**Subject code – 18MBO42C**

**Title of the paper -**
**Plant Ecology, Conservation and Phytogeography**

# UNIT -3

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## Unit – III

**Ecosystem:** Concept and types; Trophic structure, Ecological pyramids, Food chain and Food web; Energy flow, Ecological energetics, Production ecology and Biogeochemical cycles. Human impact on ecosystem: Pollution, types (air, water, soil, noise and radioactive pollution); Bioremediation; E- Waste: Concept and management.

# Concept of Ecosystem

There are many supporting systems like Forests, oceans, grasslands, deserts which have structural components and functions.

They all have living organisms interacting with their surroundings exchanging matter and energy.

The word Ecology was coined by Earnest Haeckel in 1869 from Greek Words:

Oikos (Home) + Logos(study)

So ecology is study of organisms in their natural home interacting with the biotic and abiotic components (Surroundings)

# What is Ecosystem

- An Ecosystem is a self regulating group of biotic communities of species interacting with one another with their non-living environment exchanging energy and matter.

- Therefore Ecology can be termed as---
  "Study Of Ecosystems"

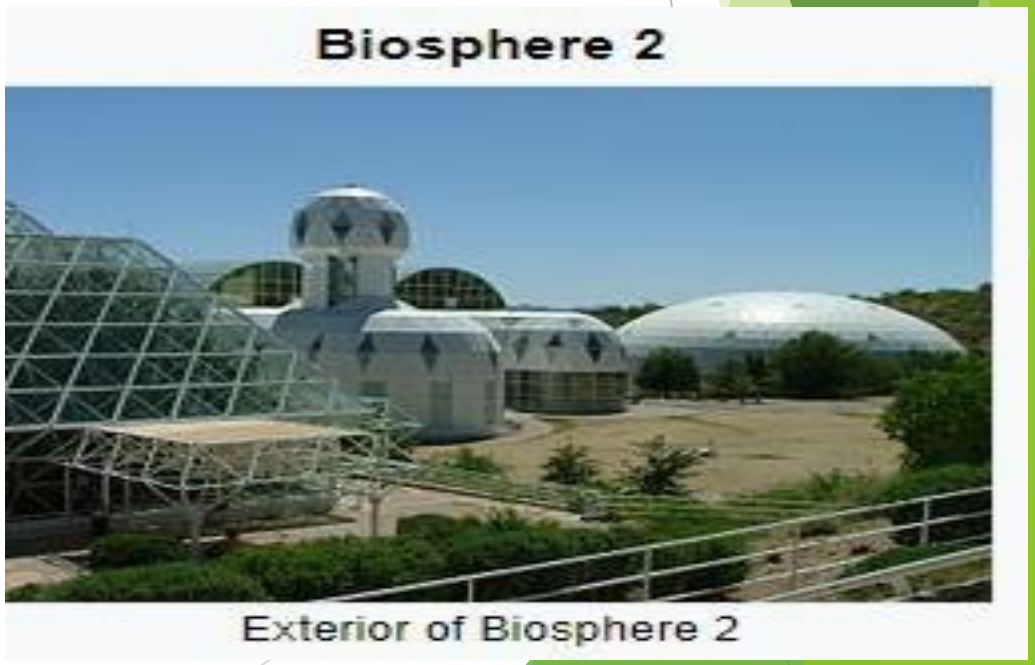
Ecosystem is a unit or a system which is composed of no. of sub-units

They may exchange energy & matter from outside – is an Open Ecosystem; or isolated from outside in a closed one.

The Closed once are generally artificial. Eg. Biosphere 2, in Oracle, Arizona

Life on earth is sustained by the flow

**Biosphere 2** is an American Earth system science research facility located in Oracle, Arizona. It was originally constructed between 1987 and 1991, and has been owned by the University of Arizona since 2011. Its mission is to serve as a center for research, outreach, teaching, and lifelong learning about Earth, its living systems, and its place in the universe. It is a 3.14-acre (1.27-hectare) structure originally built to be an artificial, materially closed ecological system, or vivarium. It remains the largest closed system ever created.



Exterior of Biosphere 2

# Characteristics of an Ecosystem

- Structure of ecosystem
  - Biotic Structure
  - Abiotic Structure
- Functions of Ecosystem
  - Trophic Structure
  - Food Chains
    - Food Web
  - Ecological Pyramids
  - Energy Flow
  - Ecological energetics, Production ecology

# Biotic Components

Producers- they produce their own food either by process of Photosynthesis or by Chemical Process

Plants produce food by Photosynthesis(using sun, $CO_2$ and water) in presence of Chlorophyll.

Thus they are also called as **Autotrophs**

There are some micro-organisms which produce organic matter to some extent by oxidation of certain chemicals in absence of sunlight. They are called as chemosynthetic or **Chemotrophs**

Consumers :All organisms which get their food by feeding on other organisms are called as Consumers

Herbivores- Feed on producers (plant eaters)also called as Primary Consumers

Carnivores- Feed on other consumers

- If they feed on Herbivores- Secondary Consumers – eg frog
- If they feed on Carnivores – tertiary Carnivores/ Consumers- eg. Snake, Big Fish

Omnivores- They feed on plants and animals- Man, many birds, fox

Detrivores- They feed on parts of dead organisms, wastes of living organisms. Also known as Saprotrophs or Detritus feeders

# Biotic Components

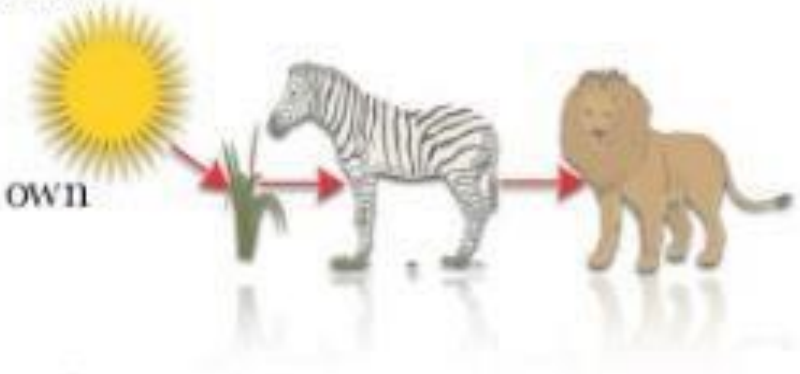
## Decomposers

They derive energy by breaking down complex organic matter to simpler once.

E.g. Bacteria & Fungi

**Trophic level:The position that an organism occupies in a food chain, or a group of organisms in a community that occupy the same position in food chains.**

It is possible to classify the way organisms obtain energy into two categories.



**Producers** or **Autotrophs**: These manufacture their own food from simple inorganic substances (plants)

**Consumers** or **Heterotrophs**: Feed on autotrophs or other heterotrophs to obtain energy (herbivores, carnivores, omnivores, detrivores and decomposers

But within the consumers their is a feeding hierarchy of feeding

**Plants capture the suns energy and convert it to glucose, herbivores eat plants and carnivores eat herbivores - different feeding levels (Greek for food is trophe)**

- **Trophic level 1** - producer
- **Trophic level 2** - herbivore (primary consumers)
- **Trophic level 3** - carnivore (secondary consumers)
- **Trophic level 4** - carnivore (tertiary consumer)

The first trophic level, the autotrophs supports the energy requirements of all the other trophic levels above.

**Ecosystems have an hierarchy of feeding relationships .**

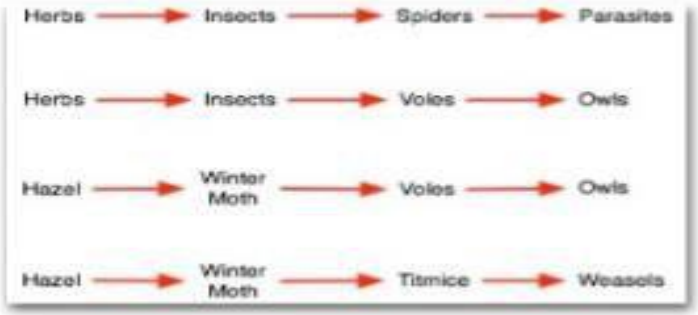
**The energy flow in the ecosystem can be illustrated as a Food chain.**

**The arrows show the direction that energy flows**


**Food chains are an oversimplification**

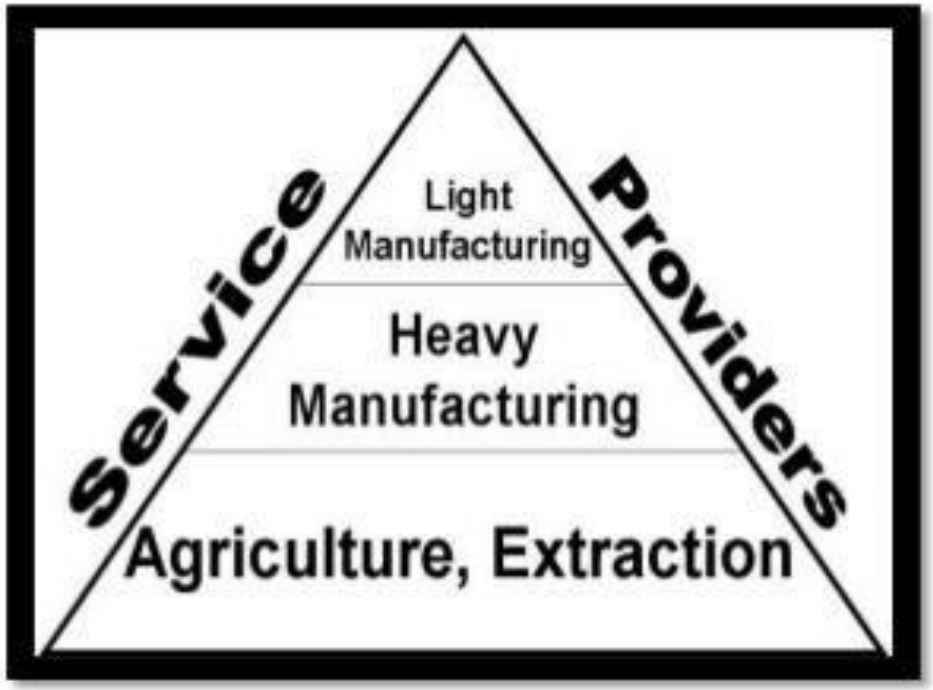
**They only show direct feeding relationships within one hierarchy**

**Some organisms can be at different trophic levels in different food chains**



- **Trophic structure,**

The amount of **energy** at each **trophic level** decreases as it moves through an ecosystem. As little as 10 percent of the **energy** at any **trophic level** is **transferred**to the next **level**; the rest is lost largely through metabolic processes as heat.



# Tropic levels in a food chain

- Producers
- Consumers
  - (i) Primary consumers
  - (ii) Secondary consumers
  - (iii) Tertiary consumers
  - (iv) Quaternary consumers
- Decomposers


Grazing Food Chain
Owl
(consumer)
Flower
(producer)
Caterpillar
(consumer)
Frog
(consumer)
Snake
(consumer)


DECOMPOSERS
They consume(eat) dead plants & animals and decomposes them - reduces them to simpler forms of matter
PRIMARY DECOMPOSERS
Fungi & Bacteria


# What is the flow of energy?

- The amount of **energy** at each **trophic level** decreases as it moves through an ecosystem. As little as 10 percent of the **energy** at any **trophic level** is **transferred**to the next **level**; the rest is lost largely through metabolic processes as heat.

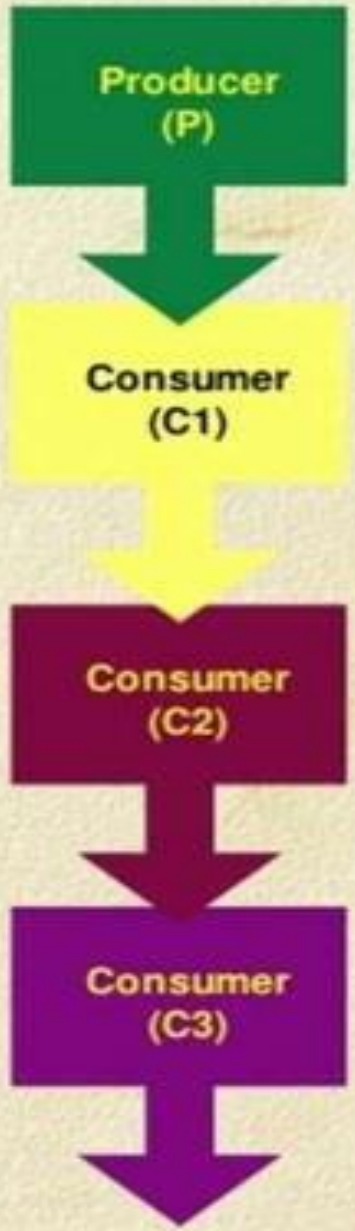
# Trophic Structure 1

- Every ecosystem has a trophic structure: a hierarchy of feeding relationships which determines the pathways for **energy flow** and **nutrient cycling**.
- Species are assigned to **trophic levels** on the basis of their nutrition.
- **Producers** (**P**) occupy the first trophic level and directly or indirectly support all other levels. Producers derive their energy from the sun in most cases.
  - Hydrothermal vent communities are an exception; the producers are chemosynthetic bacteria that derive energy by oxidizing hydrogen sulfide.

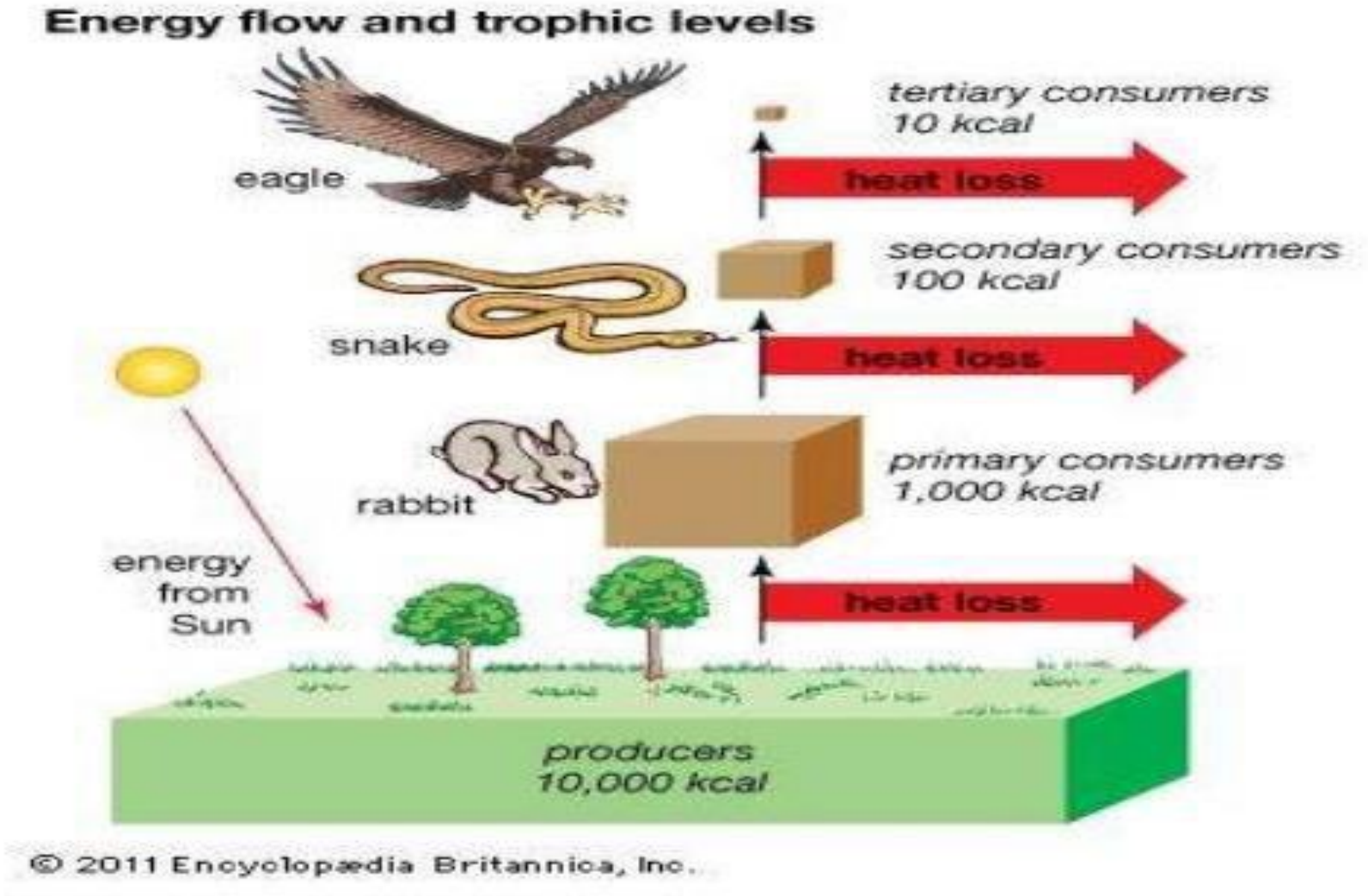

**Hydrothermal vents** act as natural plumbing systems that transport heat and chemicals from the interior of the Earth and that help regulate global ocean chemistry. In the process, **they** accumulate vast amounts of potentially valuable minerals on the seafloor.

# Trophic Structure 2

- All organisms other than producers are **consumers** (**C**).
- Consumers are ranked according to the trophic level they occupy. First order (or primary) consumers (**herbivores**), rely **directly** on producers for their energy.
  - A special class of consumers, the detritivores, derive their energy from the detritus representing all trophic levels.
- Photosynthetic productivity (the amount of food generated per unit time through photosynthesis) sets the limit for the energy budget of an ecosystem.

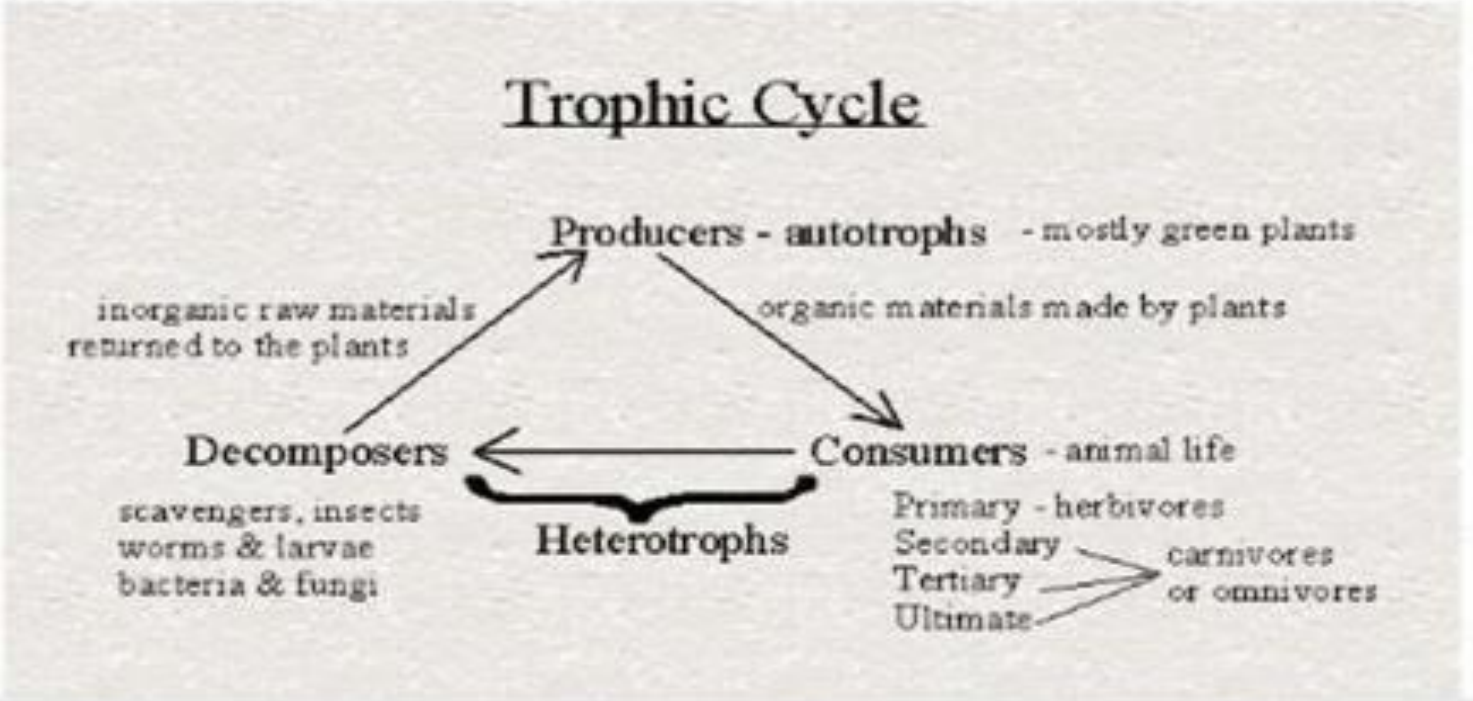


# Energy flow and tropical levels



# Trophic Structure

- All organisms in an ecosystem can be placed in trophic levels depending on what energy source they rely upon and how they provide energy for other organisms in the food web. With the exception of life near hydrothermal vents in the deep ocean, life is always dependent directly or indirectly on the energy from the sun. In every ecosystem, there is an organism at the lowest level that converts energy from the sun into useable energy for other organisms.

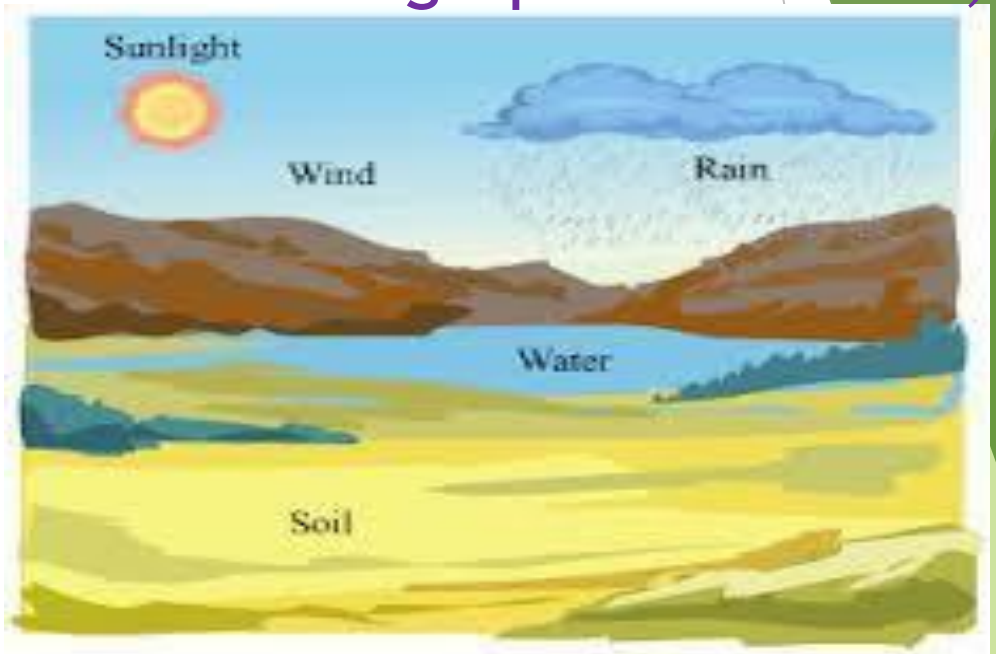


# Abiotic Components

They include various physical, chemical & Geographical factors;

Physical Factors:

- The sunlight & shade
- Intensity of Solar flux
- Average Temperature
- Annual Rainfall
- Wind
- Soil type, availability of water,




We can clearly see the difference in solar flux, temp., rainfall pattern in desert , tropical & Tundra Ecosystem. While in grassland and forest they also vary as per geographical location

# Abiotic Components

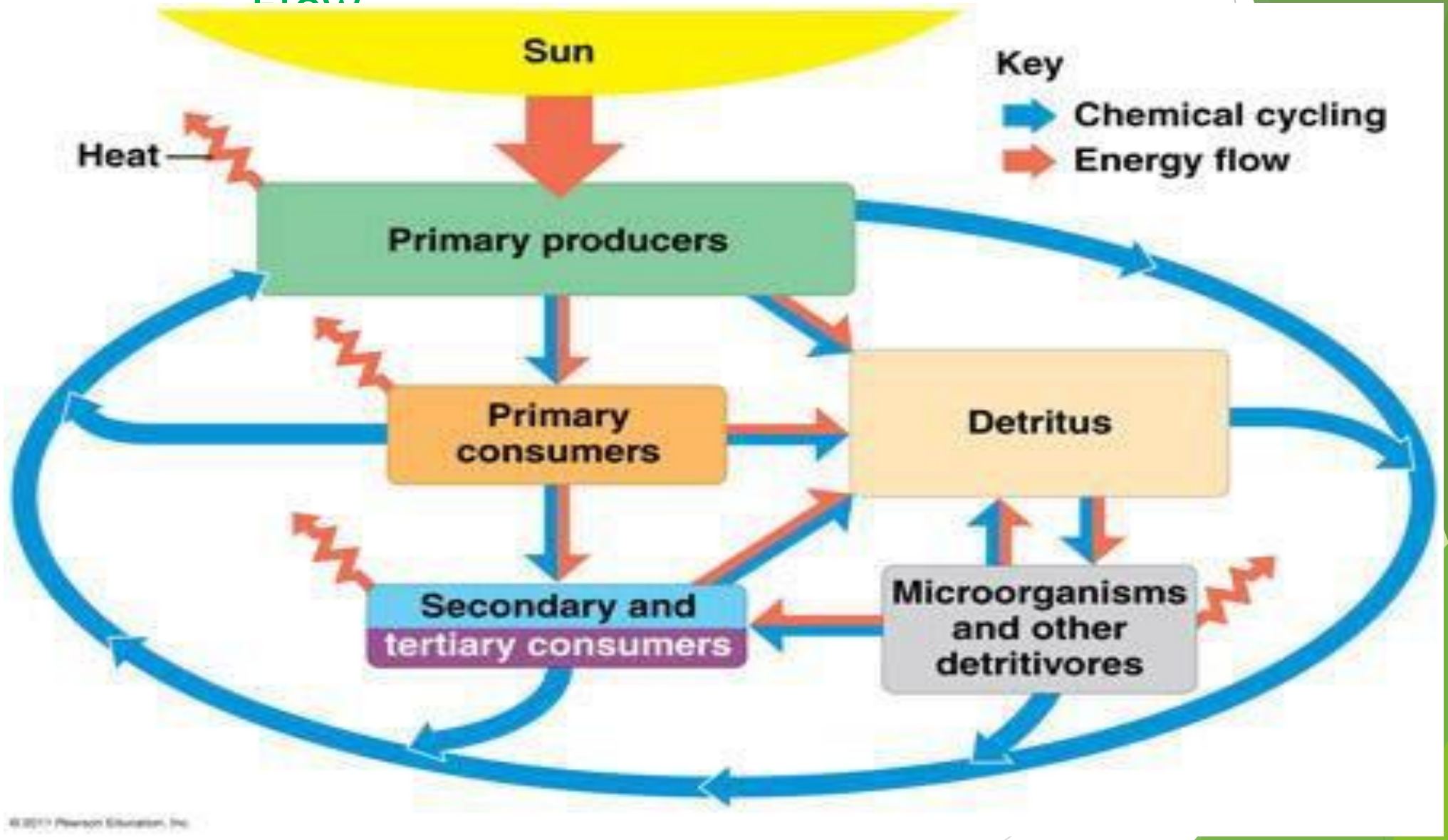
## Chemical Factors

They include availability of nutrients like Nitrogen, Phosphorus, Carbon, Hydrogen, potassium, Oxygen, sulphur, levels of toxic substances, salts causing salinity influence the function of ecosystem.

