Energy and Environment Engineering

Dr K D Yadav

Professor

Environmental Engineering Section

Department of Civil Engineering

S. V. National Institute of Technology, Surat

Mobile: +91-9428398266

E mail: kdy@ced.svnit.ac.in

Energy and Environmental Engineering

	L	T	P	Credit
CEME 106 S1				
CEME 106 S2	**3**	**0**	**2**	**04**

- **ENVIRONMENT AND ECOSYSTEMS** **(12 hours)**

  Introduction: Concept of an ecosystem- structure and functions of ecosystem. Components of ecosystem - producers, consumers, decomposers, Food chains, food webs, ecological pyramids, Energy flow in ecosystem. Bio-geo- chemical cycles, Hydrologic cycle Components of Environment and their relationship, Impact of technology on environment, Environmental degradation. Environmental planning of urban network services such as water supply, sewerage, solid waste management.

- **ENVIRONMENTAL POLLUTION** **(10 hours)**

  Water, air, soil, noise, thermal and radioactive, marine pollution: sources, effects and engineering control strategies. Drinking water quality and standards, Ambient air and noise quality standards

- **GLOBAL ENVIRONMENTAL ISSUES AND ITS MANAGEMENT (8 hours)**

  Engineering aspects of climate change. Acid rain, depletion of ozone layer. Concept of carbon credit. Concepts of Environmental impact assessment and Environmental audit. Environmental life cycle assessment

- **ENERGY FUNDAMENTALS** **(8 hours)**

  Energy systems.Importance of energy. Quantifying energy, types of energy sources and end uses. Energy conversion processes.Conventional energy sources.Non-conventional energy sources.

- **ENERGY AND THE ENVIRONMENT** **(7 hours)**

  Global and Indian energy demand and growth. Environmental impacts of energy production – air and water. Climate change and energy.Energy and environment policy.Transportation and energy. Built environment and energy

(Total Lecture Hours: 42)

REFERENCES:

1. Daniel B Botkin& Edward AKeller,Environmental Sciences, John Wiley & Sons
2. R. Rajagopalan, Environmental Studies, Oxford UniversityPress
3. Benny Joseph,Environmental Studies, TMHpublishers
4. Dr. Suresh K Dhameja,Environmental Studies, S K Kataria& Sons, 2007

(David Orr,1991)- If today is the typical day on planet earth

We will lose 116 square miles of rainforest or about an acre a second

We will lose 72 square miles of land to encroaching deserts

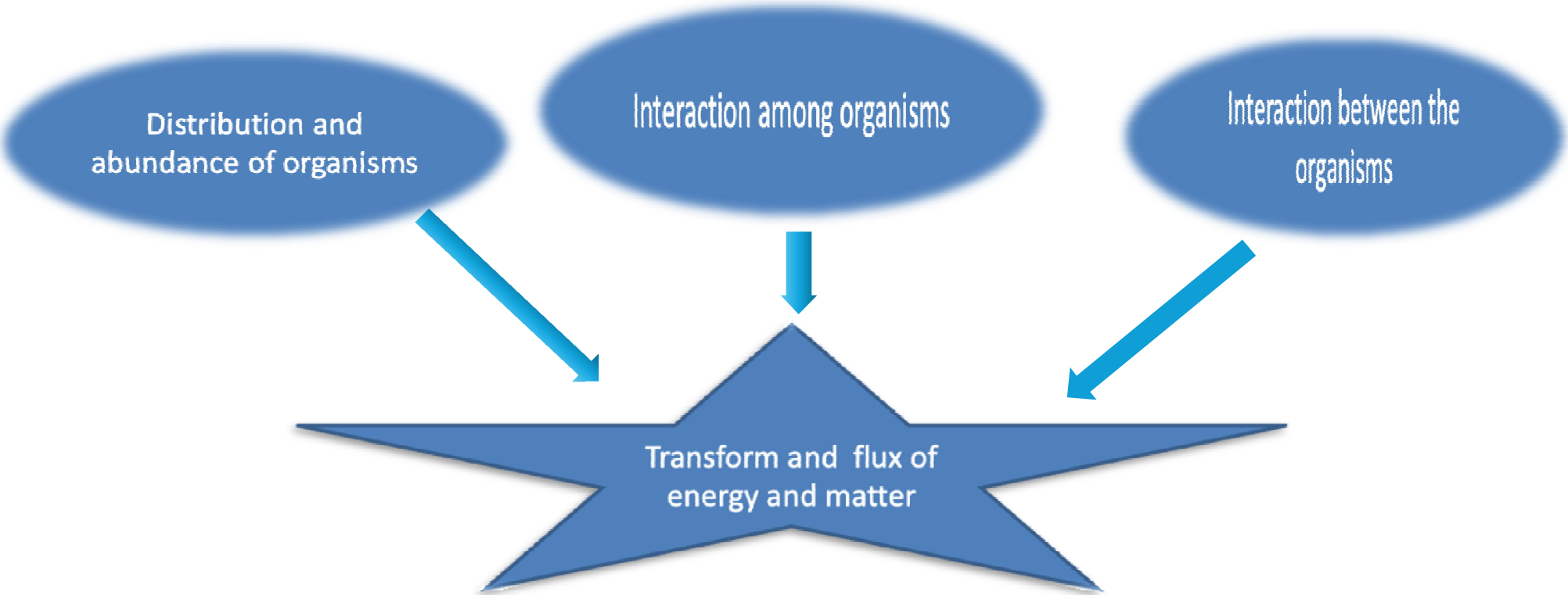
We may lose 40 to 100 species, this is we are talking about a typical day on planet

