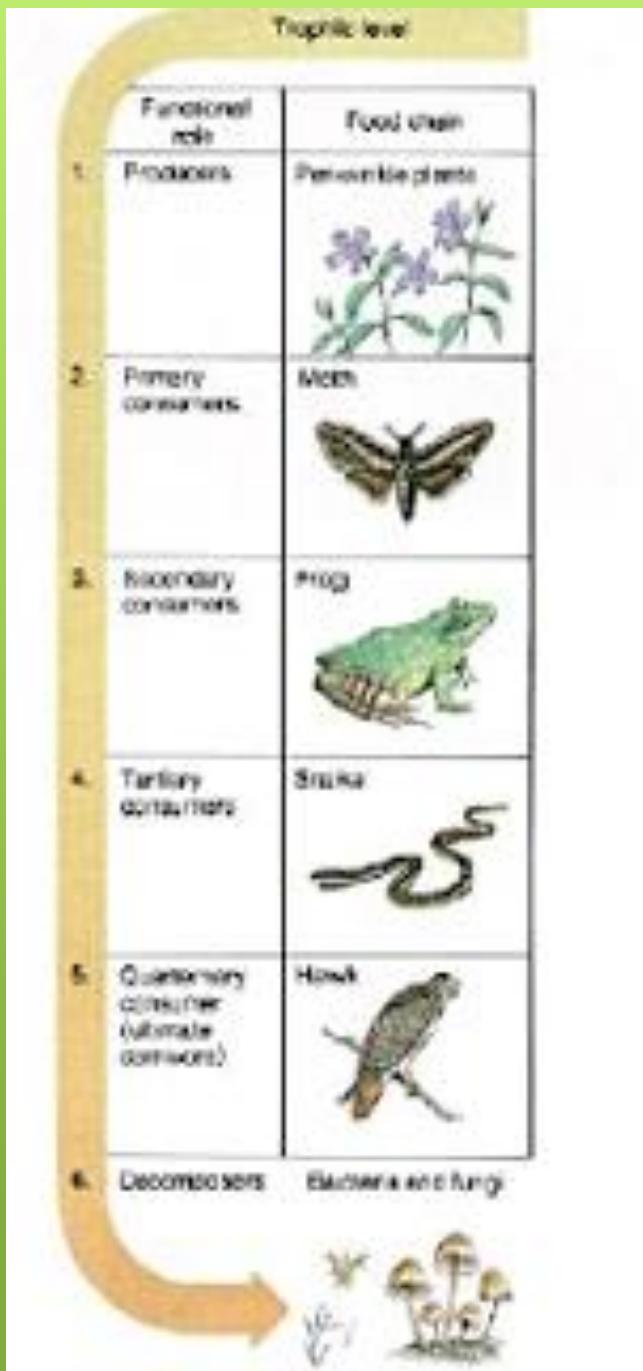
# Role in Food Chain



# Food Web

- interconnected food chains in ecosystem.





## Autotrophs

## Heterotrophs