## Geographical Factors

Latitude, Longitude and altitude

# Nutrient Cycling & Energy Flow



# Functions of Ecosystems: Trophic structure

In ecosystems energy and matter exchange occurs in a definite pattern.

Nutrients and energy move along food chain

Producers, consumers are arranged in a specific manner and their interaction along with population size is called as Trophic structure and the level as Trophic Level.

And the amount of living matter at each level is called Standing Crop or Standing Biomass

# Trophic structure

## Food chain

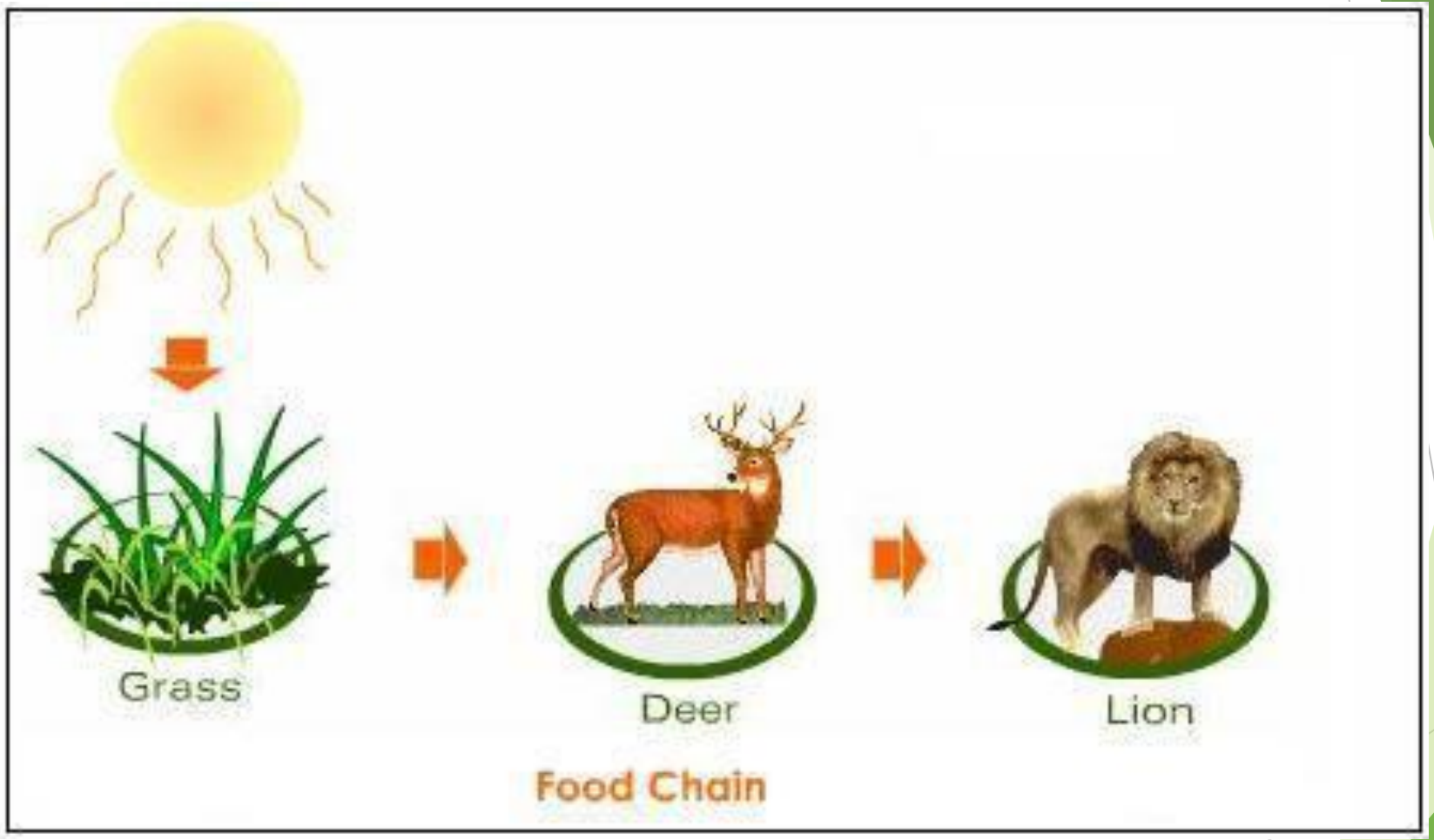
The sequence of eating and being eaten is known as food chain.

Someone is the food of other.

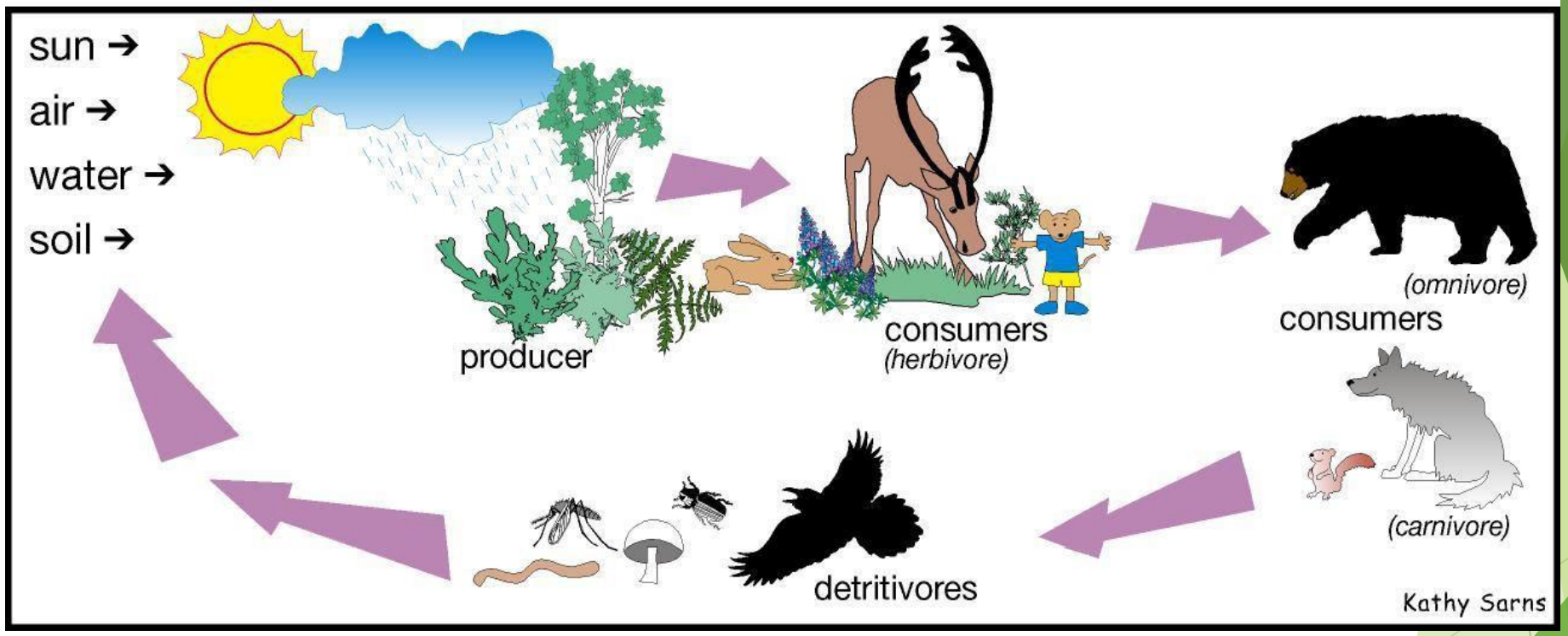
Two major food chains

- Grazing- Starts from producers that is green plants – terrestrial, marine, pond ecosystem
- Detritus- Starts with dead organic matter- Mangrove Ecosystem

# Simple Grazing Food Chain

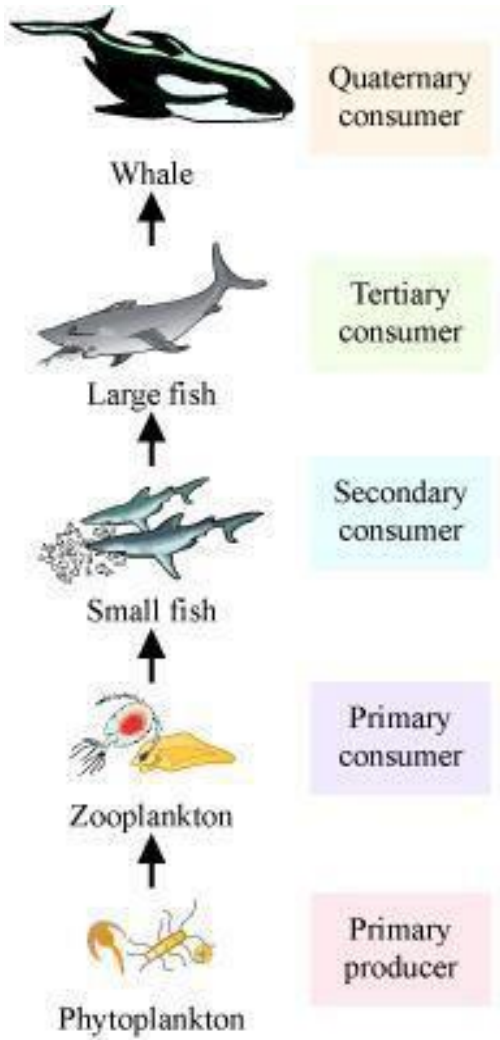


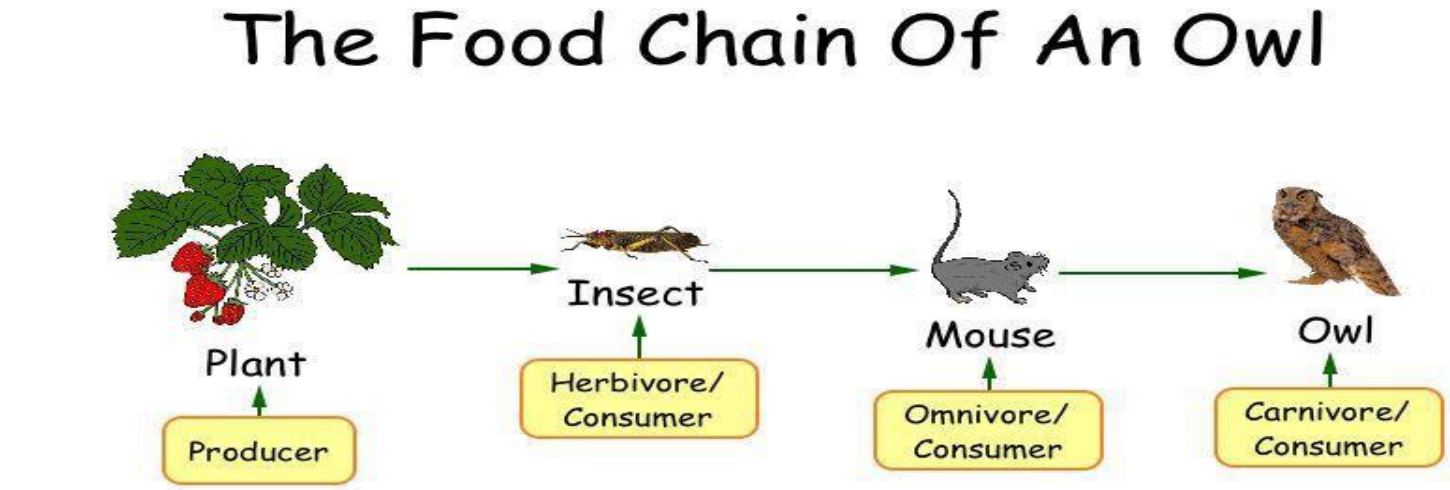
# Grazing food chain




Terrestrial Food Chain

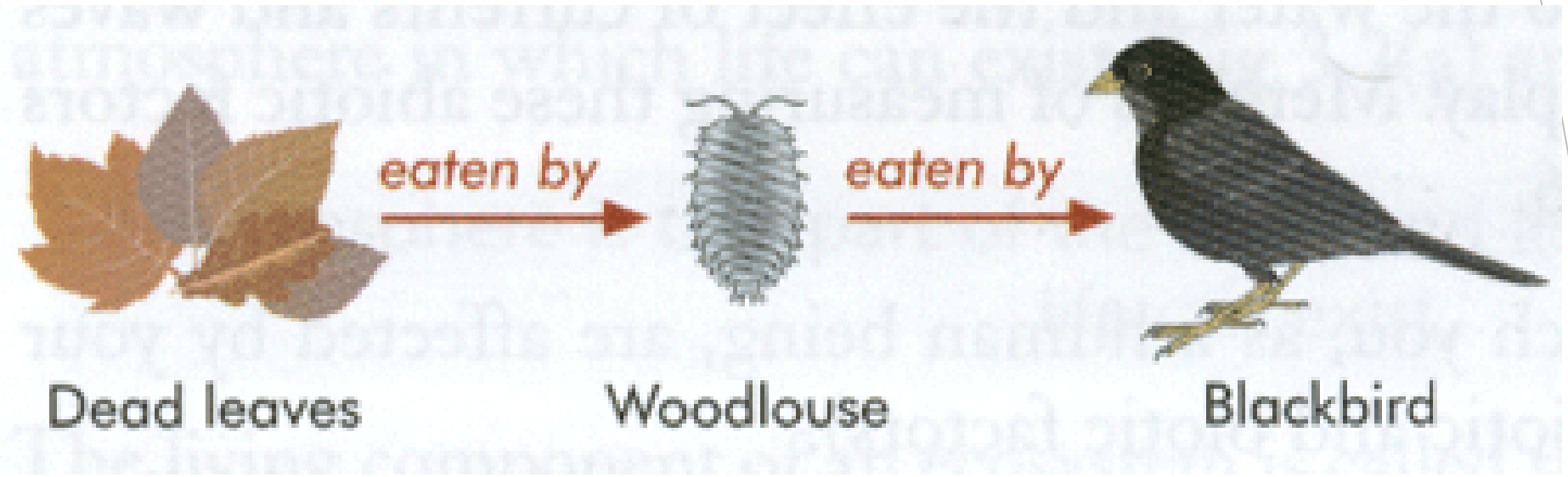
# Marine Food Chain

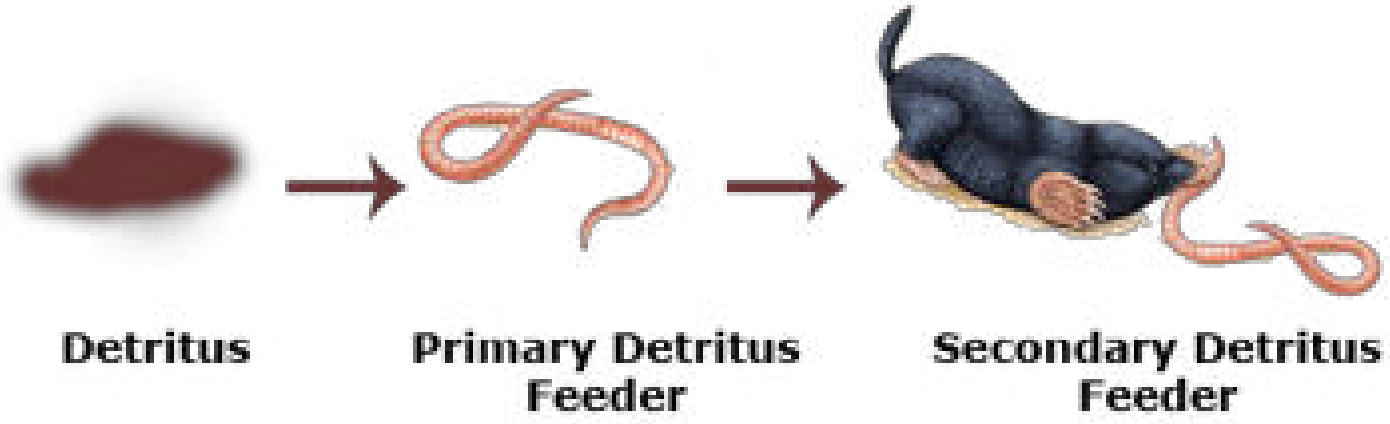


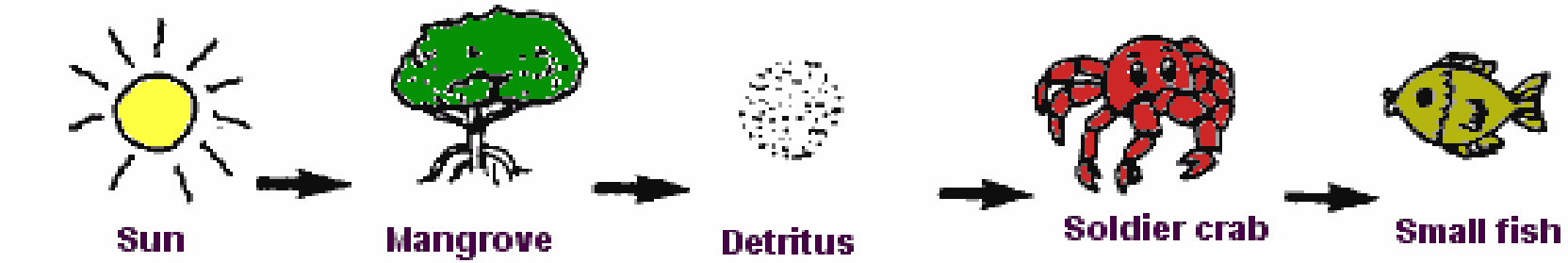

A food chain shows the path of energy from one living thing to another.
Decomposers like bacteria, are necessary for all food chains.

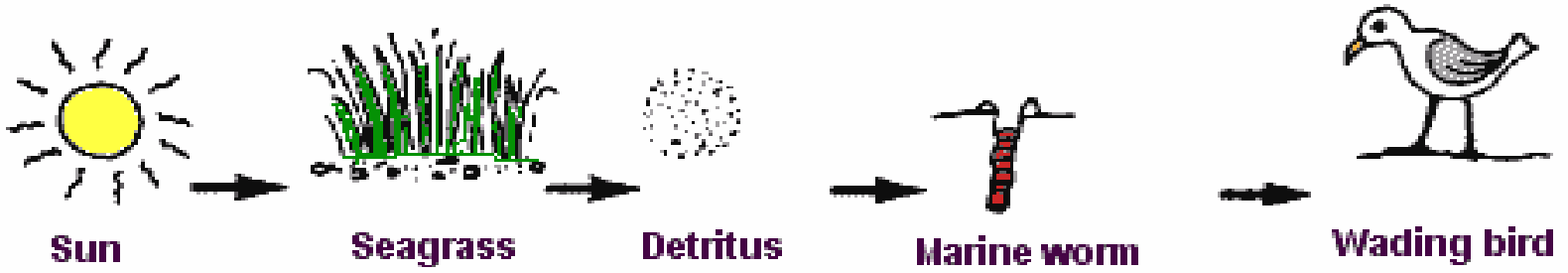
# Detritus food chain

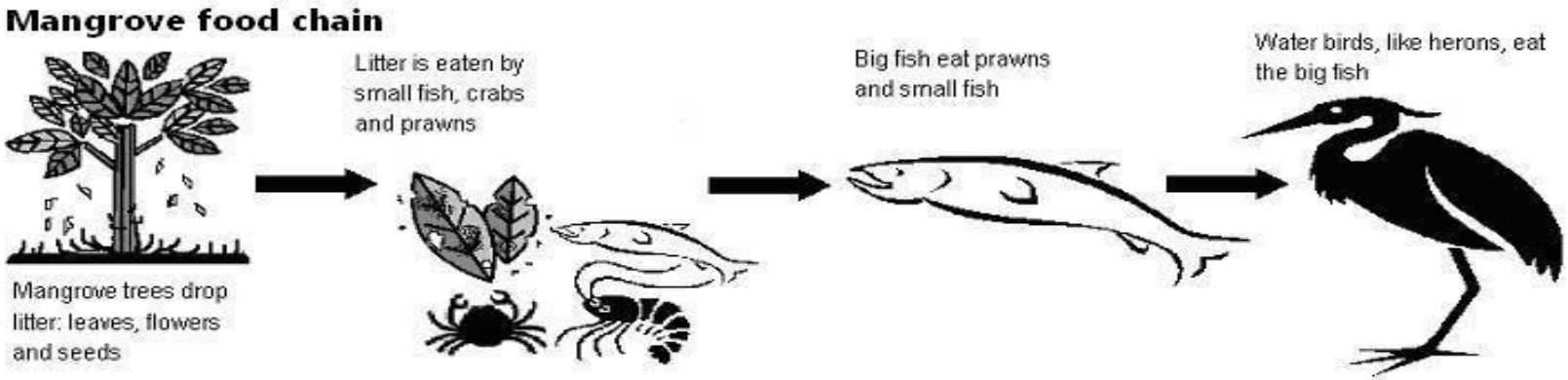


# Mangrove


Sun
Mangrove
Detritus
Soldier crab
Small fish


Sun
Seagrass
Detritus
Marine worm
Wading bird

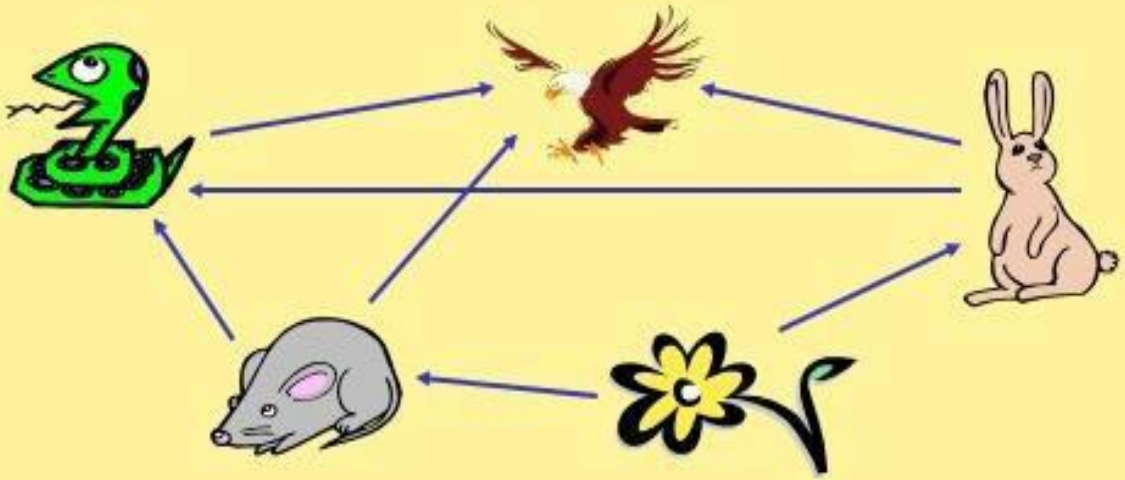

Mangrove food chain
Litter is eaten by small fish, crabs and prawns
Big fish eat prawns and small fish
Water birds, like herons, eat the big fish
Mangrove trees drop litter: leaves, flowers and seeds

FOOD WEBS

# What is food web?

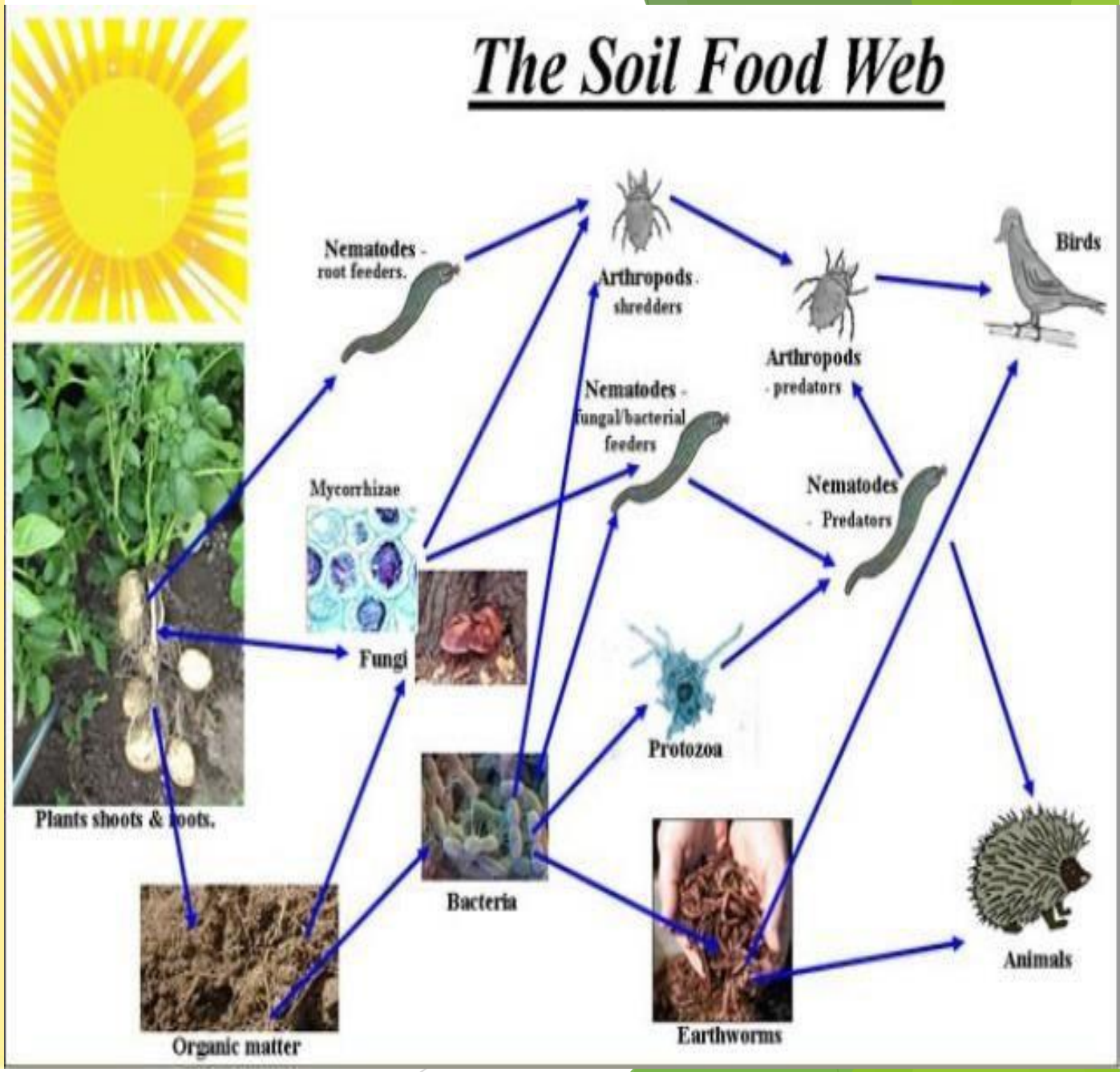
Food web can be defined as, "a network of food chains which are interconnected at various tropic levels, so as to form a number of feeding connections amongst different organisms of a biotic community".