ECOLOGY

Definition:

- it is defined as the scientific study of the processes influencing the **distribution and abundance of organisms, the interactions among organisms and the interactions between organisms and the transformation and flux of energy and matter** - Ernst Haeckel (1866)

- It emphasizes both **living and non-living components** of the natural world.



Introduction

Ecosystem is a community of living organisms in conjunction with the nonliving components of their environment, interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows.

Boundary of ecosystem:

- **Ecosystem is a region in which the organisms and the physical environment** form an **interacting unit**. Within an ecosystem there is a complex network of interrelationships.
- E.g tree, pond --- simple ecosystems. Forest ecosystem

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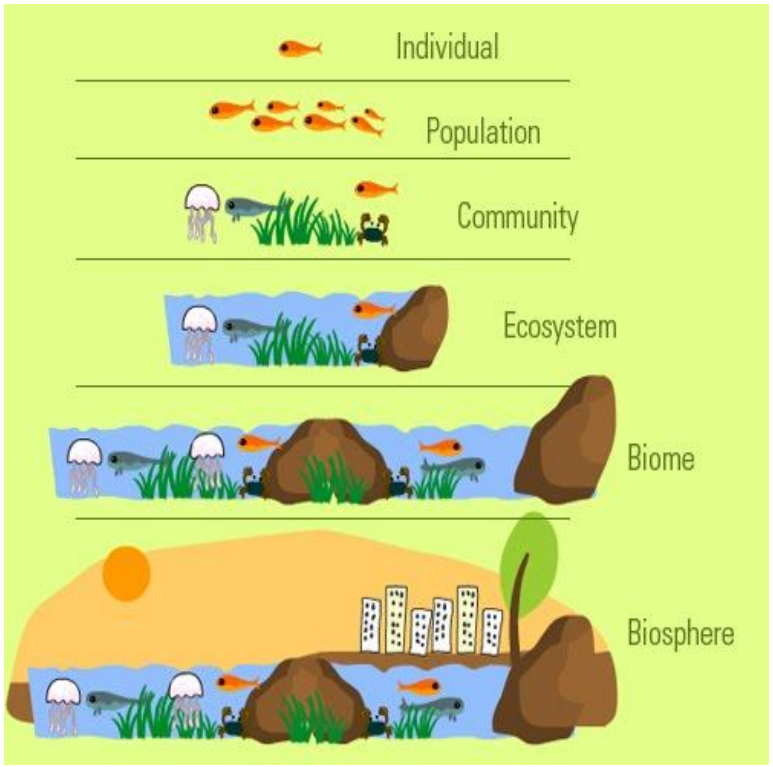
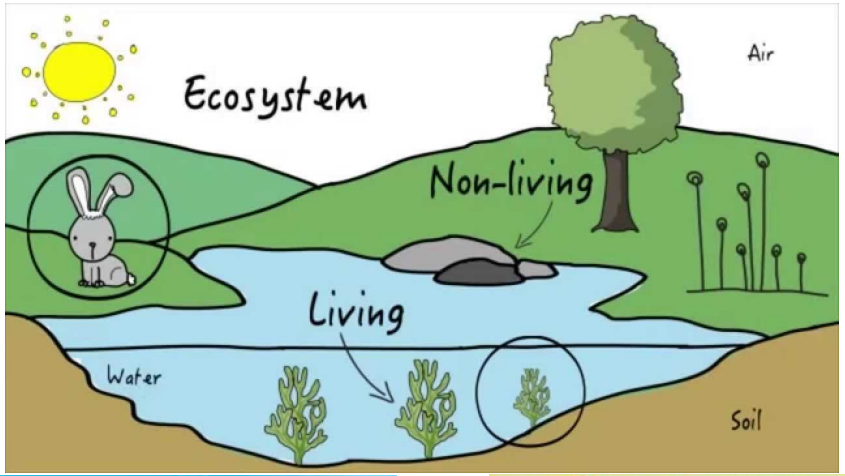
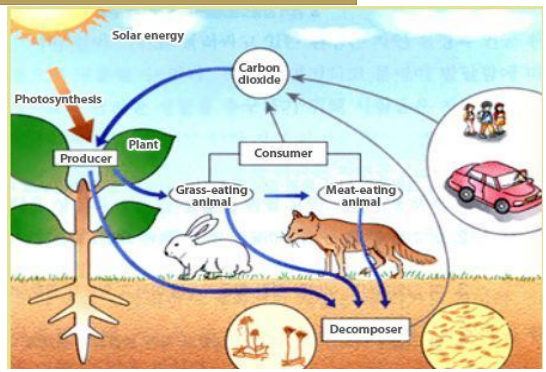
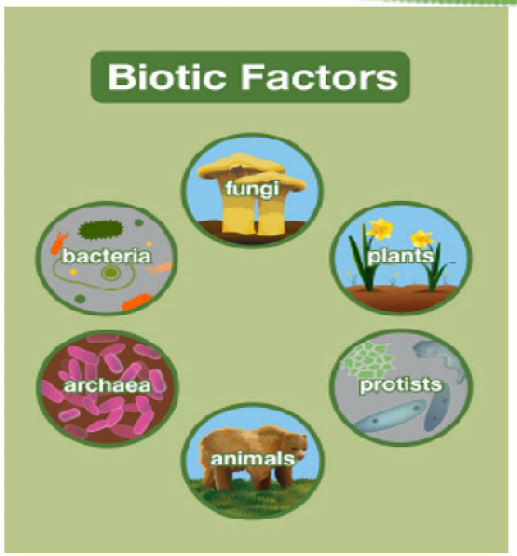