It is also known as consumer-resource system.



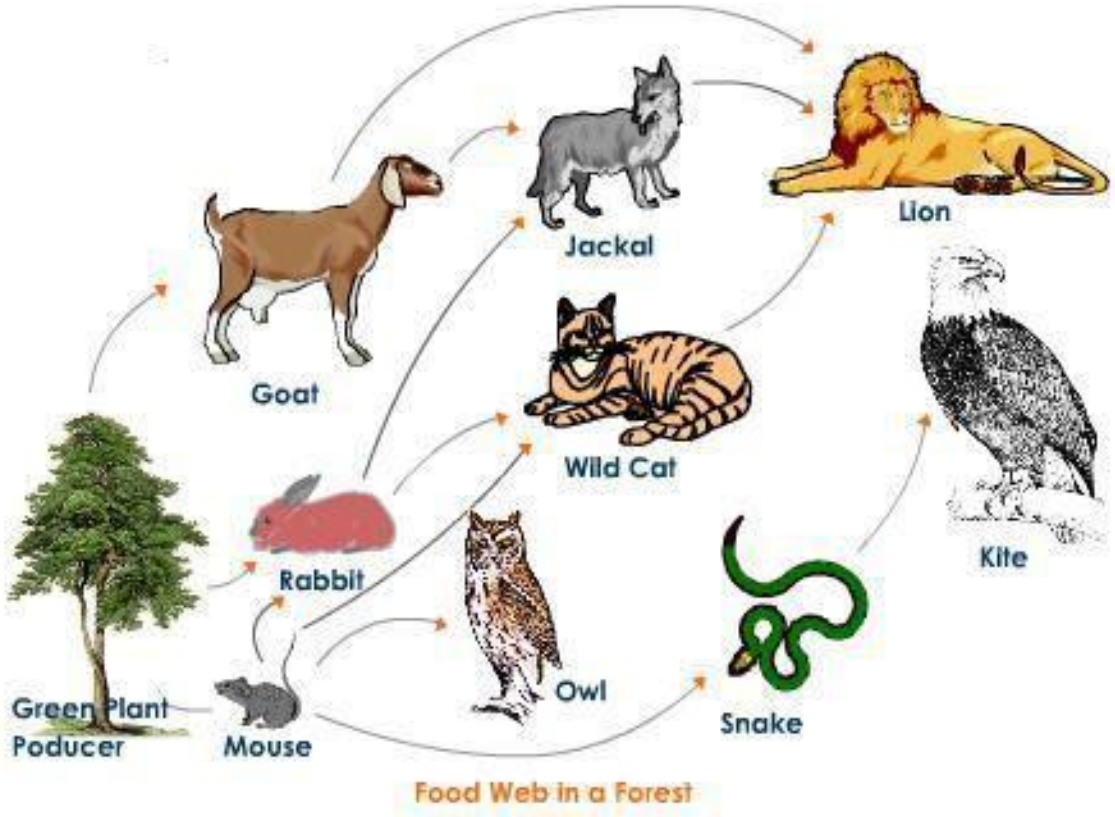
# Different food webs

- Soil food web
- Aquatic food web
- Food web in forest
- Food web of grassland
- Food web in terrestrial and aquatic ecosystem

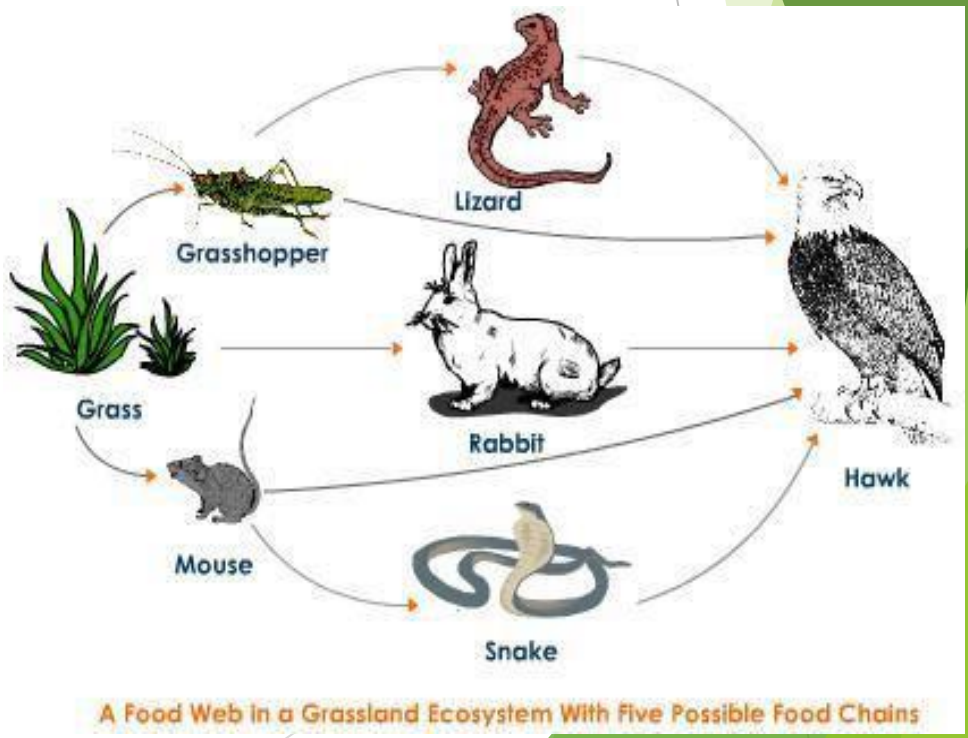


# Food web

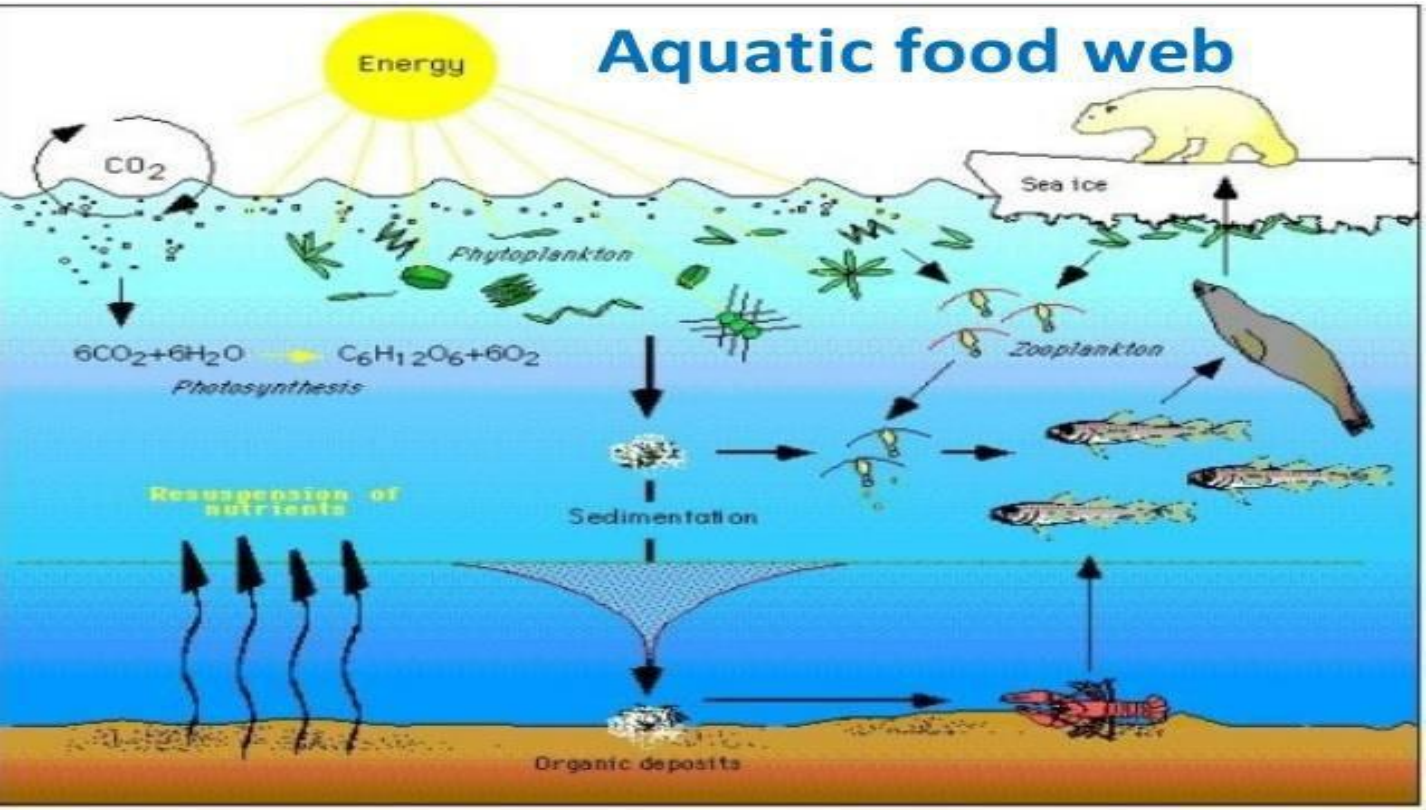
No food chain is isolated.
Organisms act at various levels in different food chains.
Feed on more than one type of organism.
Form a **Complex Food Web**.
Thus, “Food Web - is a network of food chains where different types of organisms are connected at different trophic levels”
so that there are a no. of options of eating and being eaten at each trophic level



Food Web in a Forest



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




Energy and nutrient flow

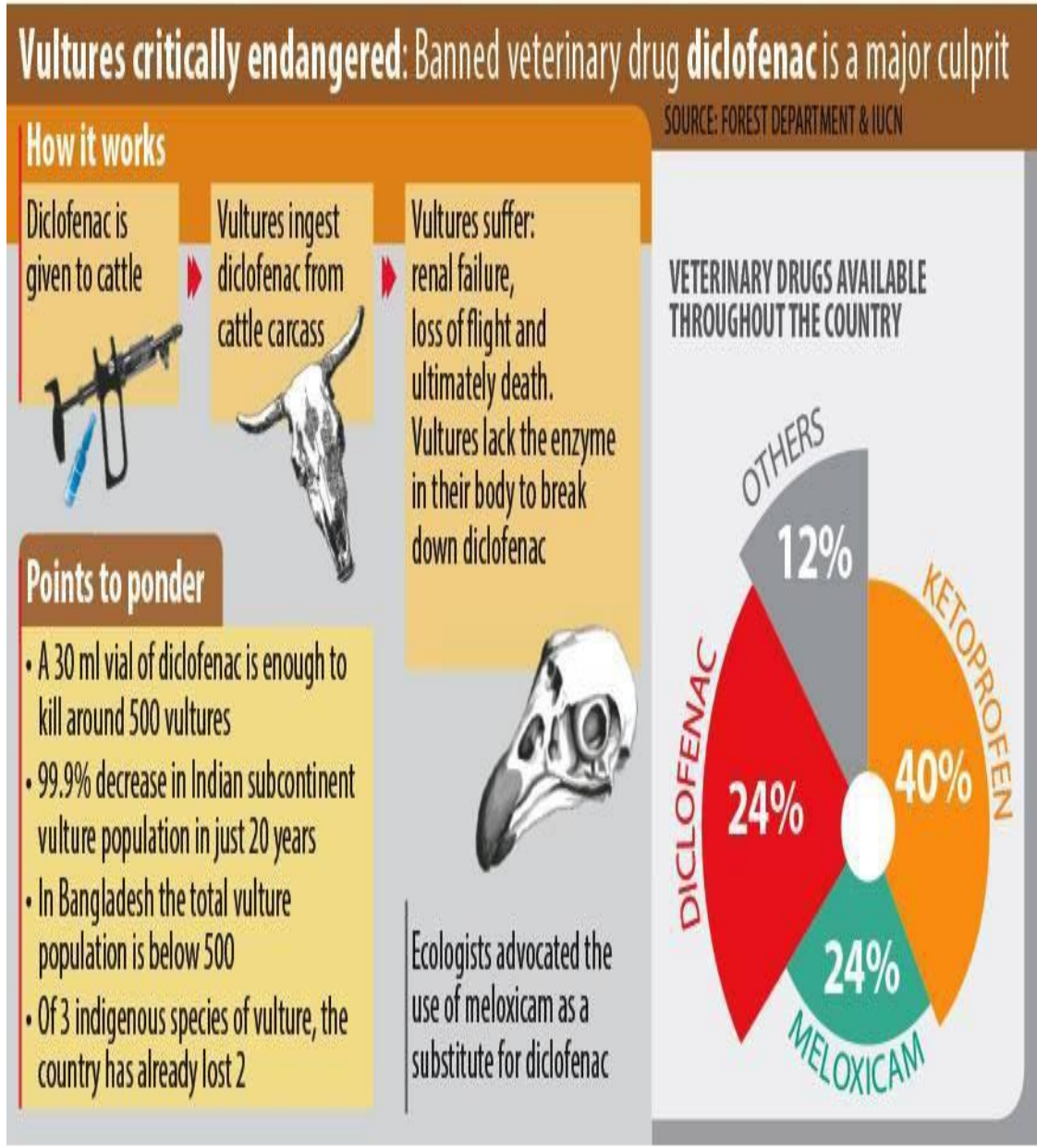
Significance: Food chain and Food Web

Maintain population of different species and thus maintain **Ecological Balance**

Bio magnification: a rather harmful phenomenon.

Eg: build up of DDT in higher animals.

(Case Study- Pesticides - Diclofenac in Vultures.)



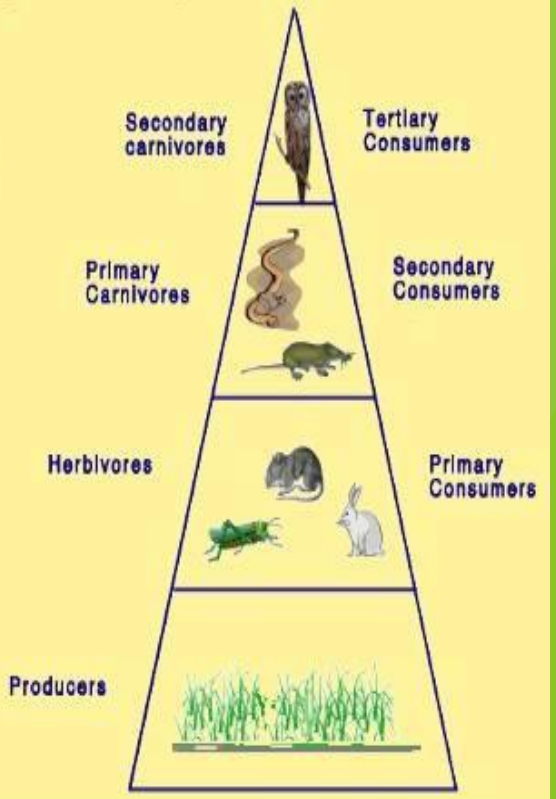

## Types of Ecological Pyramid

Three types of ecological pyramids can usually be distinguished namely:

- Pyramid of numbers
- Pyramid of biomass
- Pyramid of productivity

## What are Ecological Pyramids?

- Ecological pyramids are graphical representations of the tropic structure ecosystem.
- Tropic levels are the feeding positions in a food chain such as primary producers, herbivores, primary carnivore etc.

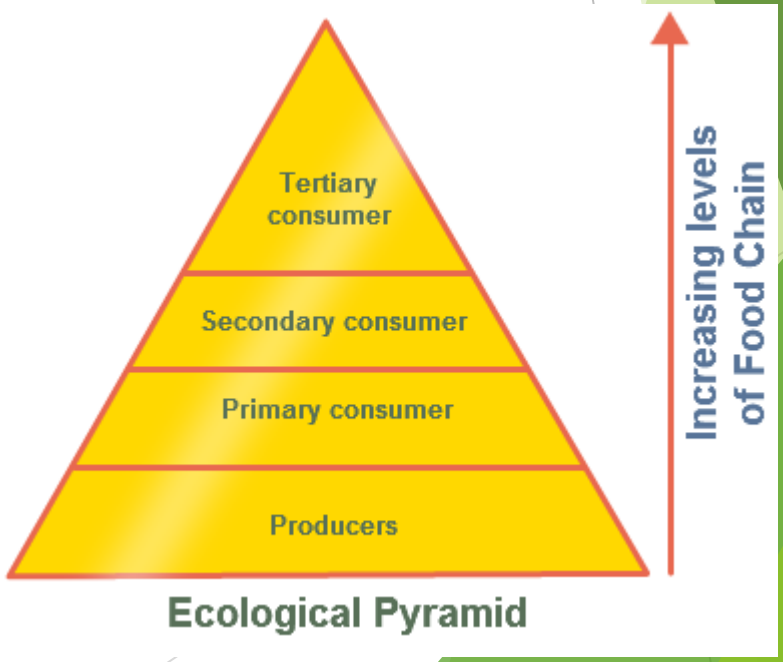


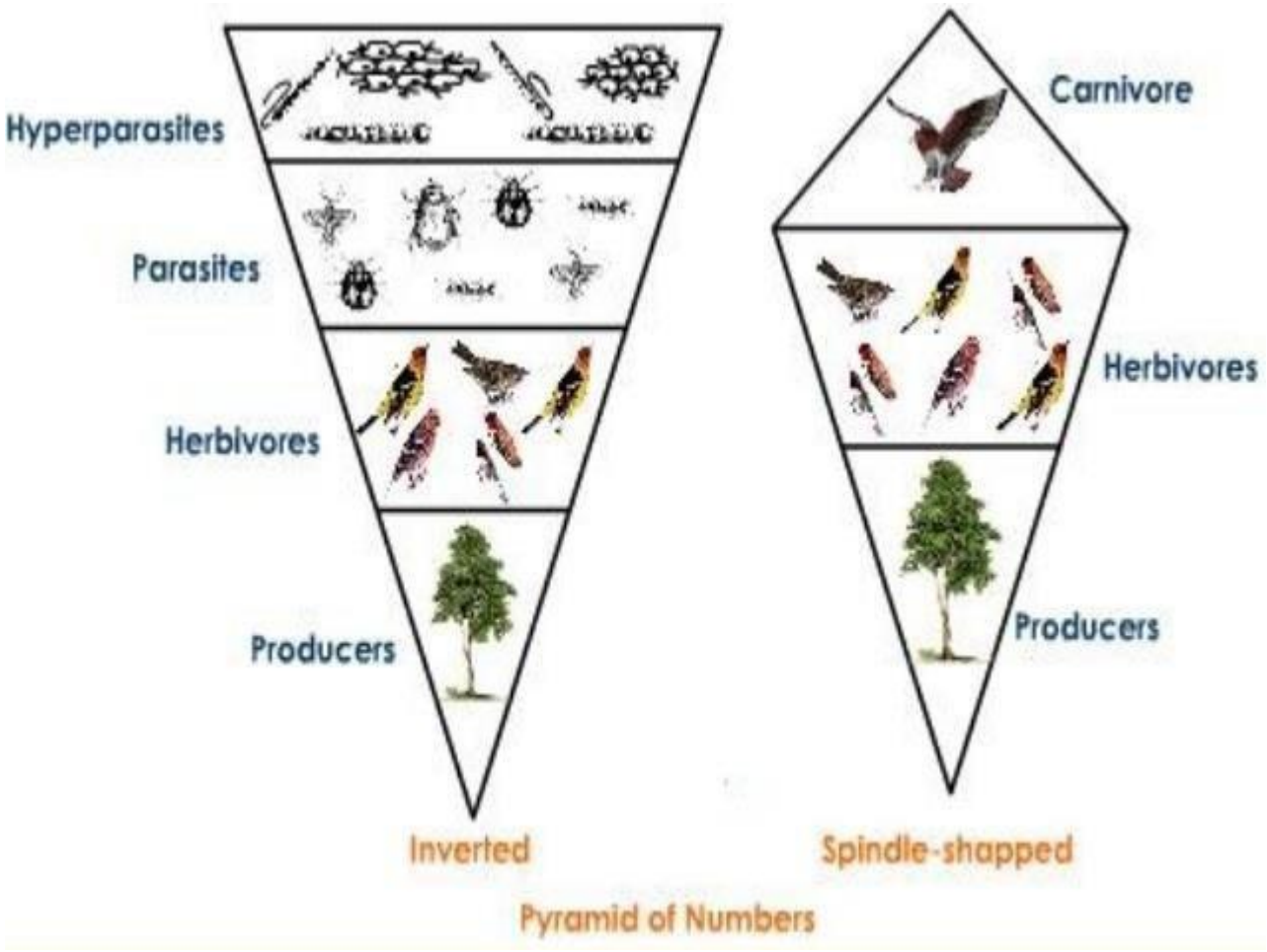
# Pyramid of Number

## Pyramid of Numbers

- It is the graphic representation of number of individuals per unit area of various tropic levels.
- Large number of producers tend to form the base.
- Lower numbers of top carnivores occupy the tip

Represents Number of individual organism at each level.
May be Upright or Inverted.
Of Forest, grassland and parasitic food chain




# Evaluating pyramid of numbers

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Simple method of giving an overview | Number of specific species may be too great to measure accurately |
| Good for comparing changes to the ecosystem at different times | Does not take into account "juveniles" or immature forms |
| | All organisms are included regardless of size |

# Pyramid of Biomass

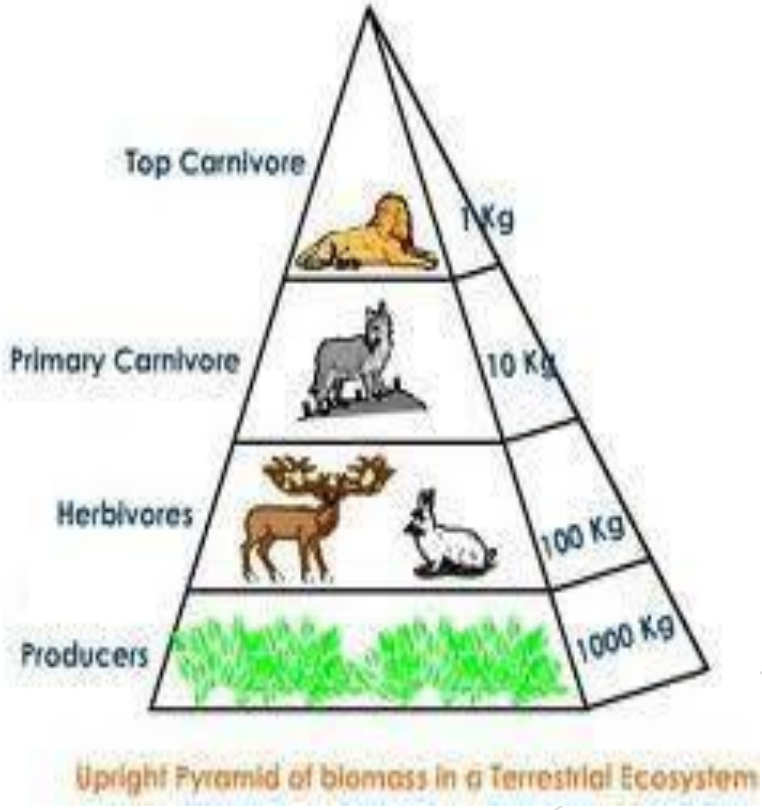
## Pyramid of biomass

- It is the graphical representation of biomass present per unit area at different tropic levels, with producers at the base and carnivores at the top.
- Biomass is calculated as mass of each individual X no. of individual at tropic levels

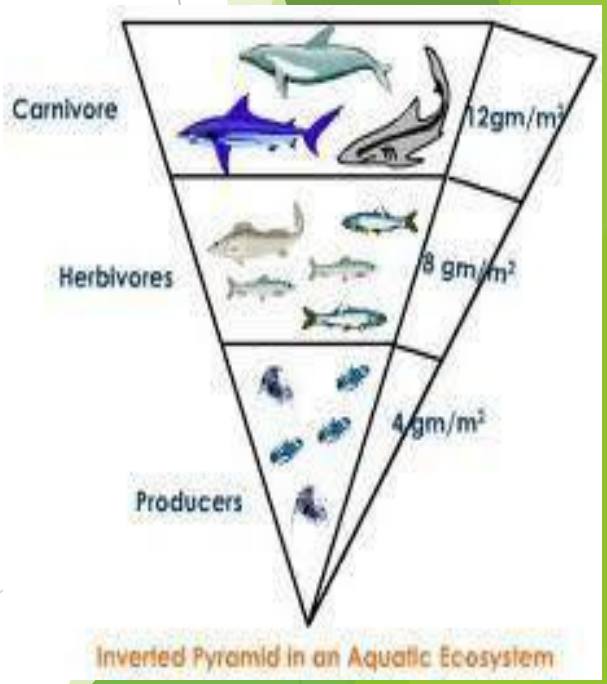
Based on total biomass i.e dry matter at every level in a food chain
Upright or Inverted

## Evaluating pyramid of biomass

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Overcomes the problems of pyramids of number | Only uses samples for population so difficult to measure biomass exactly |
| | Time of year influences result |
| | Organisms of same size do not necessarily have the same energy content |



Upright Pyramid of biomass in a Terrestrial Ecosystem

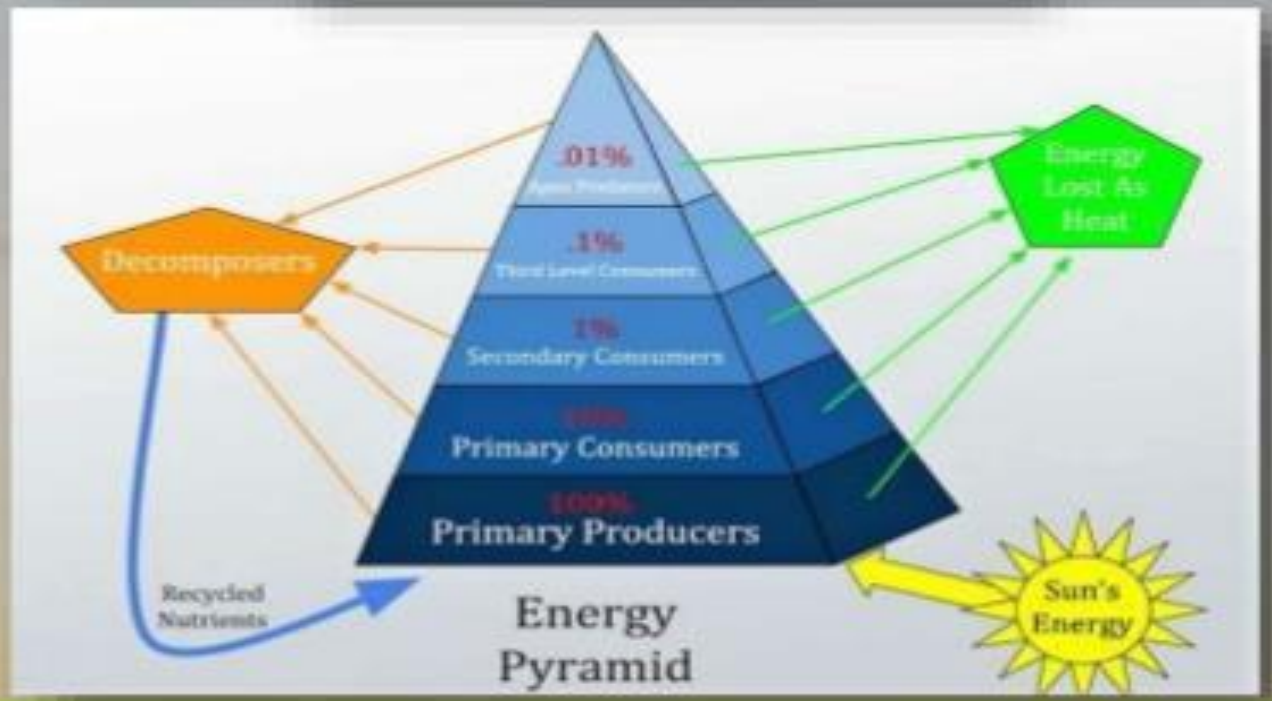


Inverted Pyramid in an Aquatic Ecosystem

# Pyramid of Energy

- Energy pyramid - Energy loss and transfer between trophic levels; the size of each layer represents the amount of energy available at that trophic level.

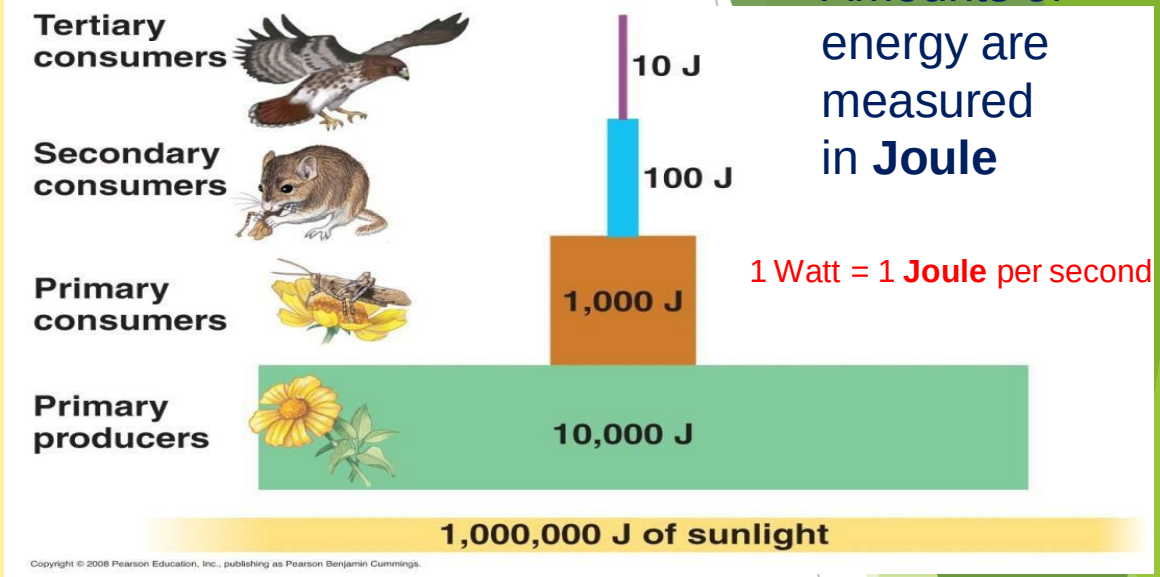
- **Only about 10% of the energy taken in by the individuals at one trophic level is passed on to individuals at the next level.**

# Pyramid of Energy

## Pyramid of productivity

- Pyramid of productivity is a graphical representation of the flow of energy through each tropic level of a food chain over a fixed time period.
- The input of solar energy may be indicated by adding an extra to the base.




Amounts of energy are measured in **Joule**

1 Watt = 1 **Joule** per second

Amount of energy at each trophic level.
Always Upright
Energy goes on reducing at each level.
Loss in the form of heat, respiration.
Shows sharp decline from producers to t carnivores.

## Evaluating pyramid of productivity

| ADVANTAGES | DISADVANTAGES |
|---|---|
| No inverted pyramids are obtained | It is difficult and cumbersome to collect energy data |
| Shows actual energy transfer | Problem occurs in assigning a species to a specific tropic level |
| Can be compared different ecosystems based on relative energy transfer | |

# Energy Flow

**What is Energy:**

- The ability or capacity to do work
- Radiant, Chemical, thermal, mechanical, nuclear, electrical.

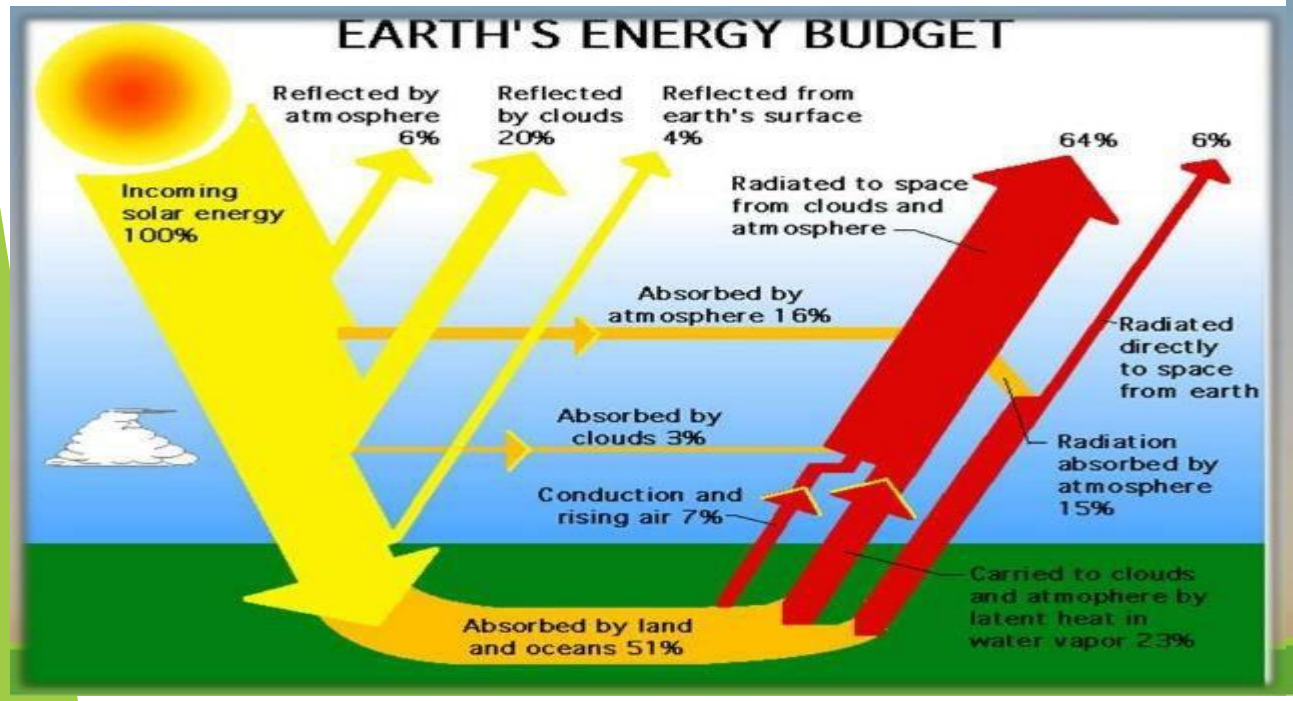
**What is Energy Flow:**

The existence of flora and fauna in ecosystem depends upon the cycle of minerals and flow of energy. Energy is needed for all the biotic activities. The only source of this energy is the sun. The entrance, transformation and diffusion of energy in ecosystem are governed by laws of thermodynamics.

Energy flow in an ecosystem is **Unidirectional**
Source of energy is sun
Plants convert this energy into chemical energy
Energy is lost in body functions like respiration
Available passes to next trophic level
Follows two laws of thermodynamics

- 1st Law: Energy can neither be created nor destroyed, it can be converted from one form to another
- 2nd Law: energy dissipates as it is used.

Energy flow models: explain the flow of energy




## The Laws of Thermodynamics

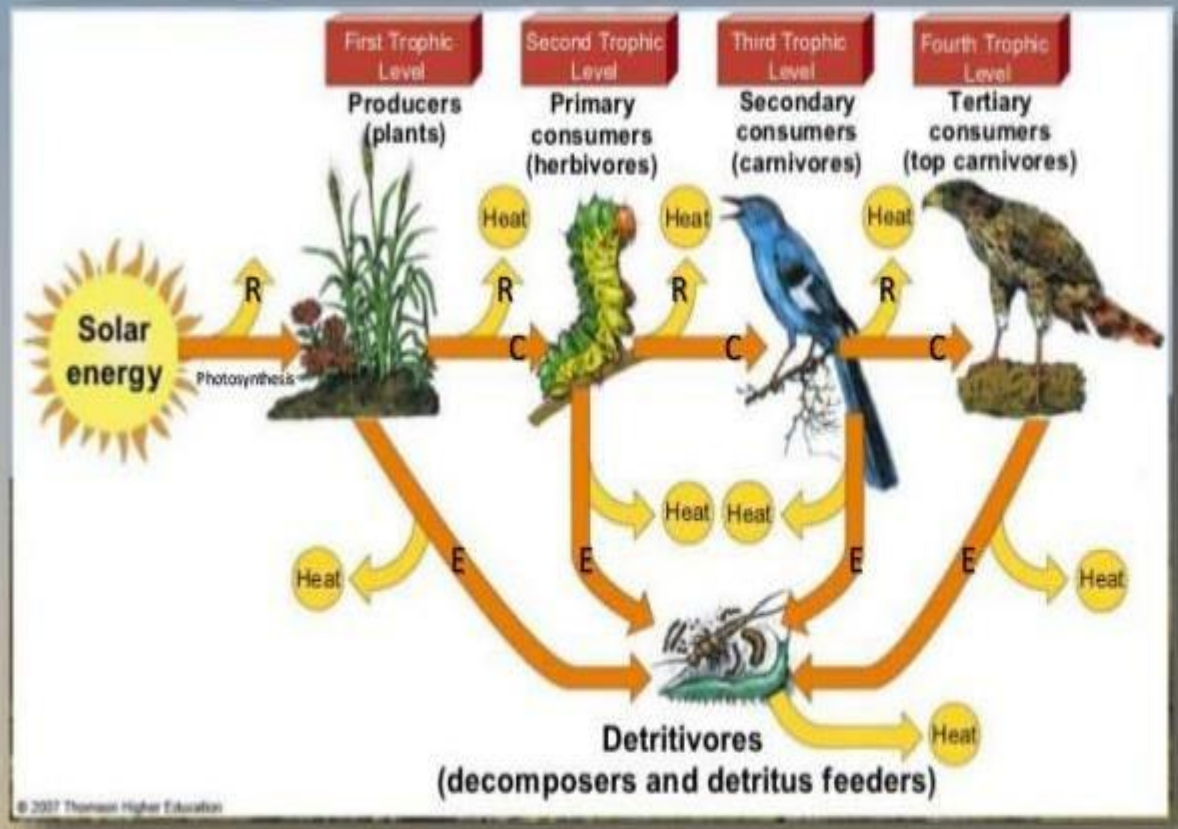
❖ **First Law of Thermodynamic:**

Energy can be transformed from one form into another, it can neither be created nor destroyed.

❖ **Second Law of Thermodynamic:**

During the process of transformation of energy, some of the transformed energy is diffused from the ecosystem in dispersed form.

# Energy Flow Through Ecosystems




R = Energy loss through Respiration

E = Energy loss from Grazing food chain to Detrivores and Decomposers Through Excretion and Egestion

C = Consumption by Organism at the higher Trophic Level

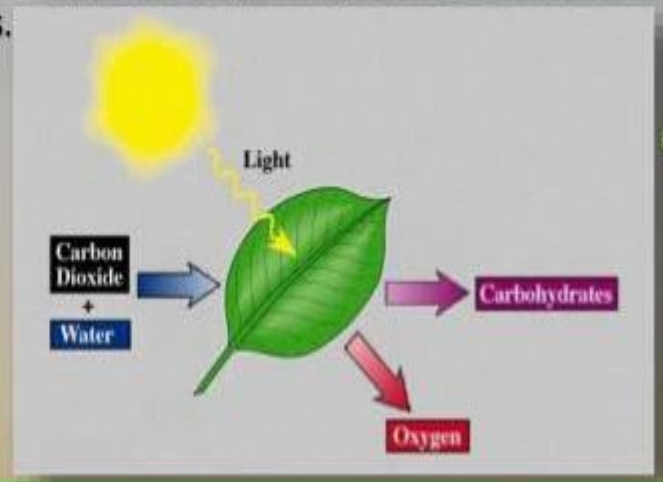
# Photosynthesis

**The process where the Sun's energy is converted into chemical energy (Glucose/Sugar).**

**Occurs in PLANTS!!**

Producer – an organism that makes its own energy-rich food compounds using the Sun's energy.

Energy captured by plants via photosynthesis is transferred to the organisms that eat the plants.




$6\,CO_2 + 12\,H_2O$ + radiant energ

$C_6H_{12}O_6 + 6\,H_2O + 6\,O_2$

$$\text{carbon dioxide} + \text{water} \xrightarrow{\text{light energy}} \text{sugar} + \text{oxygen}$$

# Cellular Respiration

- The process where the chemical energy captured in photosynthesis is released within cells of plants and animals.

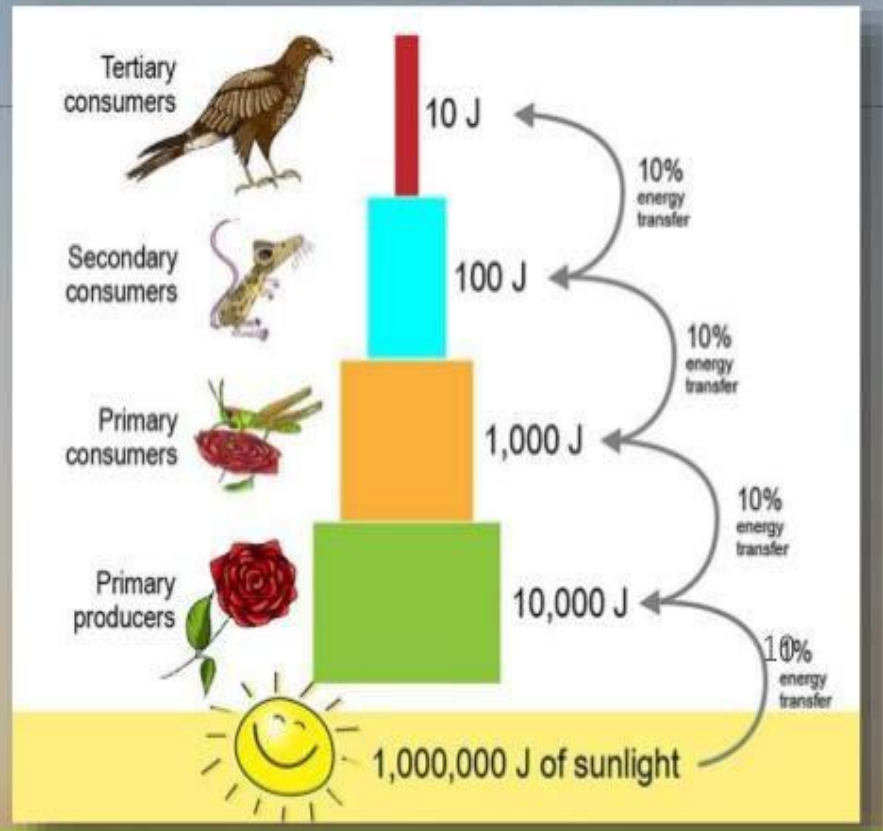
$$C_6H_{12}O_6 + 6\,O_2 + 6\,H_2O$$

$$\downarrow$$

$$6\,CO_2 + 12\,H_2O + \text{energy}$$

- This energy is then used for biological work
  Creating new cells, reproduction, movement, etc.

**"Rule of 10"** Only ~10% passes to next level.
Therefore, ~90% LOSS at each Trophic Level.

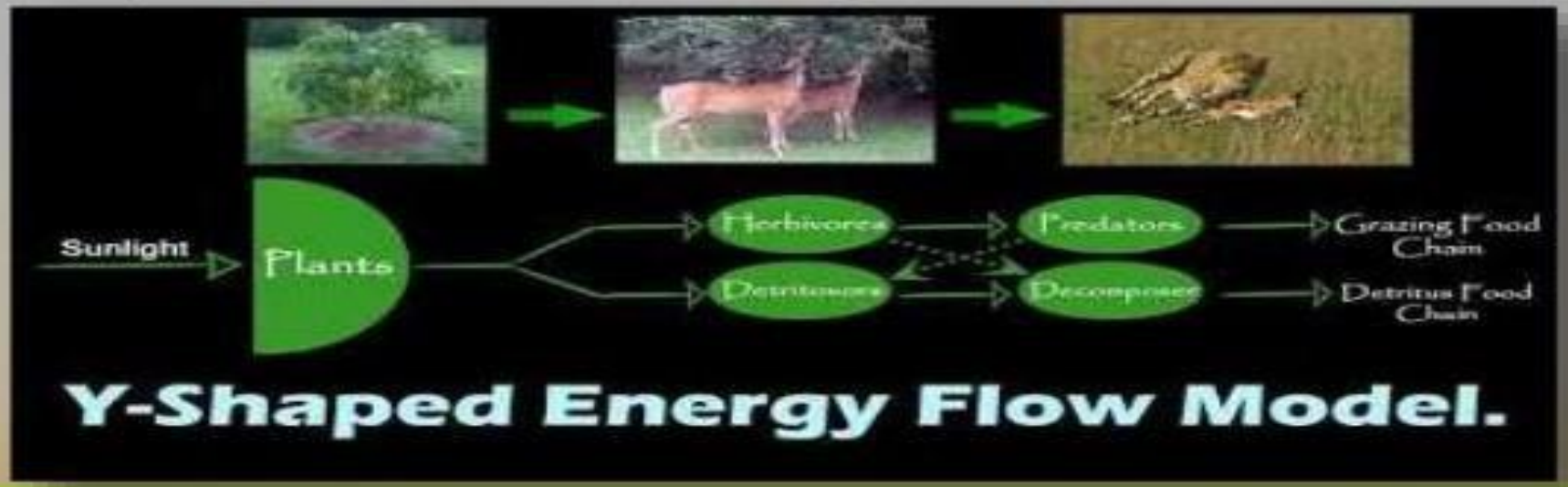


# Y-Shaped Energy Flow Model

According to **E.P. Odum (1983),** naturally, two types of food chain function in ecosystem.

**1. Grazing food chain -** Which begins from green plants and proceeds towards herbivores and then towards carnivores

**2. Detritus food chain -** Which starts from rotten organic substances and proceeds towards carnivores thought detrivores.




**Y-Shaped Energy Flow Model.**

# Ecological Pyramids

Graphic representation of trophic structure and function of ecosystem

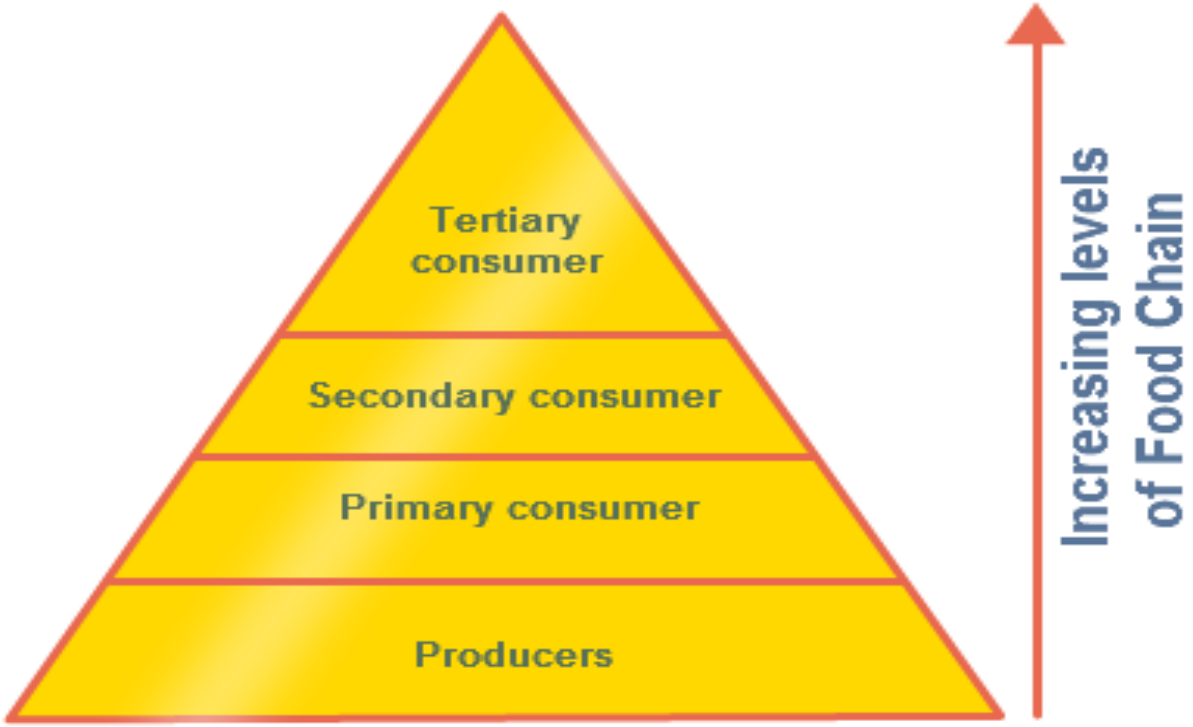
Starts with producers at the base and consumers at successive levels towards apex is called as an "Ecological Pyramid"

They are of 3 Types:

- Pyramids of Numbers
- Pyramids of Biomass
- Pyramid of Energy

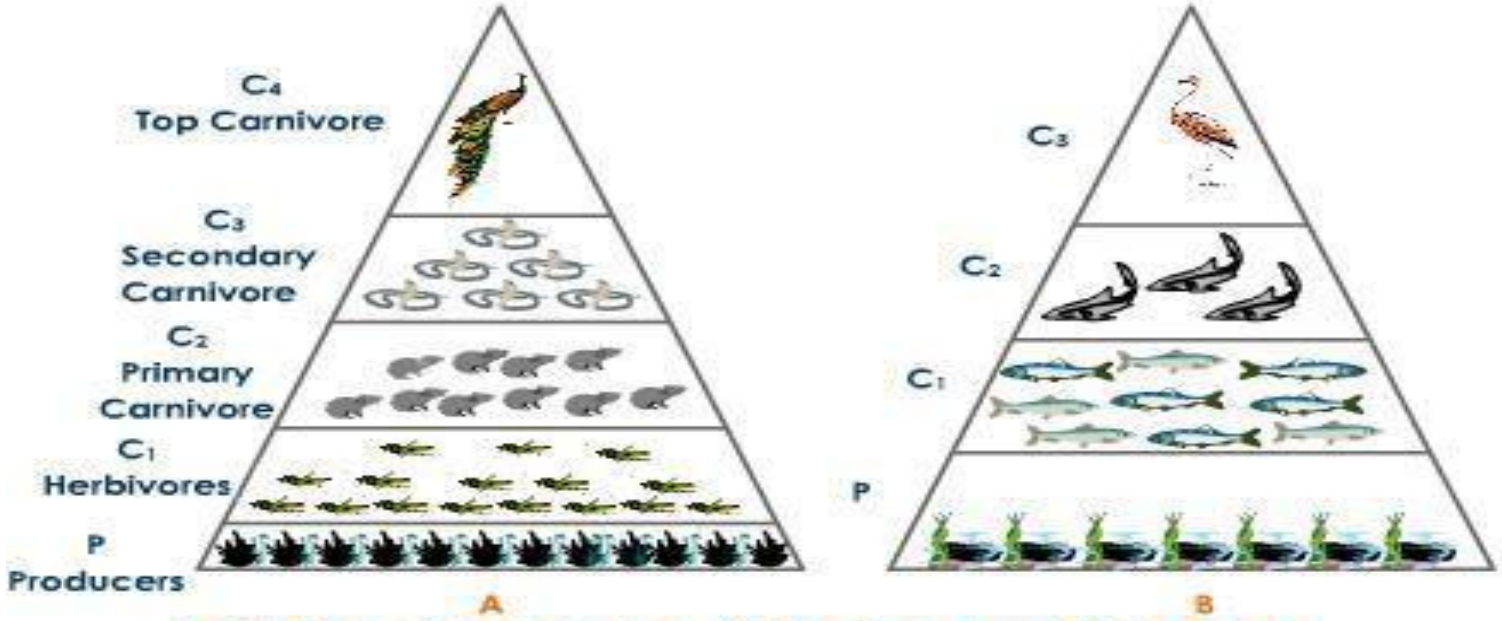
# Pyramid of Number

Represents Number of individual organism at each level.
May be Upright or Inverted.
Of Forest, grassland and parasitic food chain



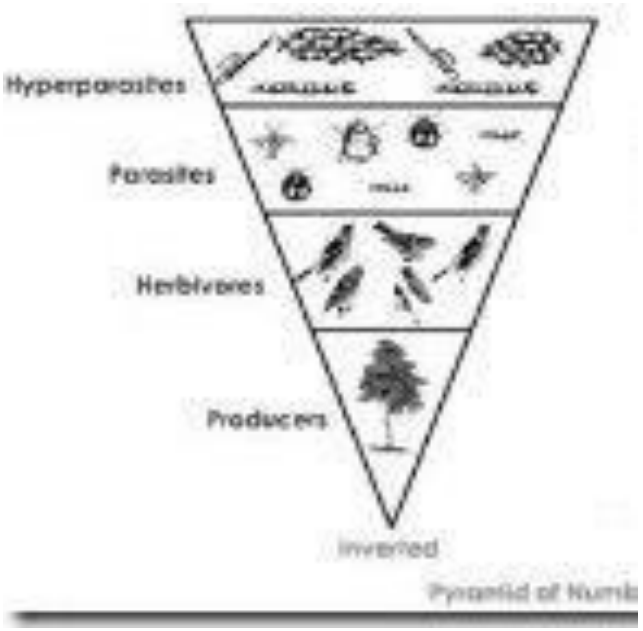

Ecological Pyramid

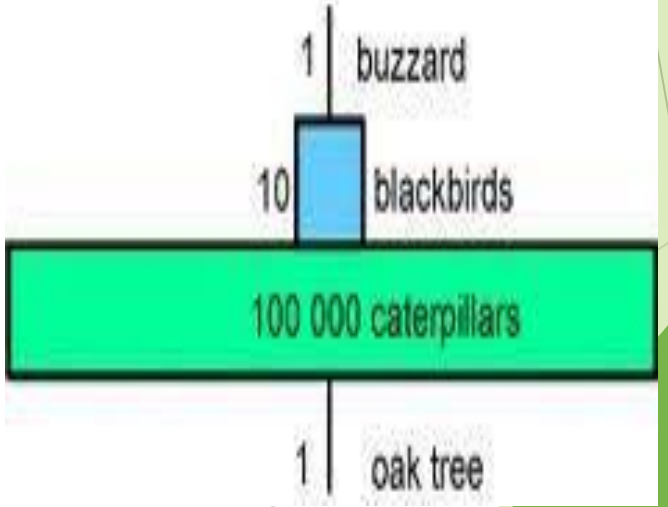
Upright – Grassland & Pond



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

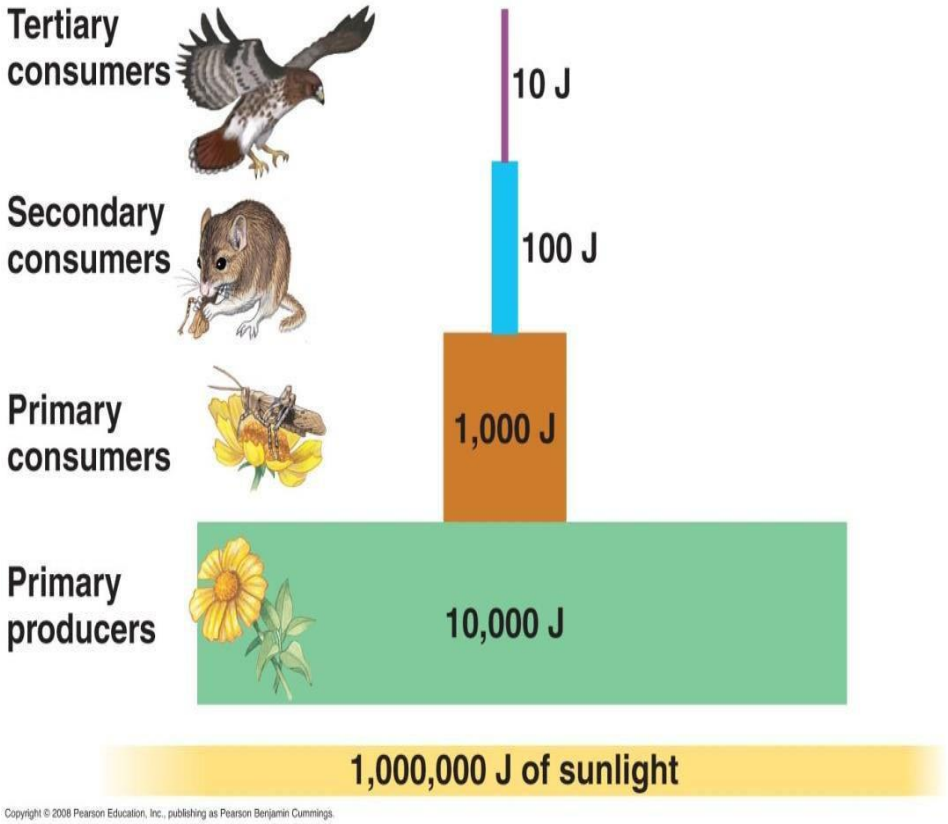
Inverted - Parasitic food Chain




Narrow Pyramid - Forest

# Pyramid of Energy





Amount of energy at each trophic level.