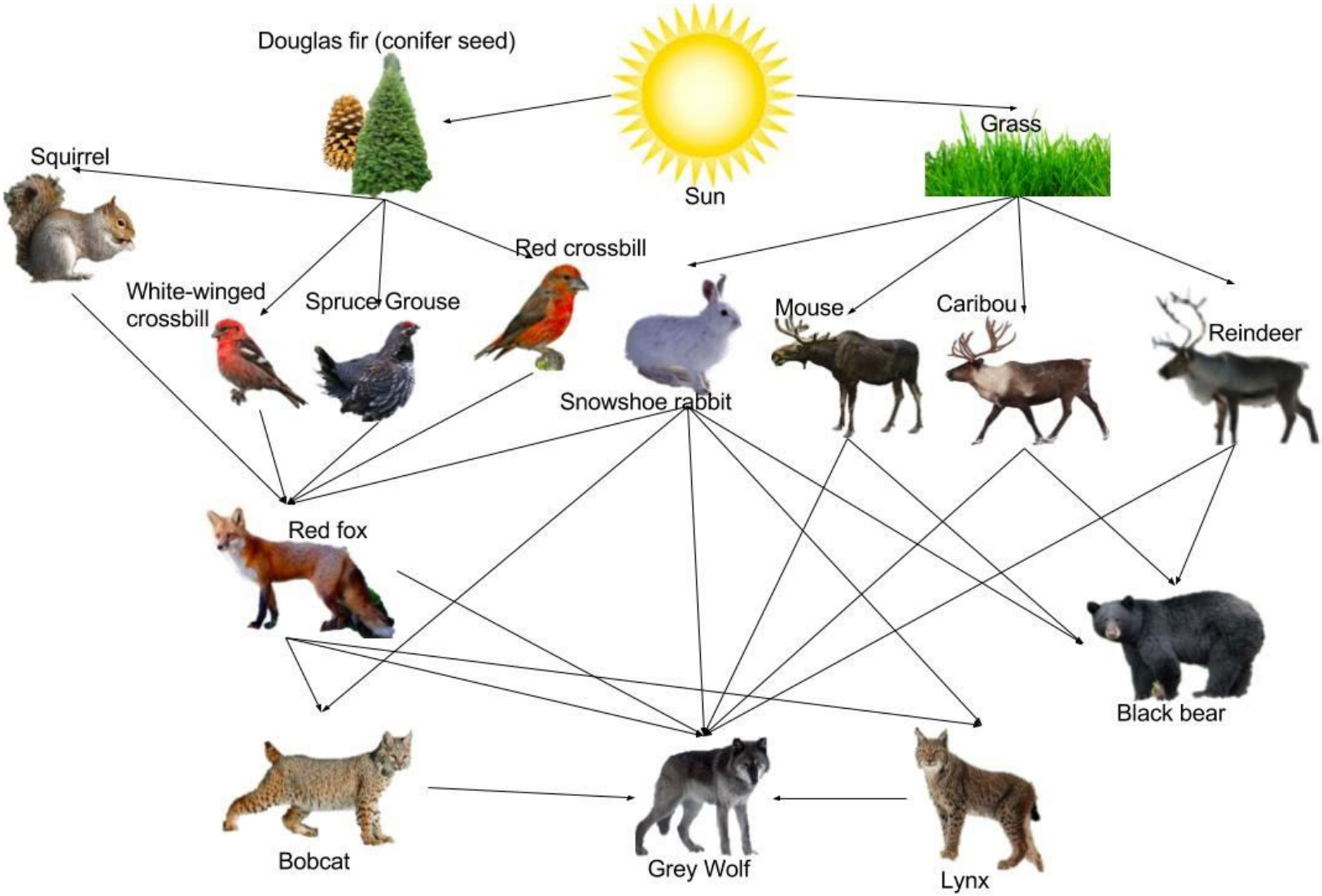


Ecosystem


Plants
Animals
Micro-organisms
Environment
Biotic (living)
Interactions
Physical and Chemical
Abiotic (non-living)
Energy and matter flow/transform


Biotic Factors
fungi
bacteria
plants
archaea
protists
animals


Abiotic Factors
air
salinity
soil
temperature
light
water
minerals
pH
humidity


Douglas fir (conifer seed)
Sun
Grass
Squirrel
Red crossbill
White-winged crossbill
Spruce Grouse
Snowshoe rabbit
Mouse
Caribou
Reindeer
Red fox
Black bear
Bobcat
Grey Wolf
Lynx

Biotic Components of Ecosystems:

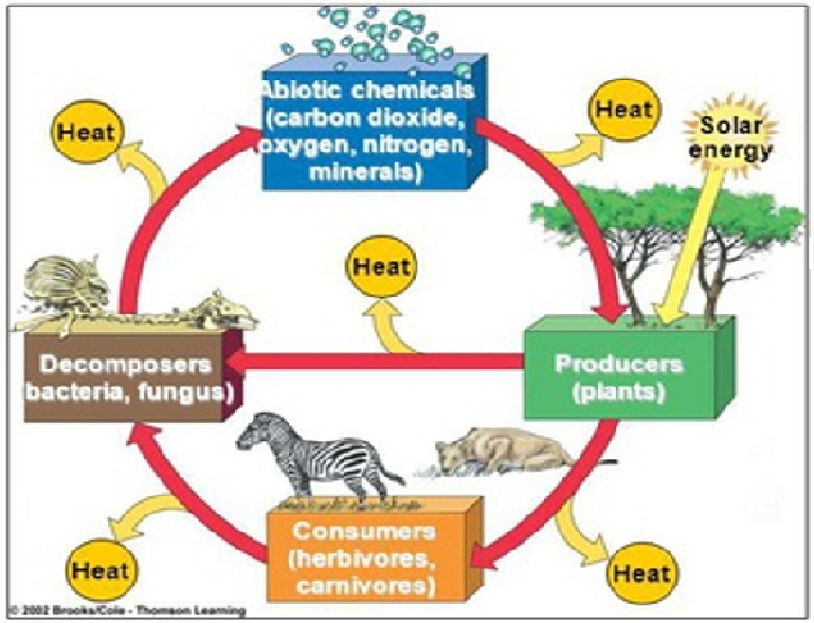
Producers (autotrophs)

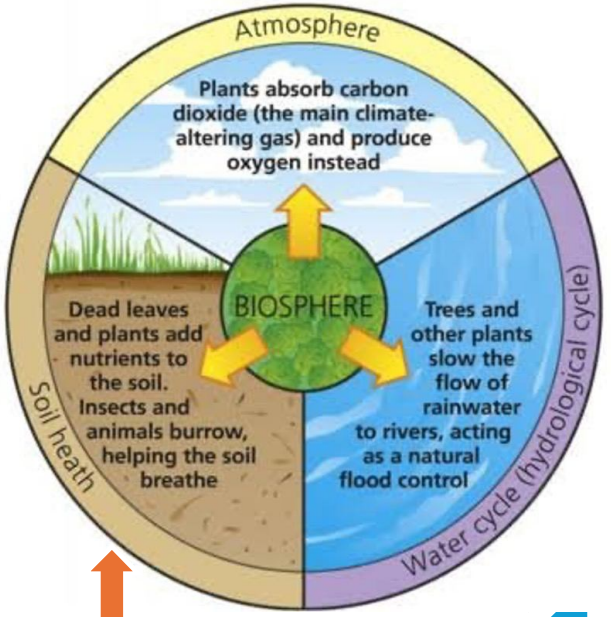
-photosynthesis

Consumers (heterotrophs)