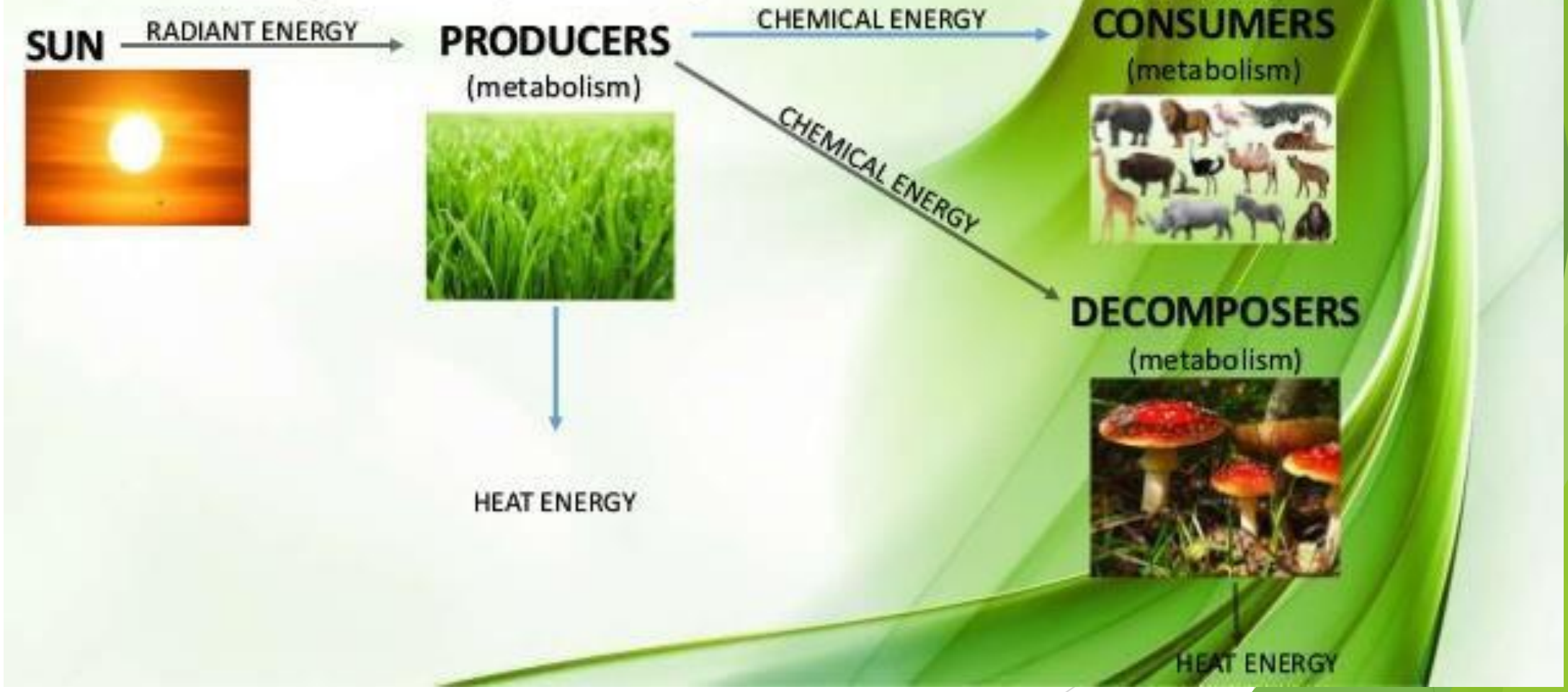
Always Upright

Energy goes on reducing at each level.

Loss in the form of heat, respiration.

Shows sharp decline from producers to top carnivores.

- Plants capture only 2 to 10 % of the PAR and this small amount of energy sustains the entire living world!
- So, it is very important to know how solar energy captured by plant flows through different organisms of an ecosystem.
- This can be shown by the following schematic diagram -

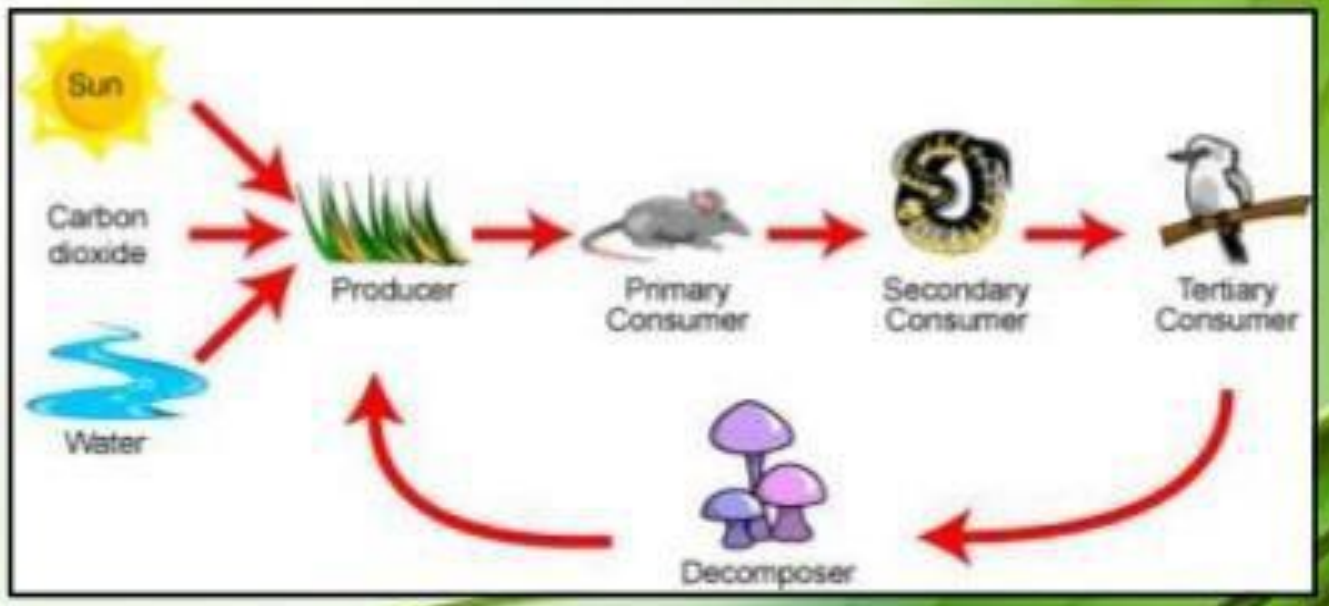


# LAWS GOVERNING ENERGY TRANSFORMATION IN ECOSYSTEM

- Energy transformation in ecosystem can be explained by the laws of thermodynamics.
- Ecosystem follows the first law of thermodynamics, which states that *energy may be transformed from one form to another but it can neither be created nor be destroyed*. This is also true in the case of an ecosystem, when an organism dies its energy is not destroyed but is dissipated in the surrounding through decomposers.
- Further, ecosystem is not exempt from the Second law of thermodynamics which states that *processes involving energy transformation does not occur spontaneously unless there is degradation of energy from a non-random to a random form.* The energy in living organisms is in non-random form i.e. in the form of chemical bonds of biomolecules, but when their decomposition occurs the non-random energy is converted to random form by the decomposers to simpler form.

# INTERCONNECTION AMONG ORGANISMS

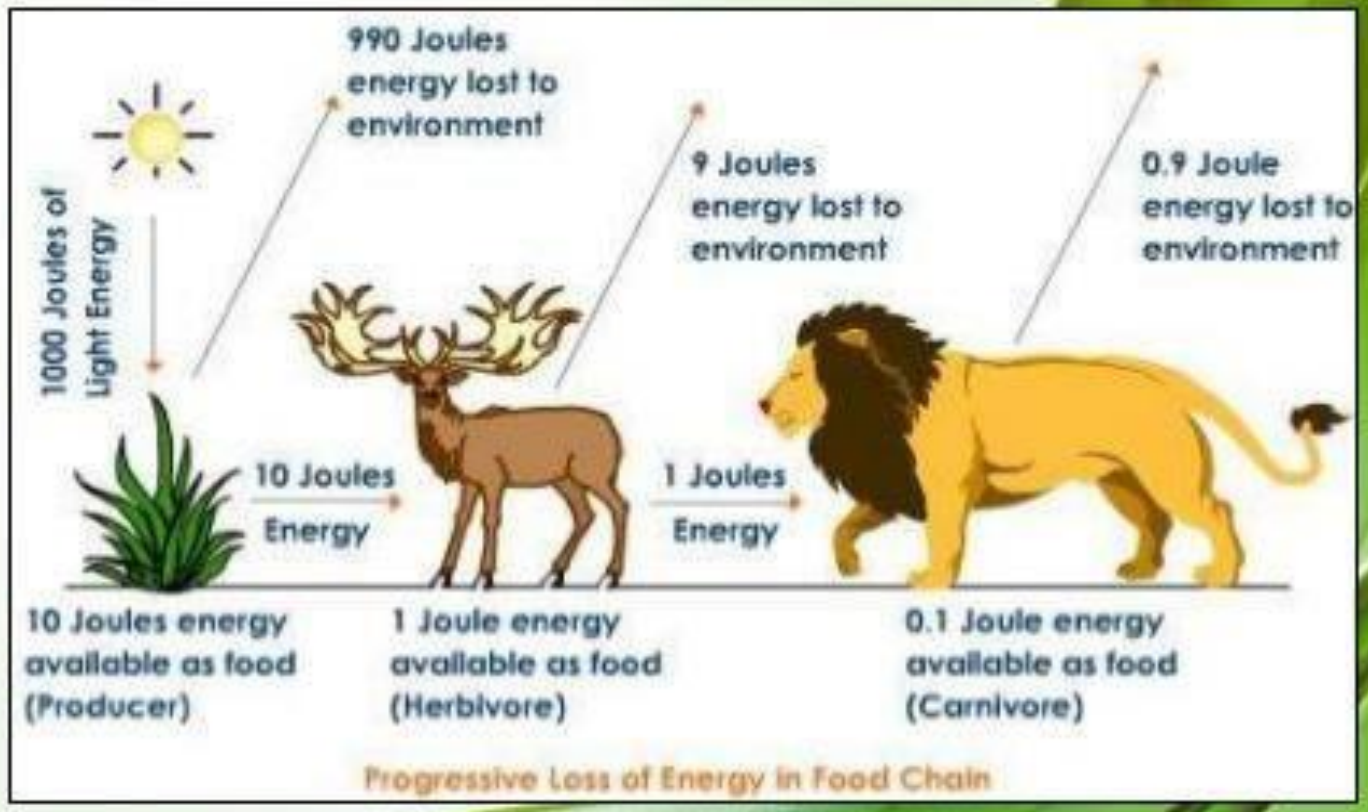
- All the organisms in an ecosystem are connected in a very intricate manner and the energy flow occurs through these interconnections.
- These interconnections can be depicted by food chains to understand the basic connection between organisms (In reality they are lot more complexly interconnected).
- There are many types of food chains operating in nature, major one among them are grazing food chain (GFC) and detritus food chain (DFC). A simple GFC is depicted below :-



# THE TEN PERCENT LAW

- This law was introduced in context to energy flow in ecosystems by Raymond Lindeman.
- According to this law, during the transfer of energy from organic food from one tropic level to the next, only ten percent of the energy from organic matter is stored as flesh.
- The remaining is lost during transfer, broken down in respiration, or lost to incomplete digestion by higher trophic level.

- The ten percent law gives us a basic understanding on the cycling of food chains.
- Furthermore, this law shows the inefficiency of energy capture at each successive tropic level.



# REPRESENTATION OF ENERGY FLOW IN ECOSYSTEM

- Tropic level – Organisms occupy a place in the natural surroundings or in a community according to their feeding relationship with other organisms. Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their tropic level. A given organism may occupy more than one tropic level simultaneously.
- Organisms at each tropic level depend on those at the lower tropic level for their energy demands.
- Standing crop - Each tropic level has a certain mass of living material at a particular time called as the standing crop. It is measured as the biomass of an organism or their number in a unit area.
- Pyramid of energy - Any calculations of energy content, biomass, or numbers has to include all organisms at that tropic level.

# PRODUCTIVITY

- rate of biomass production
  - biomass-the mass of living organisms within a particular environment
- has 2 kinds (primary and secondary)

## 2 Kinds of Productivity

**1. Primary Productivity**

☺ Green plants fix solar energy and accumulate it in organic forms as chemical energy

☺Photosynthesis

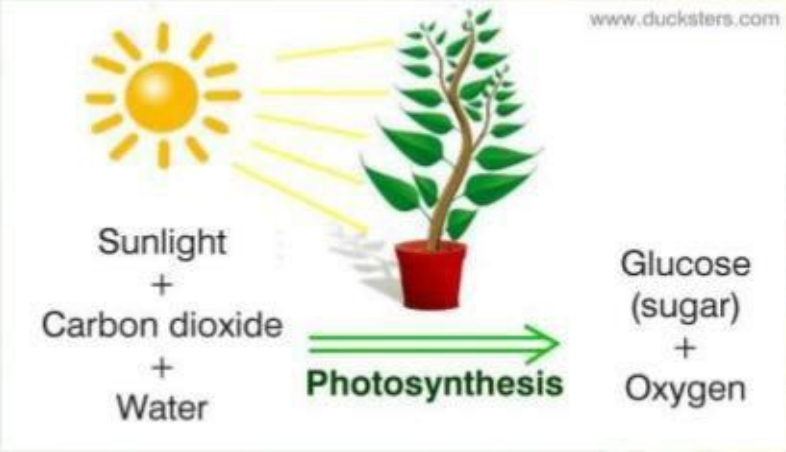
☺Chemosynthesis

## 2 Kinds of Productivity

**Primary Productivity**

**Secondary Productivity**

## 1. Primary Productivity



## 2 Aspects of Primary productivity

**Gross Primary Productivity**

**Net Primary Productivity**

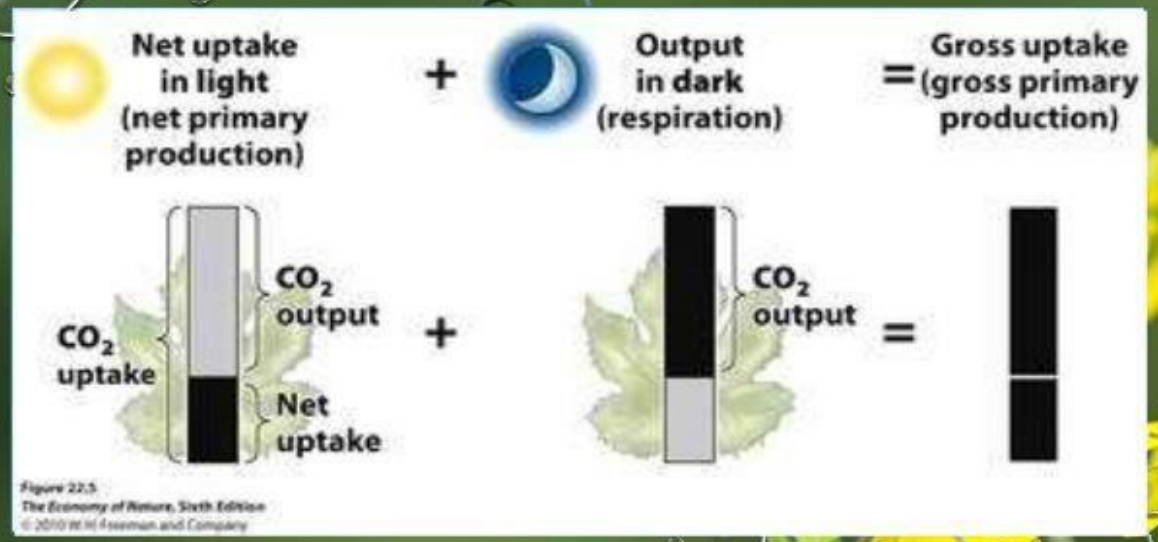



Figure 22.5
The Economy of Nature, Sixth Edition
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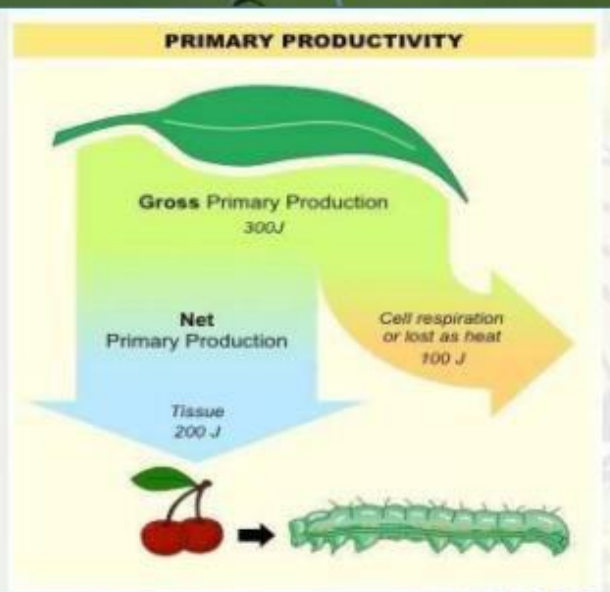
## 2 Aspects of Primary productivity

### Gross Primary Productivity (GPP)

- The rate of production of biomass/ organic matter by producers during photosynthesis
- Total gain in energy or biomass per unit time

### Respiration

- opposite of photosynthesis
- absorb free molecules of oxygen to create water, carbon dioxide, and energy which helps the plant grow



2 Aspects of Primary productivity

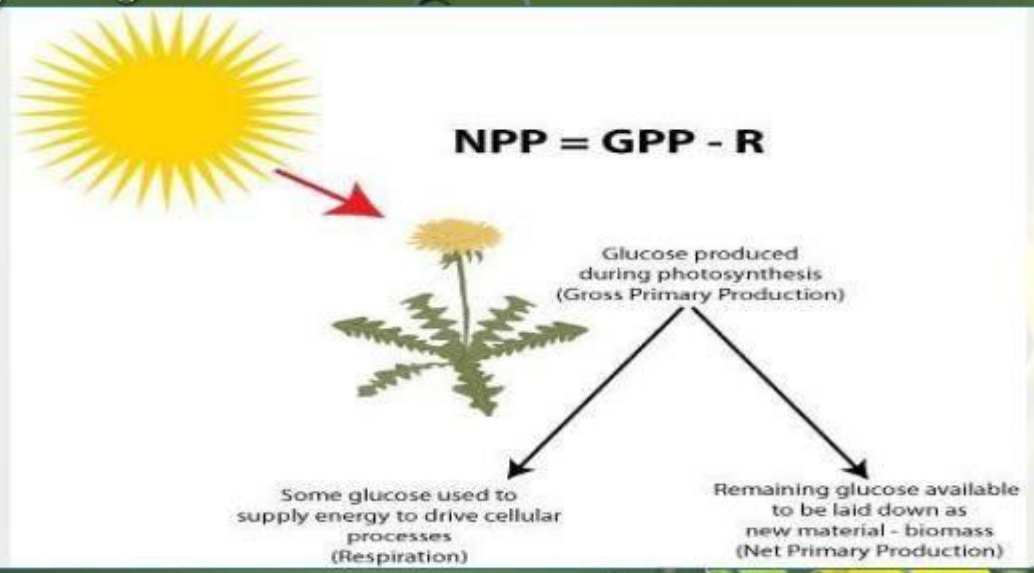
## Net Primary Productivity (NPP)

- Refers to the biomass/organic matter available for the consumption to heterotrophs, left after some respiration loses
- The amount of energy-bound organic matter created per unit area and time that is left after respiration
- NPP = GPP – respiration

## 2 Kinds of Productivity

### 2. Secondary Productivity

- The rates at which the heterotrophic organisms resynthesize the energy-yielding substances
- transfer of organic material between trophic levels

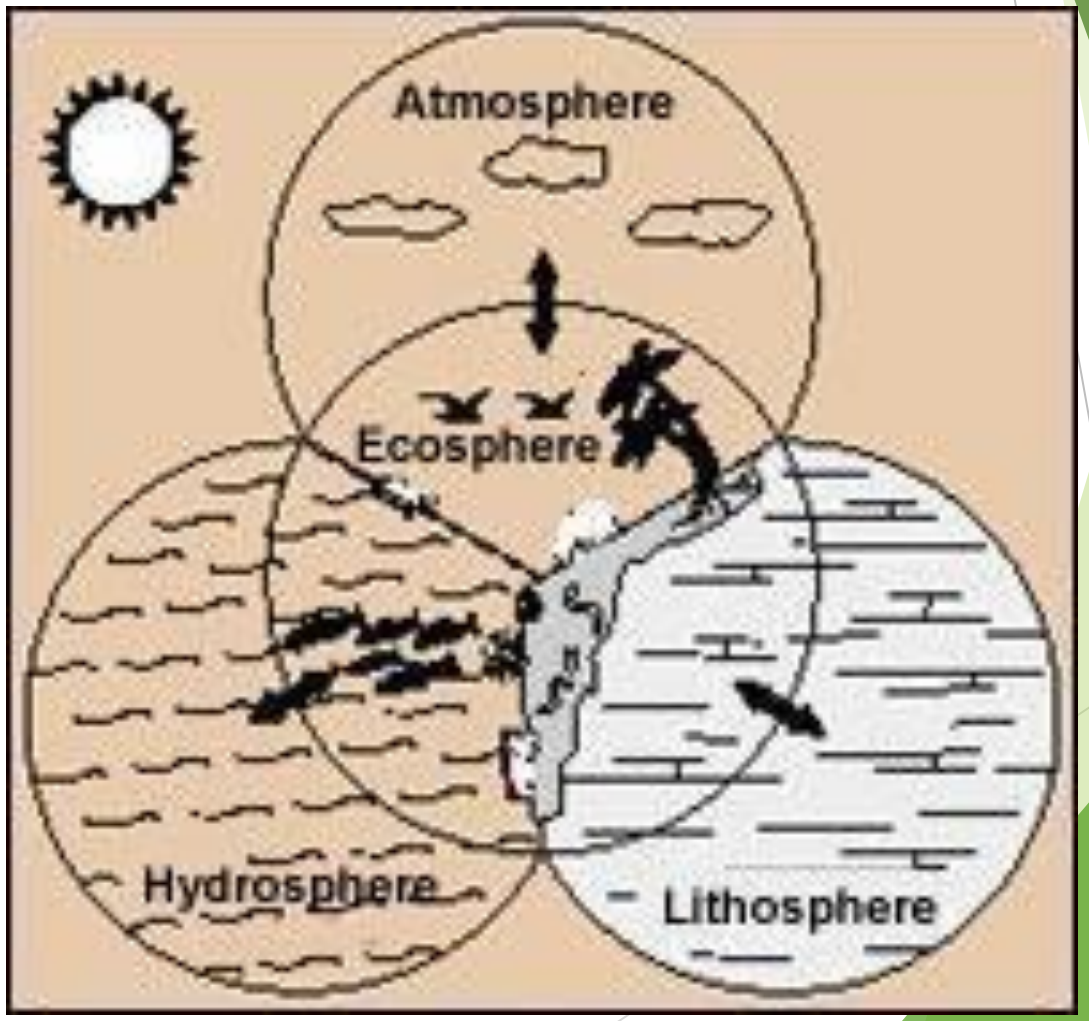



2. Secondary Productivity

# What does biogeochemical mean?

- Bio –living system
- Geo - envirnment
- Chemical - elements

Biogeochemical cycles: the movement (or cycling) of matter through a system



# ‘Fundamentals’ of biogeochemical cycles

- All matter cycles...it is neither created nor destroyed...
- As the Earth is essentially a closed system with respect to matter, we can say that *all matter on Earth cycles* .
- Biogeochemical cycles: the movement (or cycling) of matter through a system

Matter = elements (carbon, nitrogen, oxygen) or molecules (water)

so the movement of matter (for example carbon) between these parts of the system is, practically speaking, a biogeochemical cycle

The Cycling Elements:

macronutrients : required in relatively large amounts

carbon , hydrogen , oxygen , nitrogen , phosphorous
sulfur

other macronutrients:

potassium , calcium , iron , magnesium

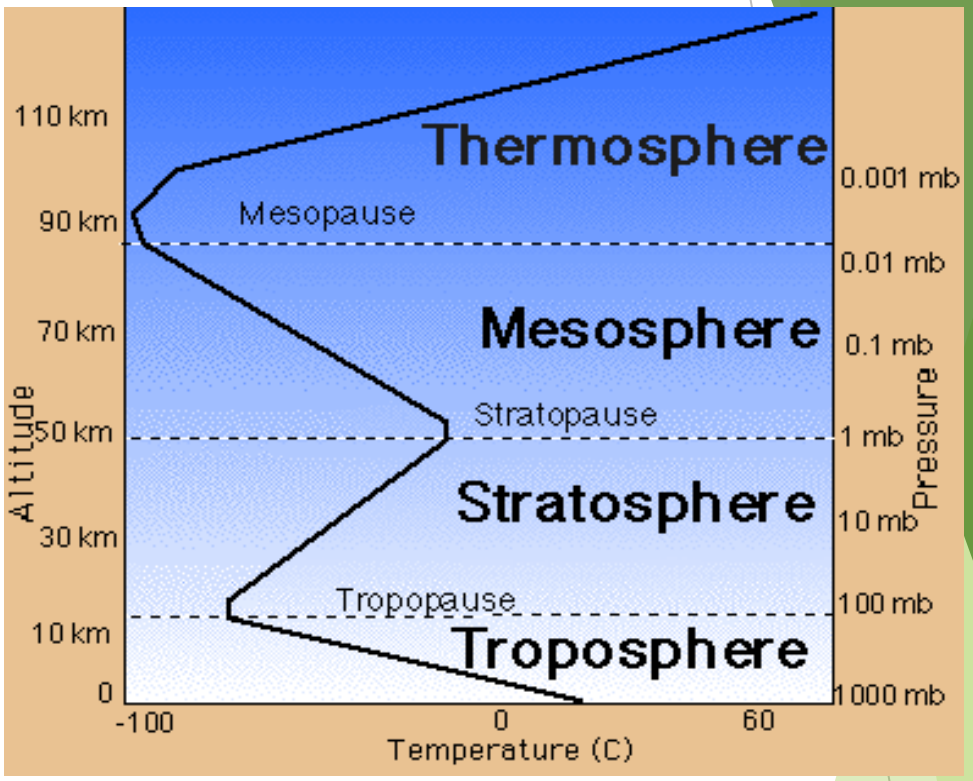
micronutrients : required in very small amounts, (but still necessary)

boron (green plants)
copper (some enzymes)
molybdenum (nitrogen-fixing bacteria)

# ATMOSPHERE

The **atmosphere** is the blanket of gases which surrounds Earth. It is held near the surface of the planet by Earth's gravitational attraction. Without the **atmosphere** there could be no life on Earth.
The **atmosphere**: ... keeps the climate on Earth moderate

compared to that of other planets.




The **atmosphere** is comprised of **layers** based on temperature. These **layers** are the troposphere, stratosphere, mesosphere and thermosphere. A further region at about 500 km above the Earth's surface is called the exosphere.

# Living things are made up of – chemicals

Carbohydrates-CHO
Proteins- CHON
fats-CHO
Vitamins-CHO and etc
Minerals-Mg,Cl,S,P,Zn….macro and micro elements and
Water

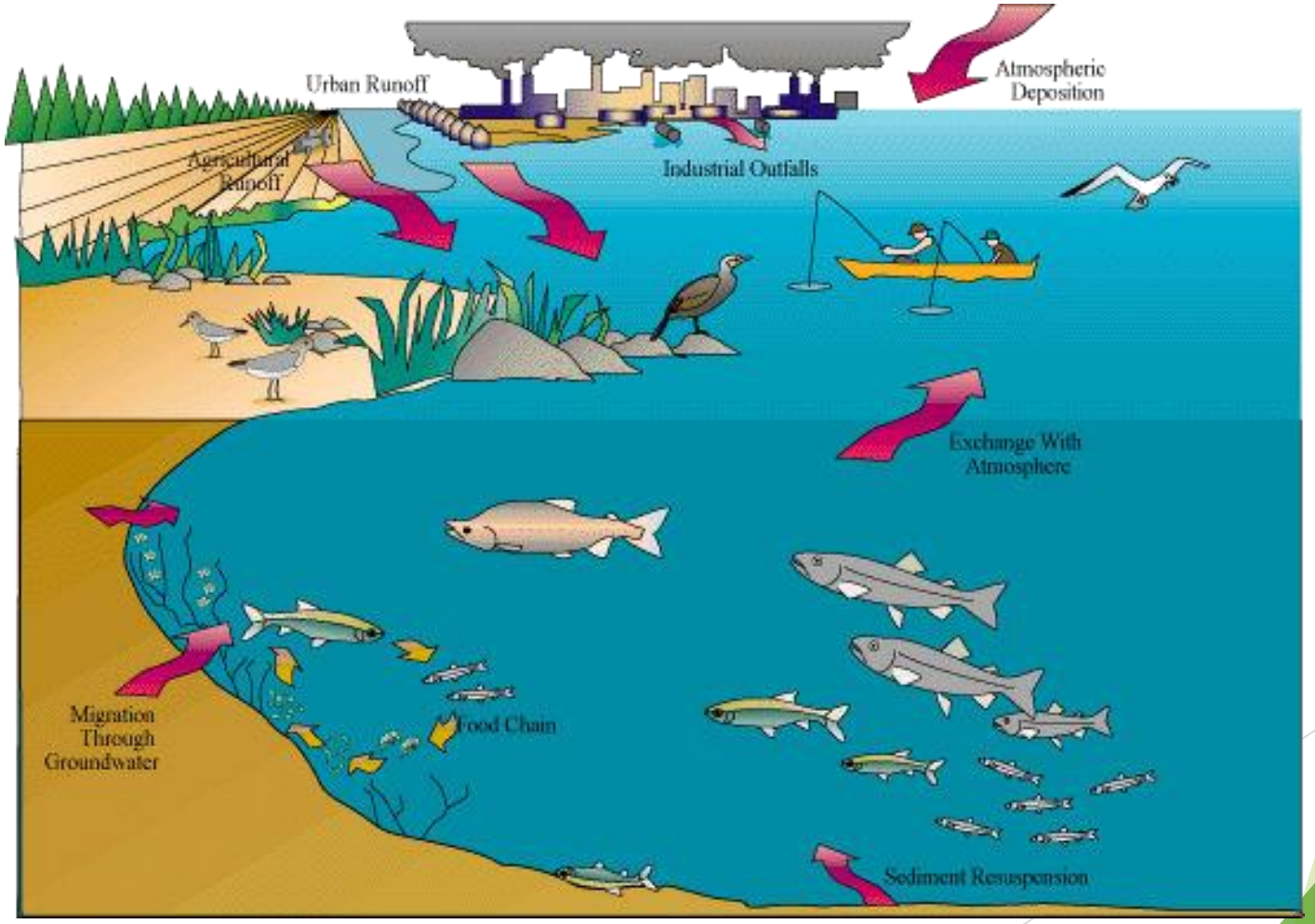
6 of the most important cycles are the water, carbon, nitrogen, sulfur, phosphorus and oxygen.

1. Water
2. Carbon
3. Nitrogen
4. Phosphorous
5. Sulfur
6. Oxygen

# Effects of Human Activities on Water Cycle

- We alter the water cycle by:
  - Withdrawing large amounts of freshwater.
  - Clearing vegetation and eroding soils.
  - Polluting surface and underground water.
  - Contributing to climate change.

# Water Quality Degradation

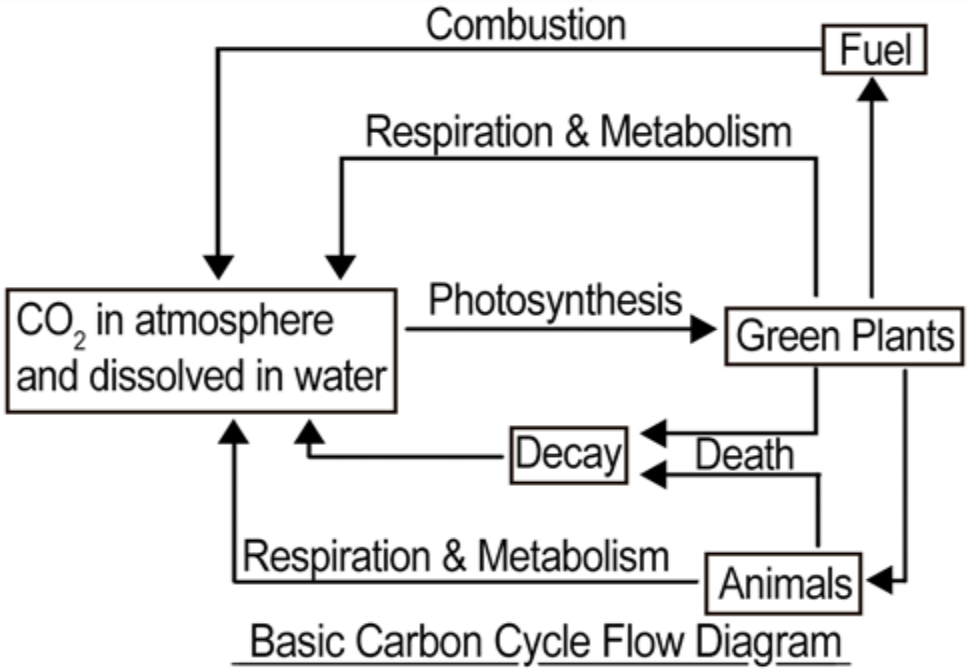


# Where does carbon come from?

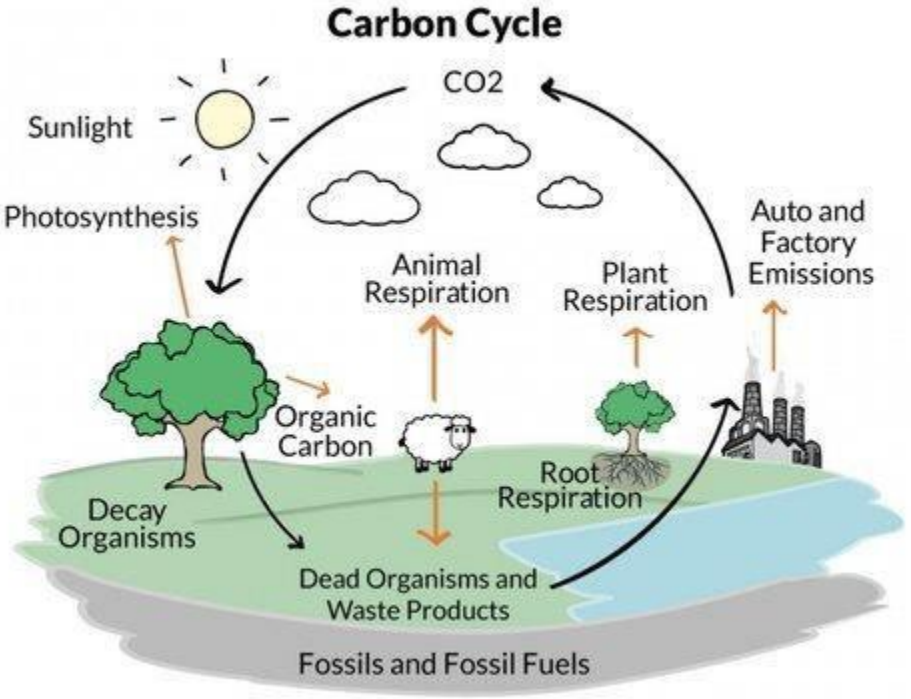
| Natural Sources of Carbon | Sources of Carbon from Human Activity |
|---|---|
| •Death of plants and animals<br>•Animal waste<br>•Atmospheric CO2<br>•Weathering<br>•Methane gas from cows (and other ruminants)<br>•Aerobic respiration from terrestrial and aquatic life | •Burning wood or forests<br>•Cars, trucks, planes<br>•Burning fossil fuels such as coal, oil and natural gas to produce heat and energy. |

# Carbon in Oceans

- Additional carbon is stored in the ocean.
- Many animals pull carbon from water to use in shells, etc.
- Animals die and carbon substances are deposited at the bottom of the ocean.
- Oceans contain earth's largest store of carbon.




Basic Carbon Cycle Flow Diagram



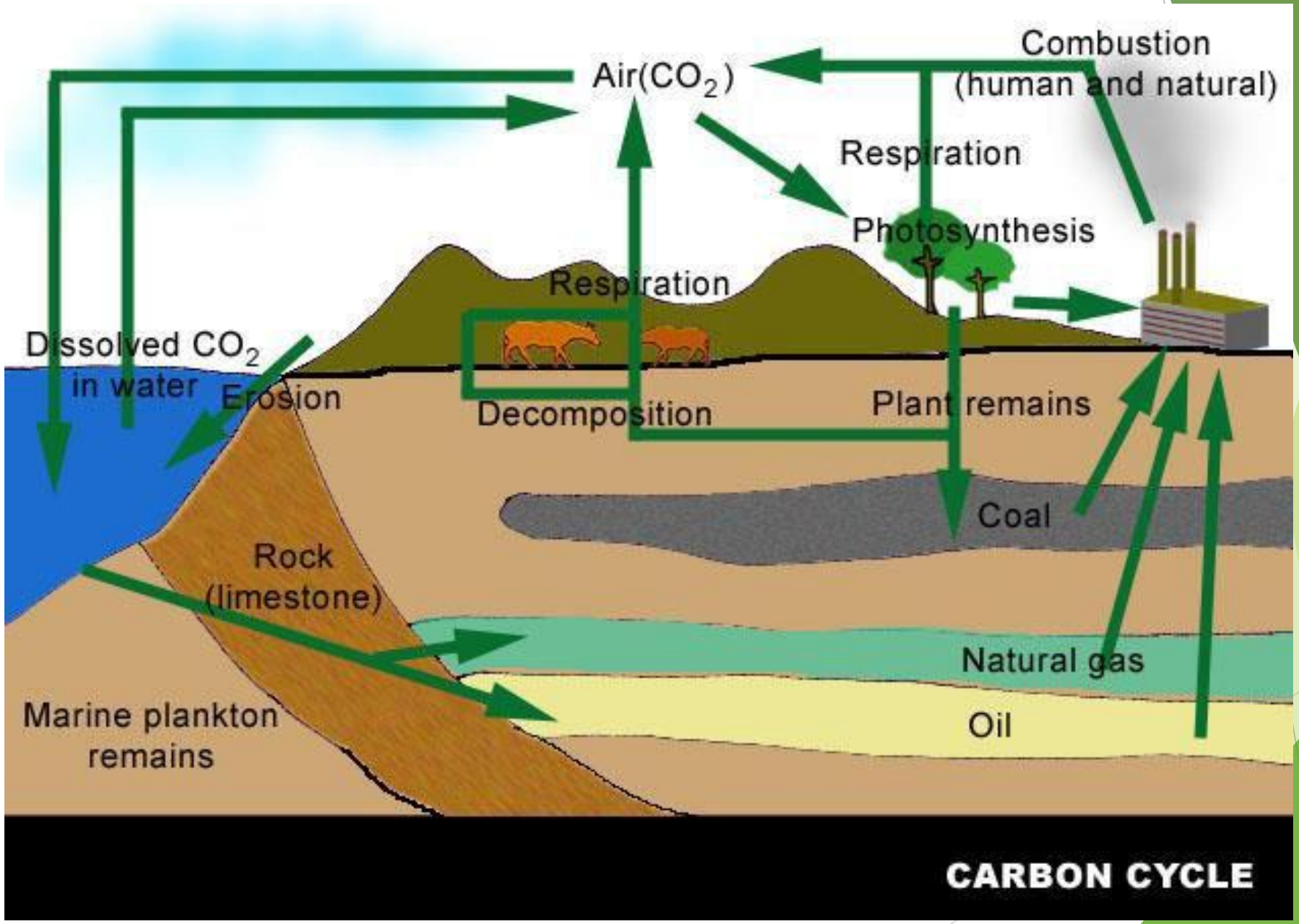
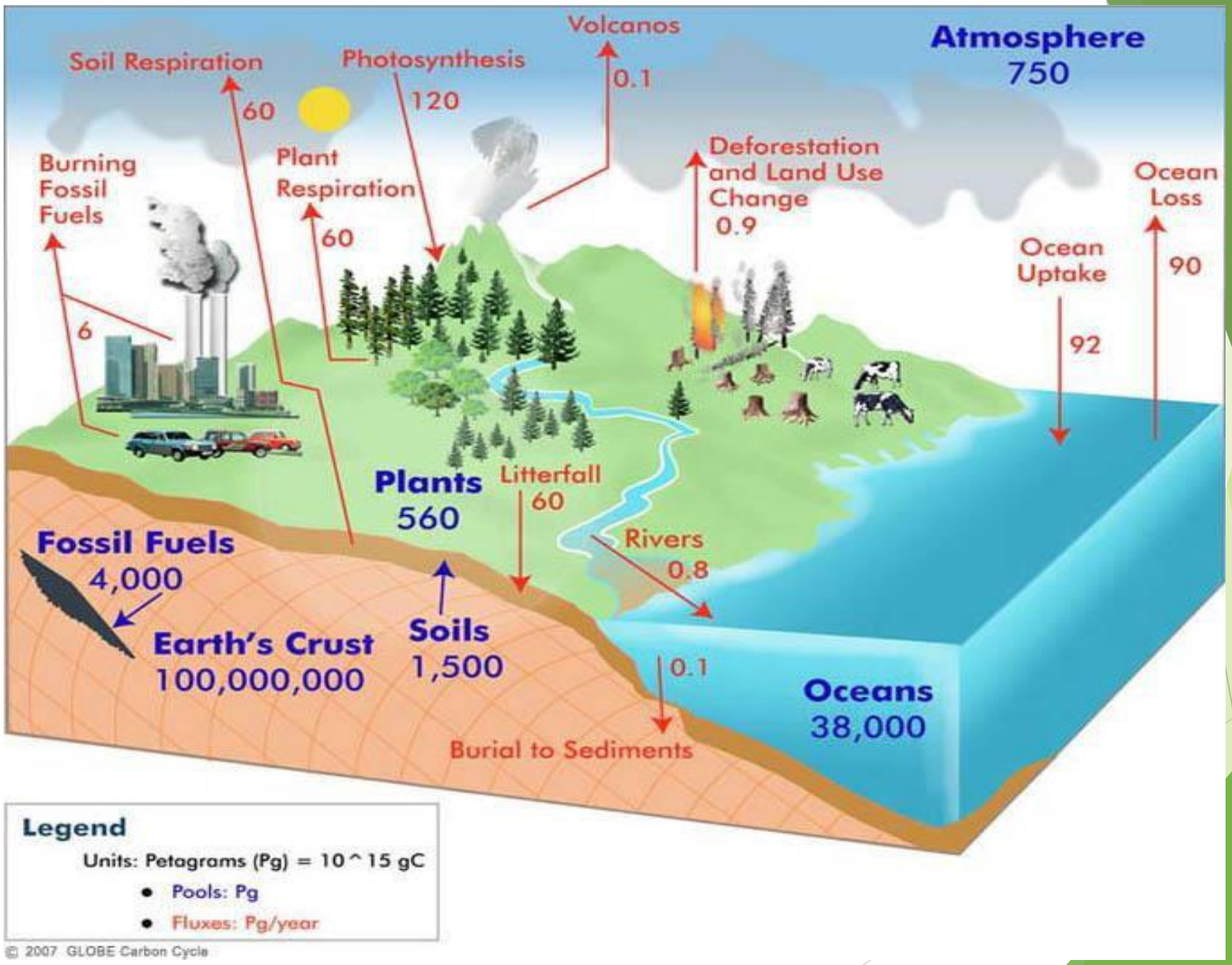



Fig. 3-27, pp. 72-73


Volcanos
0.1
Atmosphere
750
Soil Respiration
60
Photosynthesis
120
Burning
Fossil
Fuels
6
Plant
Respiration
60
Deforestation
and Land Use
Change
0.9
Ocean
Loss
90
Ocean
Uptake
92
Plants
560
Litterfall
60
Rivers
0.8
Fossil Fuels
4,000
Earth's Crust
100,000,000
Soils
1,500
0.1
Oceans
38,000
Burial to Sediments
Legend
Units: Petagrams (Pg) = 10^15 gC
Pools: Pg
Fluxes: Pg/year
© 2007 GLOBE Carbon Cycle

# MARINE CARBON CYCLE

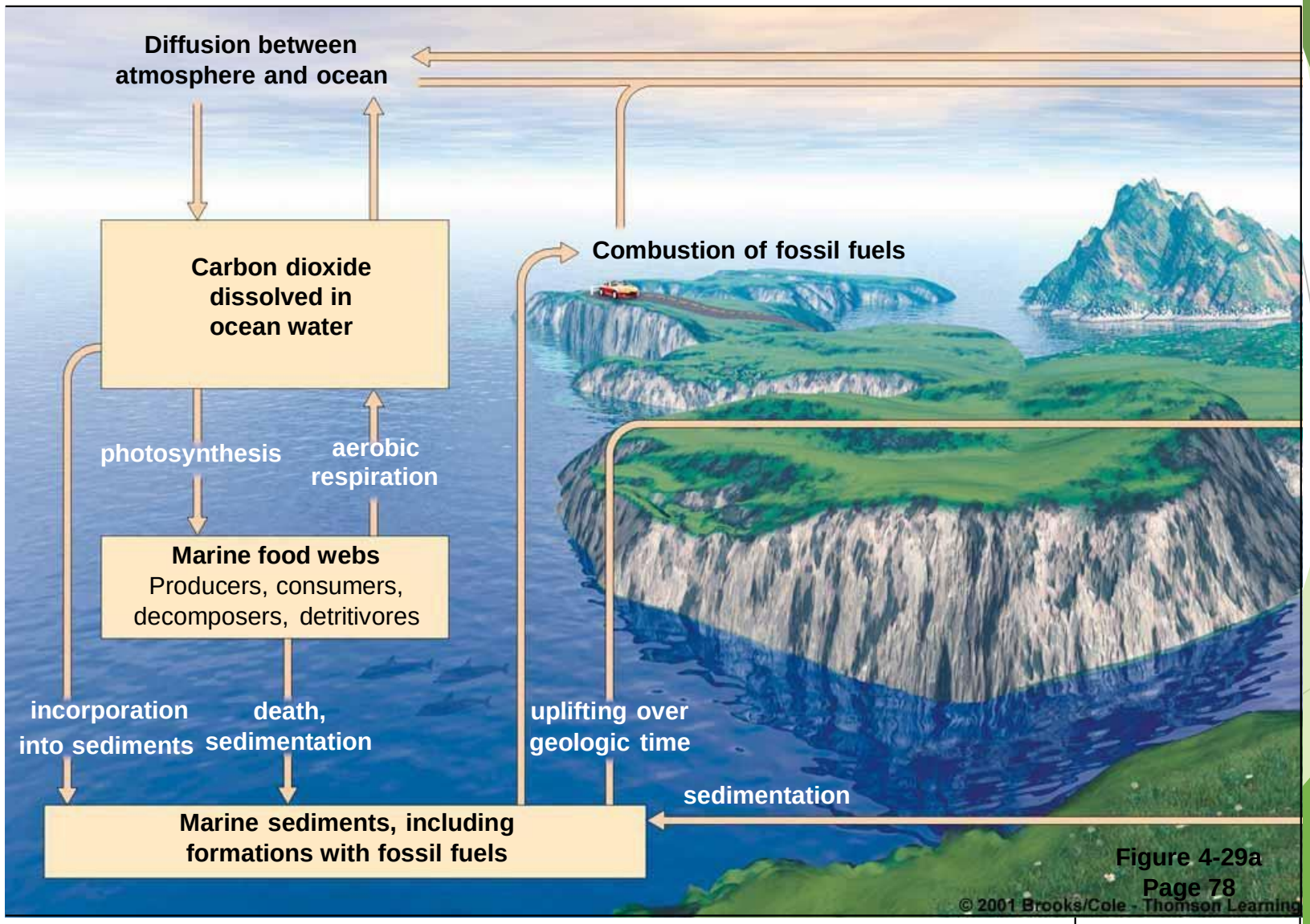
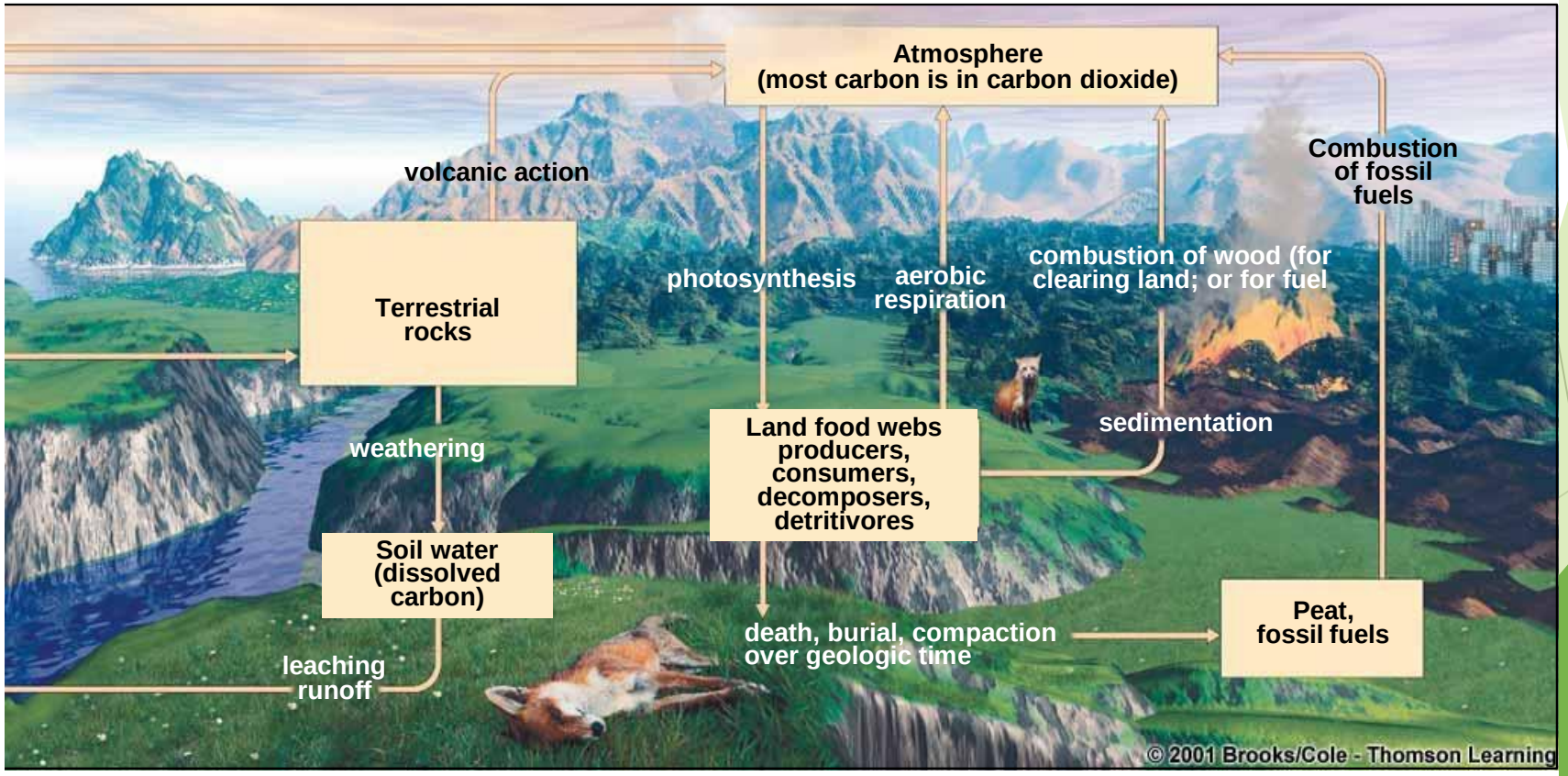



Figure 4-29a
Page 78

# TERRESTRIAL CARBON CYCLE



# Effects of Human Activities on Carbon Cycle

- We alter the carbon cycle by adding excess $CO_2$ to the atmosphere through:
  - Burning fossil fuels.
  - Clearing vegetation faster than it is replaced.

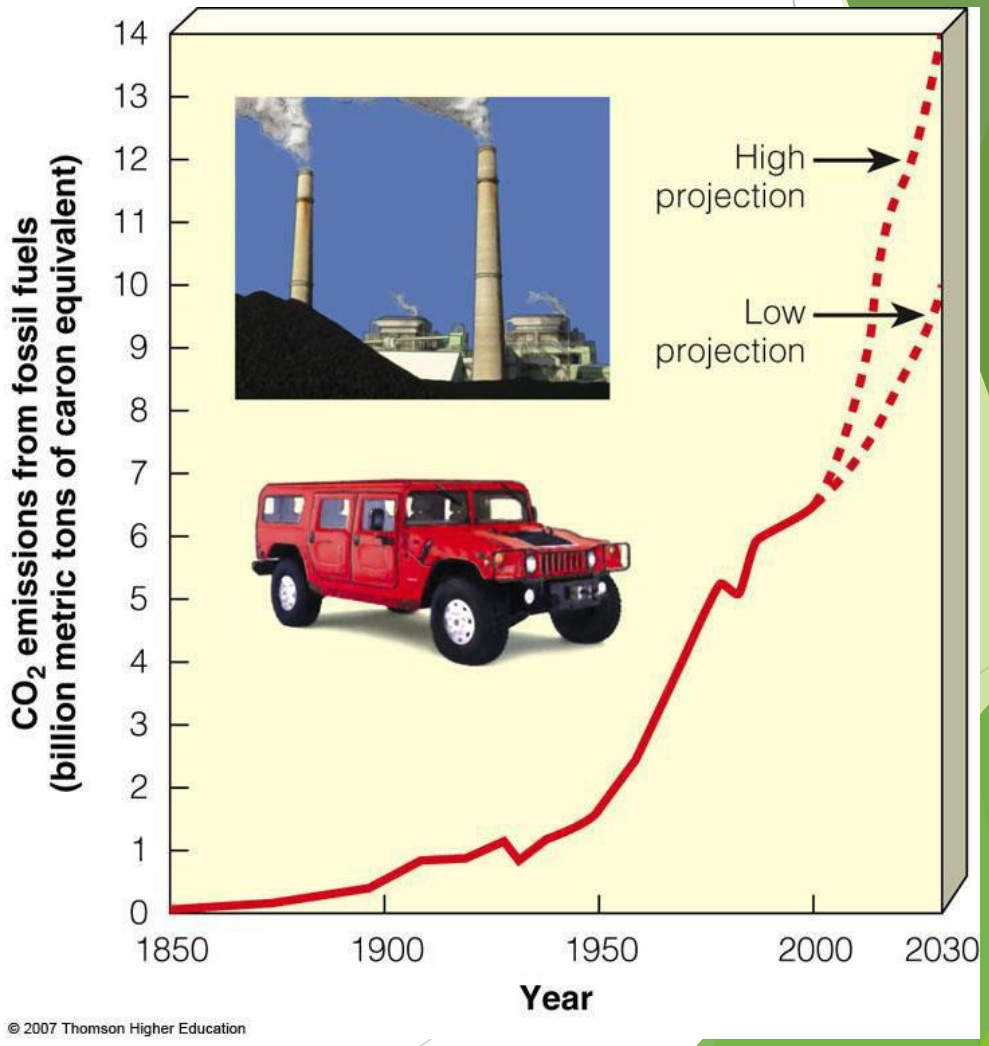





Figure 3-28

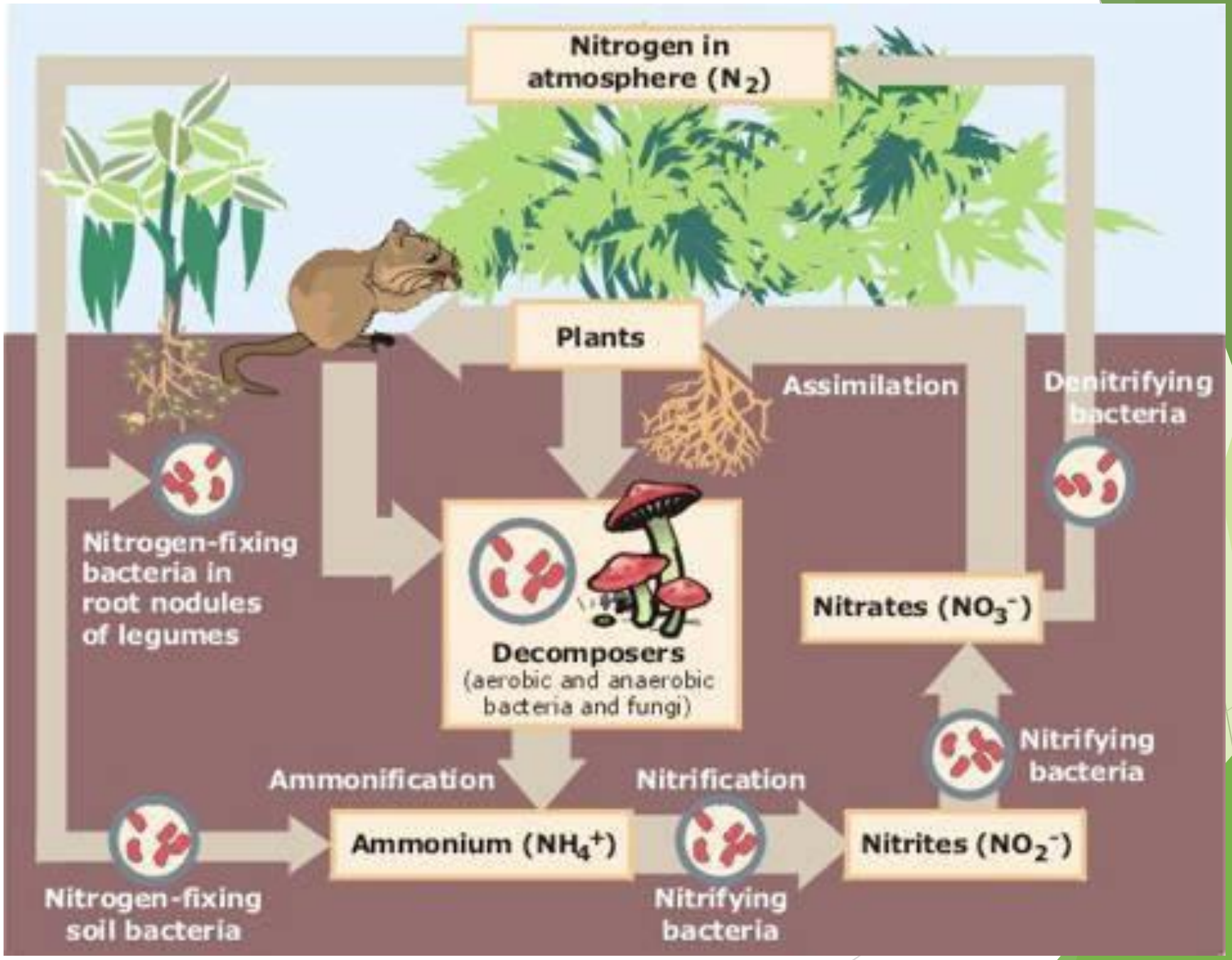
# Sources of Nitrogen

- Inorganic fertilizers
- Nitrogen Fixation
- Animal Residues
- Crop residues
- Organic fertilizers

# Forms of Nitrogen

- Urea → $CO(NH_2)_2$
- Ammonia → $NH_3$ (gaseous)
- Ammonium → $NH_4$
- Nitrate → $NO_3$
- Nitrite → $NO_2$
- Atmospheric Dinitrogen → $N_2$
- Organic N

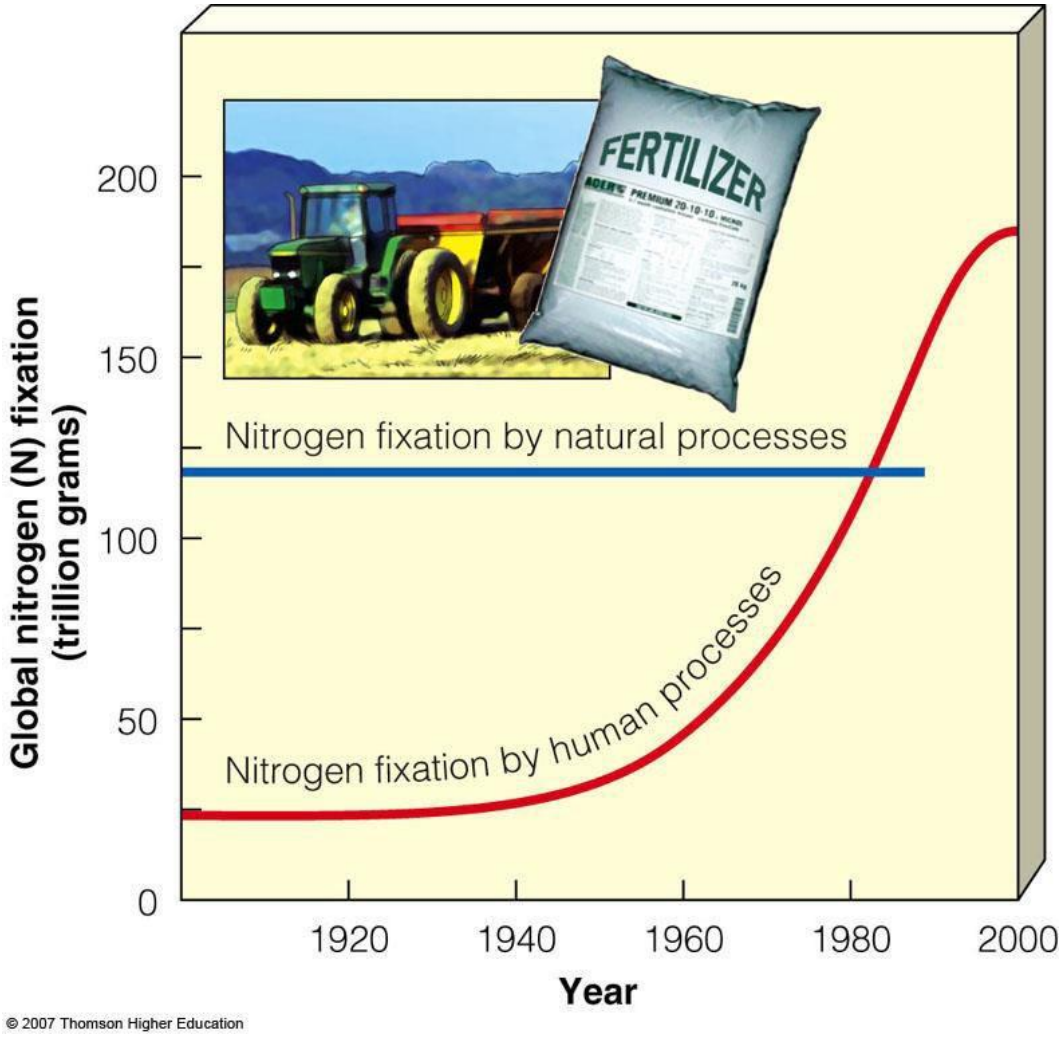
Nitrogen is a naturally occurring element that is essential for growth and reproduction in both plants and animals. It is found in amino acids that make up proteins, in nucleic acids, that comprise the hereditary material and life's blueprint for all cells, and in many other organic and inorganic compounds.


Nitrogen in atmosphere ($N_2$)
Plants
Assimilation
Denitrifying bacteria
Nitrogen-fixing bacteria in root nodules of legumes
Decomposers
(aerobic and anaerobic bacteria and fungi)
Nitrates ($NO_3^-$)
Nitrifying bacteria
Ammonification
Nitrification
Ammonium ($NH_4^+$)
Nitrites ($NO_2^-$)
Nitrogen-fixing soil bacteria
Nitrifying bacteria

# Effects of Human Activities on the Nitrogen Cycle

- We alter the nitrogen cycle by:
  - Adding gases that contribute to acid rain.
  - Adding nitrous oxide to the atmosphere through farming practices which can warm the atmosphere and deplete ozone.
  - Contaminating ground water from nitrate ions in inorganic fertilizers.
  - Releasing nitrogen into the troposphere through deforestation.

# Effects of Human Activities on the Nitrogen Cycle





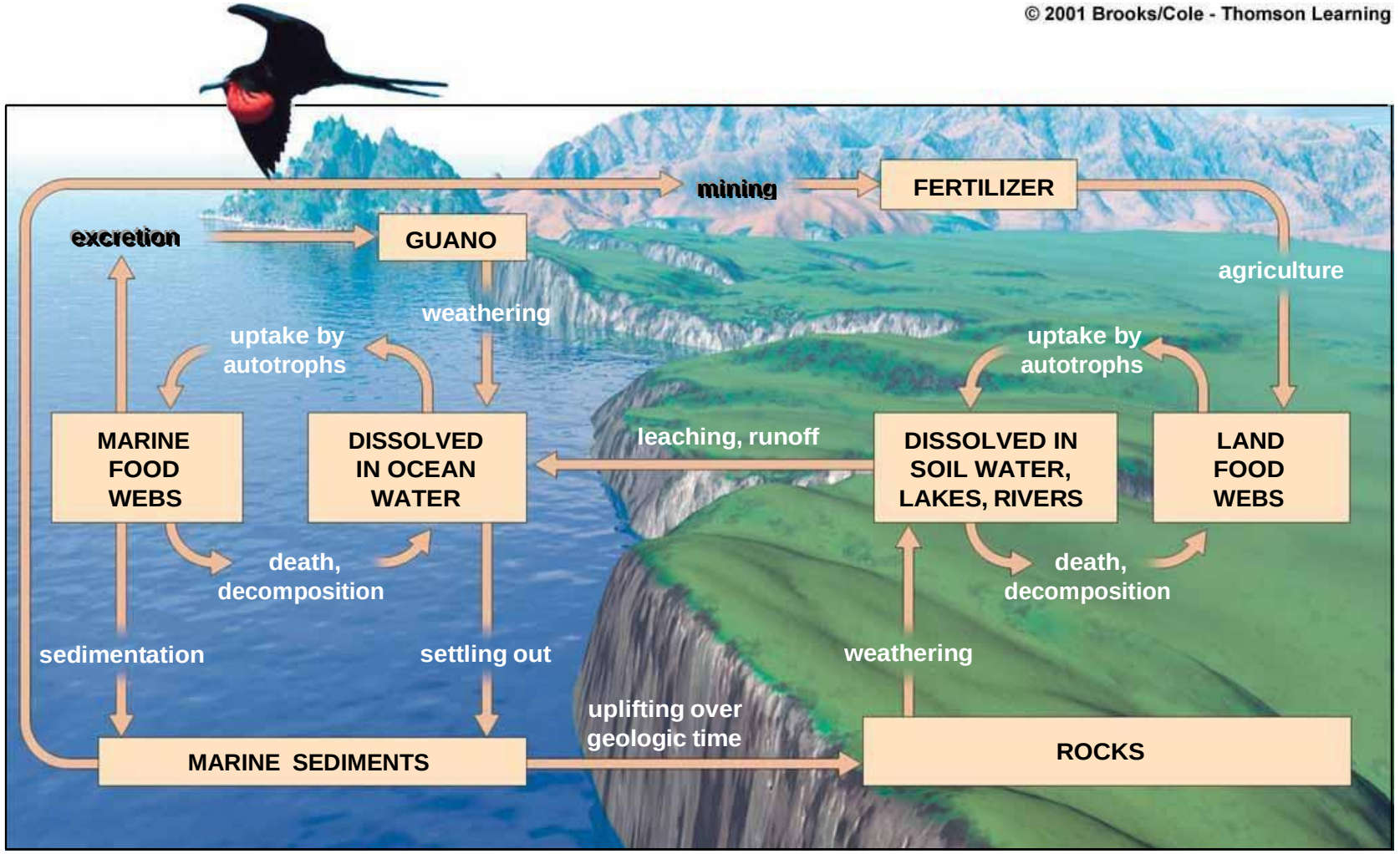
- Human activities such as production of fertilizers now fix more nitrogen than all natural sources combined.

Figure 3-30

# IMPORTANCE OF PHOSPHOROUS CYCLE

- 1.Phosphorous is an essential nutrient of both plants and animals.
- 2. It is part of DNA molecules which carry genetic information.
- 3. It is part of ATP and ADP) that store chemical energy for use by organisms in cellular respiration.
- 4. Forms phospholipids in cell membranes of plants and animal cells.
- 5. Forms bones, teeth, and shells of animals as calcium phosphate compounds.

# PHOSPHOROUS CYCLE



# HUMAN IMPACTS TO PHOSPHOROUS CYCLE

1. Humans mine LARGE quantities of phosphate rock to use in commercial fertilizers and detergents. Phosphorous is NOT found as a gas, only as a solid in the earth's crust. It takes millions to hundreds of millions of years to replenish.
2. Phosphorous is held in the tissue of the trees and vegetation, not in the soil and as we deforest the land, we remove the ability for phosphorous to replenish globally in ecosystems.
3. Cultural Eutrophication – ad excess phosphate to aquatic ecosystems in runoff of animal wastes from livestock feedlots, runoff of commercial phosphate fertilizers from cropland, and discharge of municipal sewage.

# Effects of Human Activities on the Phosphorous Cycle

- We remove large amounts of phosphate from the earth to make fertilizer.
- We reduce phosphorous in tropical soils by clearing forests.
- We add excess phosphates to aquatic systems from runoff of animal wastes and fertilizers.

# IMPORTANCE OF SULFUR CYCLE

1. Sulfur is a component of most proteins and some vitamins.
2. Sulfate ions ($SO_4^{2-}$) dissolved in water are common in plant tissue. They are part of sulfur-containing amino acids that are the building blocks for proteins.
3. Sulfur bonds give the three dimensional structure of amino acids.
4. Many animals, including humans, depend on plants for sulfur-containing amino acids.

# SULFUR CYCLE

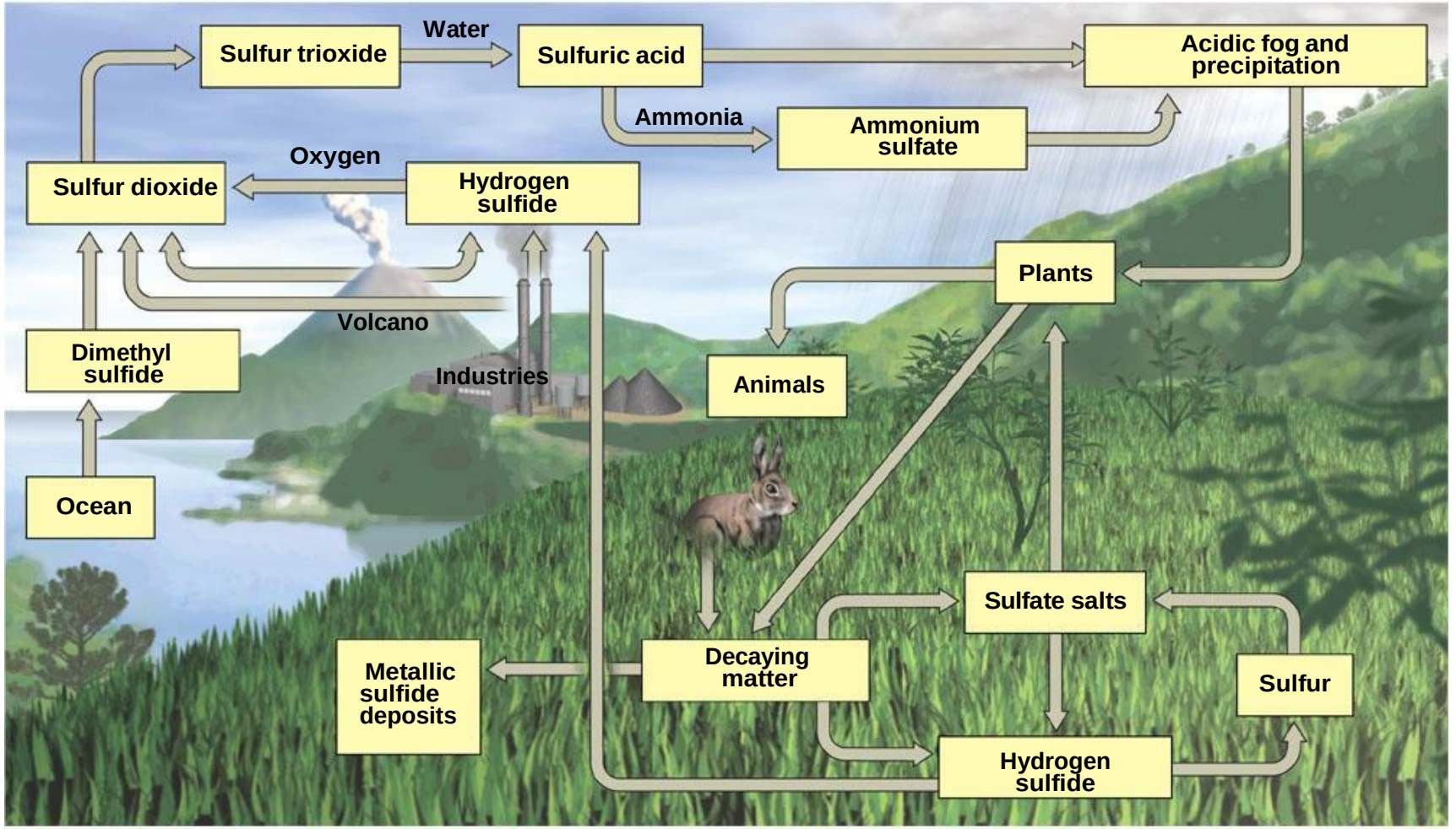


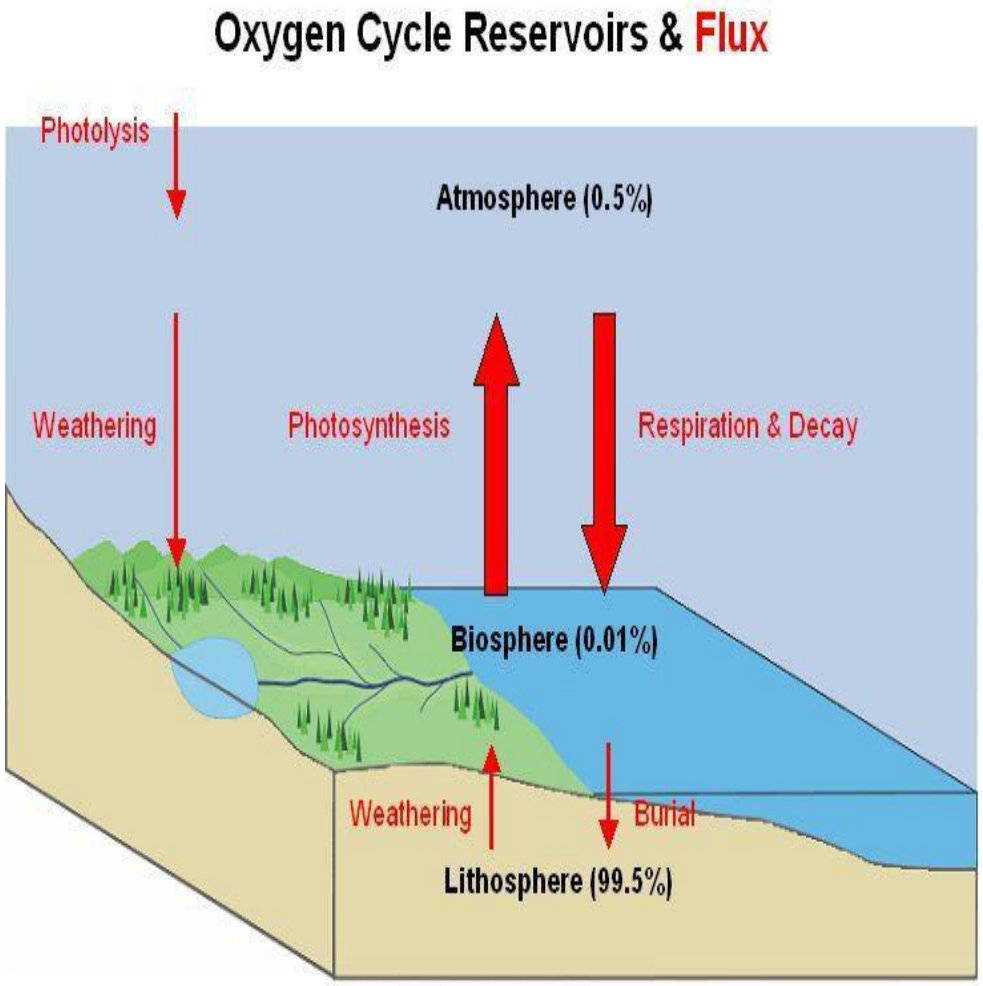


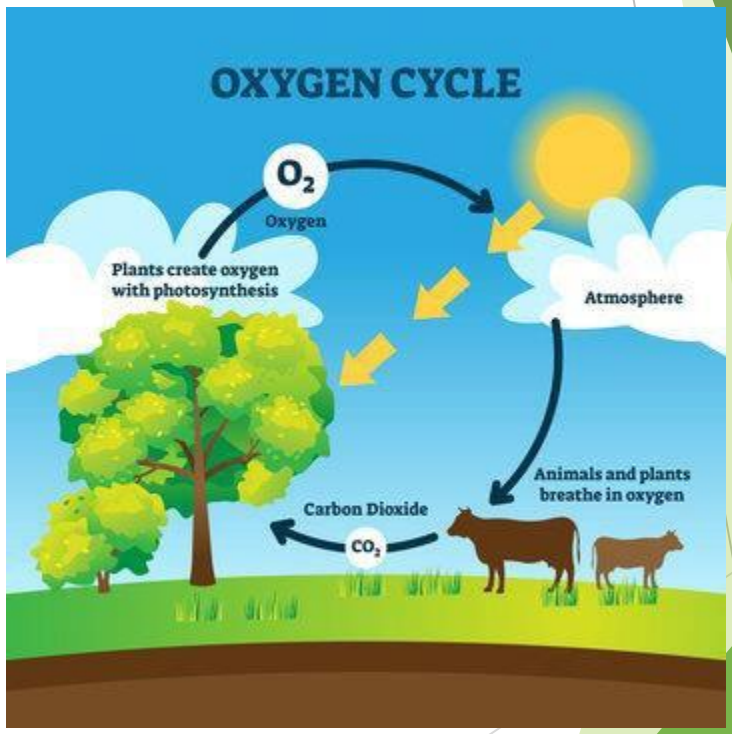

Figure 4-34

# Effects of Human Activities on the Sulfur Cycle

- We add sulfur dioxide to the atmosphere by:
  - Burning coal and oil
  - Refining sulfur containing petroleum.
  - Convert sulfur-containing metallic ores into free metals such as copper, lead, and zinc releasing sulfur dioxide into the environment.

# The Oxygen cycle




## OVERVIEW

- Definition of Pollution.
- Types of Pollution.
- Air Pollution.
- Water Pollution.
- Noise Pollution.
- Land Pollution.
- Radio Active Pollution.

## DEFINITION OF POLLUTION

When Harmful Substances Contaminate the Environment, it is Called Pollution.

Pollution refers to the very bad condition of environment in terms of quantity and quality .

# Pollution

**Pollution** is the introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to the ecosystem .

e.g. Industry

Automobiles

Nuclear Reactors etc,.

**Types of pollutants**

- Biodegradable
- Non-degradable

# TYPES OF POLLUTION

There are Five types of Pollution:

- Air Pollution
- Water Pollution
- Noise Pollution
- Land Pollution
- Radio Active Pollution

# AIR POLLUTION

Air pollution is the "presence of contaminants in atmosphere in quantities such that it is injurious to human, plant animal life and property".

**Sources of air pollution**

- ***Natural sources*** : Volcanic eruption, forest fires, biological decay.
- ***Manmade sources*** :thermal power plant ,fuel burning, agriculture activities.

## Causes of Air Pollution

Major sources of Air Pollution:

- ❖Industries.
- ❖ Automobiles and Domestic fuels.
- ❖ High Proportion of undesirable gases, such as sulphur dioxide and carbon monoxide.
- ❖Dust (e.g. cement dust, foundry dust and windblown solid dust)
- ❖Mist.
- ❖Smoke.
- ❖Carbon black.
- ❖Aerosols.


## Classification of Air pollutants

**1.Primary air pollutants**

Emitted directly in the atmosphere. E.g. CO,NO & $SO_2$

**INDOOR AIR POLLUTANTS**

- Radon gas emitted from building materials like bricks,concrete,tiles etc.,
- It is present in natural gas and ground water.
- burning of fuel in the kitchen, cigaratte, smoke.

**2.Secondary air pollutants**

**Sulphur dioxide**:

- The combustion of sulphur containing fuels such as coal and oil.
- It can be converted into sulphuric acid.

**Human Sources :**

- Coal burning in power plant (88%)
- Industrial processes (10%)

**Environmental effects** :

- In humans : it causes eye irritation, cough, lung diseases including lung cancer and asthma
- In plants: it causes damage of leaves, bleaching of chlorophyll which turns leaves brown, damage to crops and to growth of plants.

**Carbon monoxide**

**Sources:**

- Cigarette smoking,incomplete burning of fuels.
- Automobile exhaust- carbon monoxide is formed during the combustion of fuel such as petrol.(77%)
- Industries: carbon monoxide is released by industries such as iron and steel and petroleum .

$$CO_2 + C \text{ -------} \rightarrow 2CO$$

$$2CO_2 \text{ ---------} \rightarrow 2CO + O_2$$

**Effects:**

In humans:

- When the atmosphere is polluted with carbon monoxide, on inhalation, CO combines with the hemoglobin to form car boxy hemoglobin and hence oxygen carrying capacity of the blood decreases.
- This causes, headache, dizziness, unconsciousness.
- When inhaled for a long duration it may cause even death.

In environment :

- it increase globe temp.

**Lead**

Sources

- Paint, metal refineries, storage battteries…..

Effects

In humans

- Mental retardation, health problems even leads to cancer.

In environment

- Harms wild life

# Control of air pollution

## Source Control:

- Use only **unleaded** petrol.
- Use petroleum products and other fuels that have **low sulphur and ash content.**
- Reduce the no. of private **vehicles**
- Ensure the houses, schools are **not located** on busy streets.
- **Plant trees** along busy streets to reduce particulates, CO and noise.
- Industries should be **situated outside** the city
- Use **catalytic converters** to control CO &hydrocarbons

# Control measures in industries

- The **emission rates** should be restricted to permissible levels by industries.
- Air pollution **control equipments** must be made mandatory.
- Continuous **monitoring of the atmosphere for the pollutants**, to know the pollution levels.

# WATER POLLUTION

"The alteration in physical, chemical or biological properties of water, as well as the addition of any foreign substance makes it unfit for health and which decreases the utility of water" is known as water pollution.

# WATER POLLUTION

Any physical (temperature, oxygen), chemical (mercury), or biological (disease, sewage) change to water that adversely affects its use by alive beings.

Main sources of water pollution are:

- Domestic and municipal sewage
- Industrial waste
- Agricultural waste
- Radioactive materials, etc.,

## POINT AND NONPOINT SOURCES

Two types of water pollutants exist;

*Point source*

Point sources of pollution occur when harmful substances are **emitted directly into water.**

**e.g.,Oil spill**

*Nonpoint source.*

A non-point source **delivers pollutants indirectly** through environmental changes.

e.g., **Fertilizer from a field is carried into a stream by rain**

### Point Sources

### Non Point Sources

### Effects of Water Pollution

- Diseases like Cholera.
- Malaria.
- Typhoid (spread during the rainy season).
- Aquatic life gets destroyed.

Types of water pollutant:

1.Infectious agents: Bacteria, viruses, protozoa

source : animal waste.

Effect : variety of diseases

2.Oxygen demanding waste:

Dissolved oxygen (DO) is the amount of oxygen dissolved in given quantity of water at a particular P and T. The saturation point 8-15mg/lit.

Sources: Sewage, paper waste, food processing waste.

Effects: affect the water quality, affect fish survival and migration.

3.Inorganic chemicals : Acids, pb, arsenic, selenium, sodium chloride and fluorides.

Sources : surface runoff, effluents

Effects: Cause skin cancer, damage nervous system,harm to fish and aquatic life, lower crop yields.

4.Organic chemicals:Oil, gasoline,plastics, solvents ,detergents.

Sources: Industrial efflents, surface runoff forms.

Effects: Causing effect nervous system ,cancer, harm fish and wild life.

5.Plant nutrients:

Nitrate, phosphate and ammonium ions

Sources: sewage, runoff water from agriculture, fertillizer.

Effects: Excessive growth of algae, lower the oxygen carrying capacity.

6.Sediment: Soil

Source: Land erosion.

Effects: Can reduce photosynthesis, Affect aquatic food webs.

**Testing of water**

**Dissolved oxygen (DO)**

- Amount of oxygen dissolved in water at a particular pressure and temp.

**Bio chemical oxygen demand (BOD)**

- Oxygen required for biological decomposition of organic matters.

**Chemical oxygen demand (COD)**

- Oxygen required for chemical oxidation of organic matters

## Control measures of water pollution:

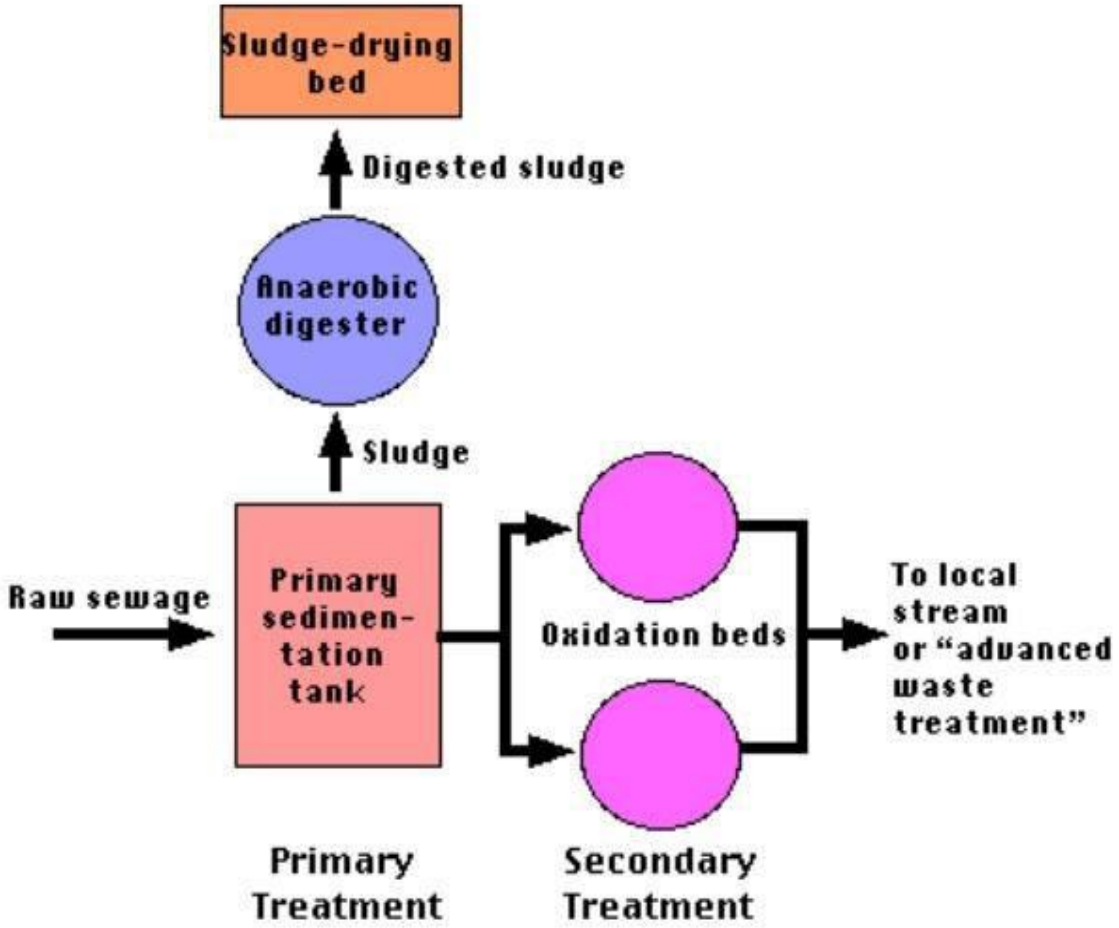
- Avoid Pesticides and fertilizers on sloped land areas.
- The nutrient rich water can be used as fertilizer in the fields.
- Separate drainage of sewage and rain water should be provided to prevent overflow of sewage with rain water.
- Planting more trees.
- Use nitrogen fixing plants to supplement the use of fertilizers.

## Sewage treatment

Main objective is to convert harmful compounds into harmless compounds.

*In primary treatment*, the suspended solids and floating objects are removed using coarse screens and sieves.

*In secondary treatment*, the maximum proportions of the suspended inorganic/ organic solids are removed from the liquid sewage. The liquid material passes into the sedimentation tank and finely suspended particles are allowed to settle by adding coagulants like Alum.




## *Tertiary treatment*

- Remove detergents, metal ions, nitrates and pesticides, as these are not removed in the earlier treatments.
- The phosphates are removed as calcium phosphates by adding calcium hydroxide at pH 10-11. At this pH, ammonium salts are also converted into ammonia.
- The effluent is chlorinated to remove pathogenic bacteria's and finally passed through activated charcoal to absorb gases.

## LAND POLLUTION

- One fourth of area is covered by land.
- Land is a earth which is occupied by people for shelter, occupation, etc...

## SOIL POLLUTION

**Soil pollution** is caused by the presence of human-made chemicals or other alteration in the natural soil environment.

This type of contamination typically arises from,

- Application of pesticides and fertilizers
- Percolation of contaminated surface water to subsurface strata, oil and fuel dumping.
- Discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals.

**Effects of soil pollution:**

- Chronic exposure to chromium, lead and other metals, petroleum, solvents, and many pesticide and herbicide formulations can be carcinogenic.
- Chronic exposure to benzene leads to leukemia.(blood cancer)
- Mercury and cyclodienes are known to induce higher incidences of kidney damage.
- Sewage sludge has many types of bacteria, viruses and worms which cause types of diseases and also emits toxic vapours.

- Radioactive fallout cause abnormalities .eg., Strontium-90 instead of calcium gets deposited in the bones.
- Effects occur to agricultural lands which have certain types of soil contamination.
- Alteration of metabolism of endemic microorganisms.

- N & P from fertilizer in soil reach water bodies with agricultural runoff cause Eutrophication.
- Chemicals contaminates ground water resources.
- Acids, alkalis, heavy metals affect soil fertility.
- Inhibit non target organism like flora, fauna and soil productivity.

Plastic

Chemical

Trash

Fertilization

**Control of soil pollution :**

- Effluents should be properly treated before discharging on the soil.
- Solid waste should be properly collected and disposed off by appropriate method.
- From the waste, recovery of useful products should be done.
- Cattle dung should be used for methane generation.
- Microbial degradation of biodegradable substance for reducing soil pollution.

# NOISE POLLUTION

Definition: Noise Pollution can be defied as unwanted or unpleasant sounds that causes discomfort for all living things.

- The various sources of noises are associated with urban development; road-air and rail transport; Industrial noise.
- In our country, indiscriminate use of loud speakers, generator sets and firecrackers has given new dimensions to the noise pollution problem.
- The commonly used parameter for noise is the sound level in decibel(dB). Human ears are sensitive in the frequency range of 20Hz to 20000Hz

**Major Noise Sources:**

**1. Road Traffic:**

Road traffic noise is one of the most widespread and growing environmental problems in urban area. The impact of road traffic noise on the community depends an various factors such as road location and design, land use planning measures, building design, Vehicle standards and deriver behavior. Motor vehicle ownership in India has increased substantially over the last 30 years and general levels of road traffic noise throughout India have increased through out the period.

**2. Air Traffic:**

The extend of aircraft noise impact depends on the type of aircraft flown, the number of flights and flight paths. The increase in number of flights, an important factor is overall noise levels, the led to an increase in general noise levels associated with air traffic.

**3. Rail Traffic:**

The two main sources of noise and vibration relating to the operation of the rail network is

1. The operation of trains and the maintenance
2. Construction of rail infrastructure.

**4.Neighborhood & Domestic Noise:**

Other significant source of noise annoyance is car alarms, building construction and household noise,Celebrations- religious function,social and elections.

5.Noise generated by noise levels of 125dB as per Environmental rules 1999.

**Effects:**

1. Noise can disturb out work, rest, sleep and communication.
2. It can damage our hearing and evoke other psychological, physiological and possibly pathological reactions.
3. It effects health efficiency and behaviour. It may cause damage to heart, brain,kidneys and liver.
4. It causes muscles to contract leading to nervous breakdown, tension.

5.Change in hormone content of blood, which turn increase the rate of heart beat.

6.Recently it has been reported that blood is also thickened by excessive noise.

7. Hearing damage : it can cause permanent hearing loss.

8.Interferences with man's communication :In noise area communication is affected.

The CPCB-The central pollution control board recommended noise levels.

| Sound Source | Sound Level dB | Subjective Feeling of Human Beings |
|---|---|---|
| Rockets and missiles, heavy explosives | 160 | Unbearable |
| Jet Planes and cannons, explosives | 140 | Unbearable |
| Aircraft Propeller and Machine Guns | 130 | Unbearable |
| Diesel, steam engine and ball mills, crackers | 120 | Unbearable |
| Electric saws and looms, heavy trucks | 110 | Unbearable |

## CONTROL MEASURES OF NOISE POLLUTION:

1. REDUCTION IN SOURCE OF NOISE : Heavy vehicles and old vehicles may not be allowed in populated areas.
2. Noise making machines should be kept in containers with sound absorbing media.
3. Proper oiling will reduce the noise from the machinery.
4. Use sound absorbing silencers: Silencers can reduce noise by absorbing sound.
5. Planting more trees having broad leaves.
6. Through law:

   sound production is minimized at various social function.
7. The use of fireworks or fire crackers shall not be permitted except between 6.00a.m and 10.00p.m.No fireworks or fire crackers shall be used between 10.00p.m and 6.00a.m.
8. Silence zone in area comprising not less than 100meters around hospitals, educational institutions ,courts and religious places.

# THERMAL POLLUTION

- **Thermal pollution** is the degradation of water quality by any process that changes ambient water temperature.
- A common cause of **thermal pollution** is the use of water as a coolant by power plants and industrial manufacturers.
- Energy is the basic necessity for the economic development of a country.
- The electrical energy is produced in power plants or generating stations. The conventional power plants are:
  - Steam or Thermal Power station,
  - Hydro-electric Power station,
  - Nuclear Power station

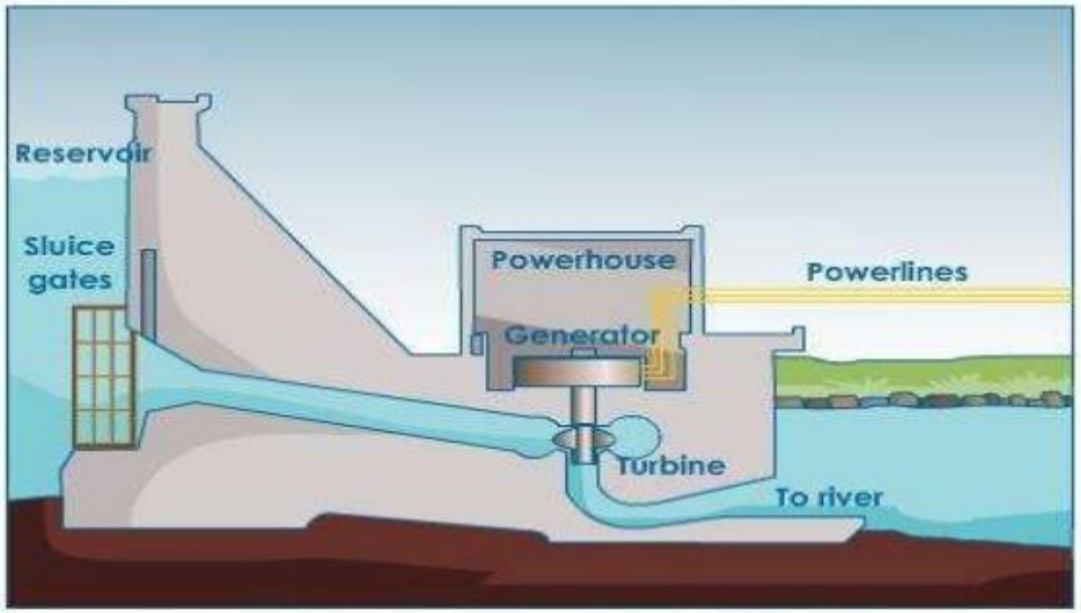
## Steam or Thermal Power station

- In the thermal power station, the steam is produced in the boiler, using the heat released by the combustion of coal, oil or natural gas.
- The steam is used to rotate the steam turbine (impulse/ reaction).
- The steam turbine drives the alternator, which converts mechanical energy into electrical energy.10-16°C higher than initial temp.

## Hydro-electric Power station

- **Hydroelectricity** is the term referring to electricity generated by hydropower.
- The production of electrical power through the use of the gravitational force of falling or flowing water.
- It is the most widely used form of renewable energy.

Once a hydroelectric complex is constructed, the project produces no direct waste, and has a considerably lower output level of the greenhouse gas & carbon dioxide ($CO_2$).




A schematic view of a hydro power plant

## Effects of thermal pollution

- Elevated temperature typically decreases the level of dissolved oxygen (DO) in water.
- Thermal pollution may also increase the metabolic rate of aquatic animals.
- Fish migration is affected due to formation of various thermal zones.
- Discharge of hot water near the shores could disturb and even kill young fishes.
- Toxicity of pesticides ,detergents and chemicals into the effluent increases with increase in temp.
- The composition of flora and fauna changes.

## Control of thermal pollution

- Thermal pollution from industrial sources is generated mostly by power plants, petroleum refineries, pulp and paper mills, chemical plants, steel mills and smelters.
- Cooling ponds, man-made bodies of water designed for cooling by evaporation, convection, and radiation.
- Cooling towers, which transfer waste heat to the atmosphere through evaporation and/or heat transfer.
- Cogeneration, a process where waste heat is recycled for domestic and/or industrial heating purposes.

## RADIO ACTIVE OR NUCLEAR POLLUTION

- The uncontrolled distribution of radioactive material in a given environment.
- Radioactive contamination is typically the result of a spill or accident during the production or use of radionuclide (radioisotopes), an unstable nucleus which has excessive energy.
- Contamination may occur from radioactive gases, liquids or particles

**Effects**

- Radioactive contamination can enter the body through ingestion, inhalation, absorption, or injection that causes discomfort, diarrhea, nausea or vomiting, and burns skin and hair loss.
- The cumulative damage can cause serious health problems long term, such as cancer, especially leukemia and Thyroid Cancer.
- For this reason, it is important to use personal protective equipment when working with radioactive materials.

**Control methods:**

- It includes the stoppage of leakage from the radioactive materials including the nuclear reactors, industries and laboratories.
- The disposal of radioactive material must be safe and secure.
- The protective garments must be worn by the workers who work in the nuclear plants.
- The natural radiation must be at the permissible limits and they must not cross it.

**SOLID WASTE MANAGEMENT:**

Each household generates garbage or waste day in and day out. There are different types of solid waste depending on their source

**Types of solid waste:** Solid waste can be classified into different types depending on their source: Household waste is generally classified as,

- Municipal waste
- Industrial waste as hazardous waste
- Biomedical waste or hospital waste
- E waste-Electronic waste

# E-Waste

**E-Waste or Electronic Waste** may be defined as discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets and refrigerators. This definition includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal.

# Composition of E-Waste

The various parts / materials / composition of e-waste may be divided broadly into **six categories** such as

- Iron and steel, used for casings and frames
- Non-ferrous metals, especially copper used in cables, and aluminium
- Glass used for screens, windows
- Plastic used as casing, in cables and for circuit boards
- Electronic components
- Others (rubber, wood, ceramic etc.).

# Need of E-Waste Management

E-waste is much more hazardous than many other municipal wastes because electronic gadgets contain thousands of components made of deadly chemicals and metals like lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominated flame retardants, beryllium, antimony and phthalates. Long-term exposure to these substances damages the nervous systems, kidney, bones, reproductive and endocrine systems. Some of them are carcinogenic and neurotoxic.

# Pollutants in E-Waste

| Pollutant | Occurrence |
|---|---|
| Arsenic | Semiconductors, diodes, microwaves, LEDs (Light-emitting diodes), solar cells |
| Barium | Electron tubes, filler for plastic and rubber, lubricant additives |
| Brominated flame-proofing agent | Casing, circuit boards (plastic), cables and PVC cables |
| Cadmium | Batteries, pigments, solder, alloys, circuit boards, computer batteries, monitor cathode ray tubes (CRTs) |
| Chrome | Dyes/pigments, switches, solar |
| Cobalt | Insulators |
| Copper | Conducted in cables, copper ribbons, coils, circuitry, pigments |
| Lead | Lead rechargeable batteries, solar, transistors, lithium batteries, PVC |
| | (polyvinyl chloride) stabilizers, lasers, LEDs, thermoelectric elements, circuit boards |
| Liquid crystal | Displays |
| Lithium | Mobile telephones, photographic equipment, video equipment (batteries) |
| Mercury | Components in copper machines and steam irons; batteries in clocks and pocket calculators, switches, LCDs |
| Nickel | Alloys, batteries, relays, semiconductors, pigments |
| PCBs (polychlorinated biphenyls) | Transformers, capacitors, softening agents for paint, glue, plastic |
| Selenium | Photoelectric cells, pigments, photocopiers, fax machines |
| Silver | Capacitors, switches (contacts), batteries, resistors |
| Zinc | Steel, brass, alloys, disposable and rechargeable batteries, luminous substances |

# Impact of hazardous substances on health and environment

| Metal | Danger |
|---|---|
| Lead | A neurotoxin that affects the kidneys and the reproductive system. High quantities can be fatal. It affects mental development in children. Mechanical breaking of CRTs (cathode ray tubes) and removing solder from microchips release lead as powder and fumes. |
| Plastics | Found in circuit boards, cabinets and cables, they contain carcinogens. BFRs or brominated flame retardants give out carcinogenic brominated dioxins and furans. Dioxins can harm reproductive and immune systems. Burning PVC, a component of plastics, also produces dioxins. BFR can leach into landfills. Even the dust on computer cabinets contains BFR. |
| Chromium | Used to protect metal housings and plates in a computer from corrosion. Inhaling hexavalent chromium or chromium 6 can damage liver and kidneys and cause bronchial maladies including asthmatic bronchitis and lung cancer. |
| Mercury | Affects the central nervous system, kidneys and immune system. It impairs foetus growth and harms infants through mother's milk. It is released while breaking and burning of circuit boards and switches. Mercury in water bodies can form methylated mercury through microbial activity. Methylated mercury is toxic and can enter the human food chain through aquatic. |
| Beryllium | Found in switch boards and printed circuit boards. It is carcinogenic and causes lung diseases. |
| Cadmium | A carcinogen. Long-term exposure causes *Itai-itai* disease, which causes severe pain in the joints and spine. It affects the kidneys and softens bones. Cadmium is released into the environment as powder while crushing and milling of plastics, CRTs and circuit boards. Cadmium may be released with dust, entering surface water and groundwater. |
| Acid | Sulphuric and hydrochloric acids are used to separate metals from circuit boards. Fumes contain chlorine and sulphur dioxide, which cause respiratory problems. They are corrosive to the eye and skin. |

# E-Waste Disposal Methods

**1. Landfilling**

This is the most common methodology of e-waste disposal. Soil is excavated and trenches are made for burying the e-waste in it. An impervious liner is made of clay or plastic with a leachate basin for collection and transferring the e-waste to the treatment plant. However, landfill is not an environmentally sound process for disposing off the e-waste as toxic substances like cadmium, lead and mercury are released inside the soil and ground water.

**2. Acid Bath:**

Acid bath involves soaking of the electronic circuits in the powerful sulphuric, hydrochloric or nitric acid solutions that free the metals from the electronic pathways. The recovered metal is used in the manufacturing of other products while the hazardous acid waste finds its ways in the local water sources.

# E-Waste Disposal Methods

**3. Incineration**

This is a controlled way of disposing off the e-waste and it involves combustion of electronic waste at high temperature in specially designed incinerators. This e-waste disposal method is quite advantageous as the waste volume is reduced extremely much and the energy obtained is also utilized separately. However, it is also not free from disadvantages with the emission of the harmful gases mercury and cadmium in the environment

**4. Recycling of e-waste**

Mobile phones, monitors, CPUs, floppy drives, laptops, keyboards, cables and connecting wires can be re-utilized with the help of the recycling process. It involves dismantling of the electronic device, separation of the parts having hazardous substances like CRT, printed circuit boards etc. and then recovery of the precious metals like copper, gold or lead can be done with the help of the efficient a powerful e-waste recycler. The most crucial thing here is choosing the right kind of recycler that does not break laws and handle the e-waste in the eco-friendly manner.

# E-Waste Disposal Methods

**5. Reuse of electronic devices**

This is the most desirable e-waste recycling process where with slight modifications the mobile phones, computers, laptops, printers can be reused or given as second hand product to the other person. The old electronic equipment can also be donated in the various charity programs and thus helping the persons in need. Moreover, there is a better way also by selling the old mobile phones or laptops to the some recycling and refurbishing companies. Several websites are acting as the middleman between recyclers and electronic users. It is a win-win situation for the users as they not only get rid off the old mobile phones but also get paid after reselling it.