-respiration

Decomposers





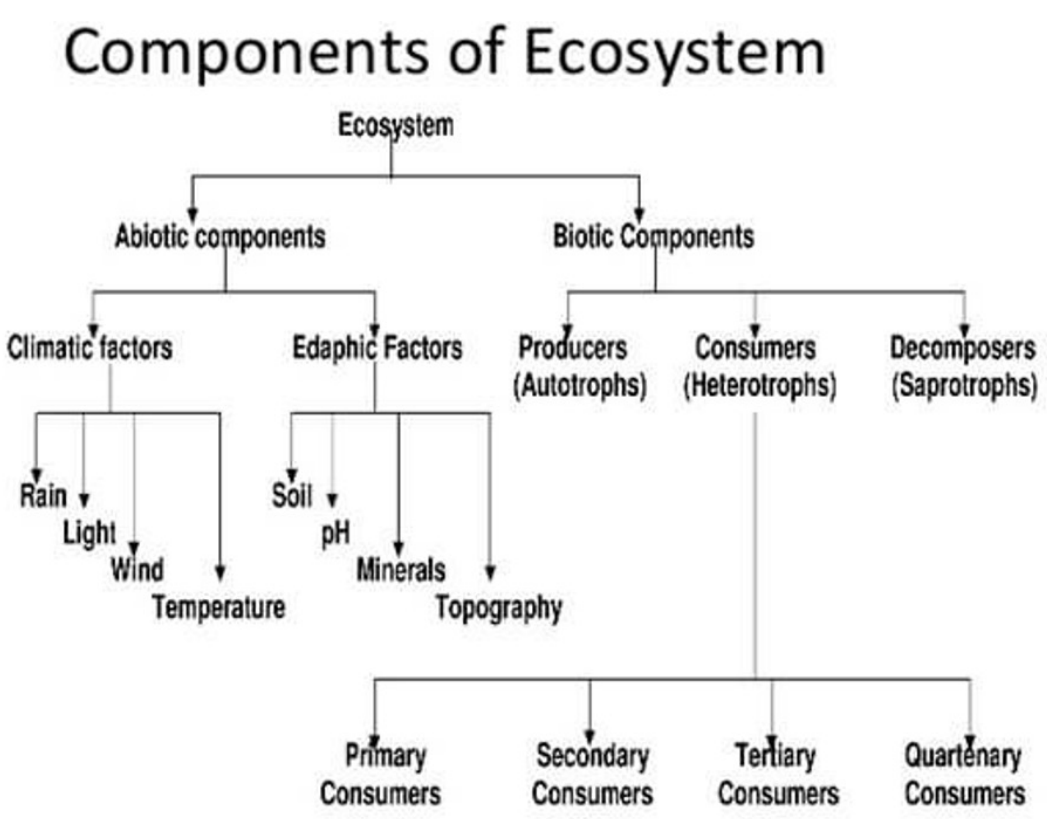
Biotic components of ecosytem

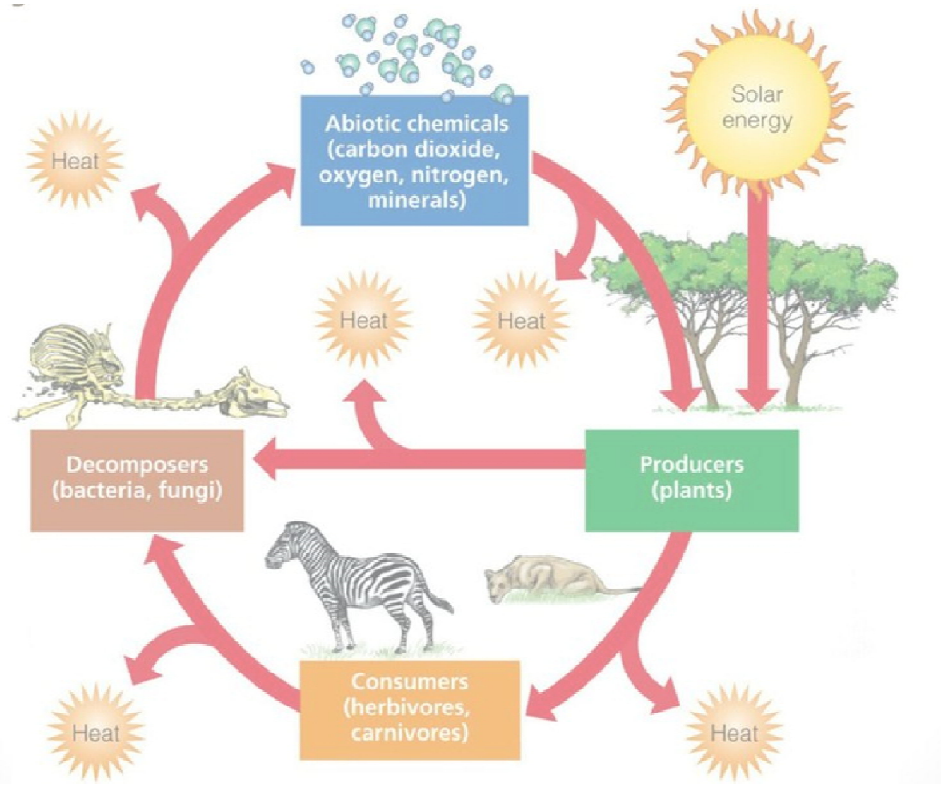
Producers are any kind of green plant. Green plants make their food by taking sunlight and using the energy to make sugar.

Consumers have to feed on producers or other **consumers** to survive. Consumer in a food chain are living creatures that eat organisms from a different population.

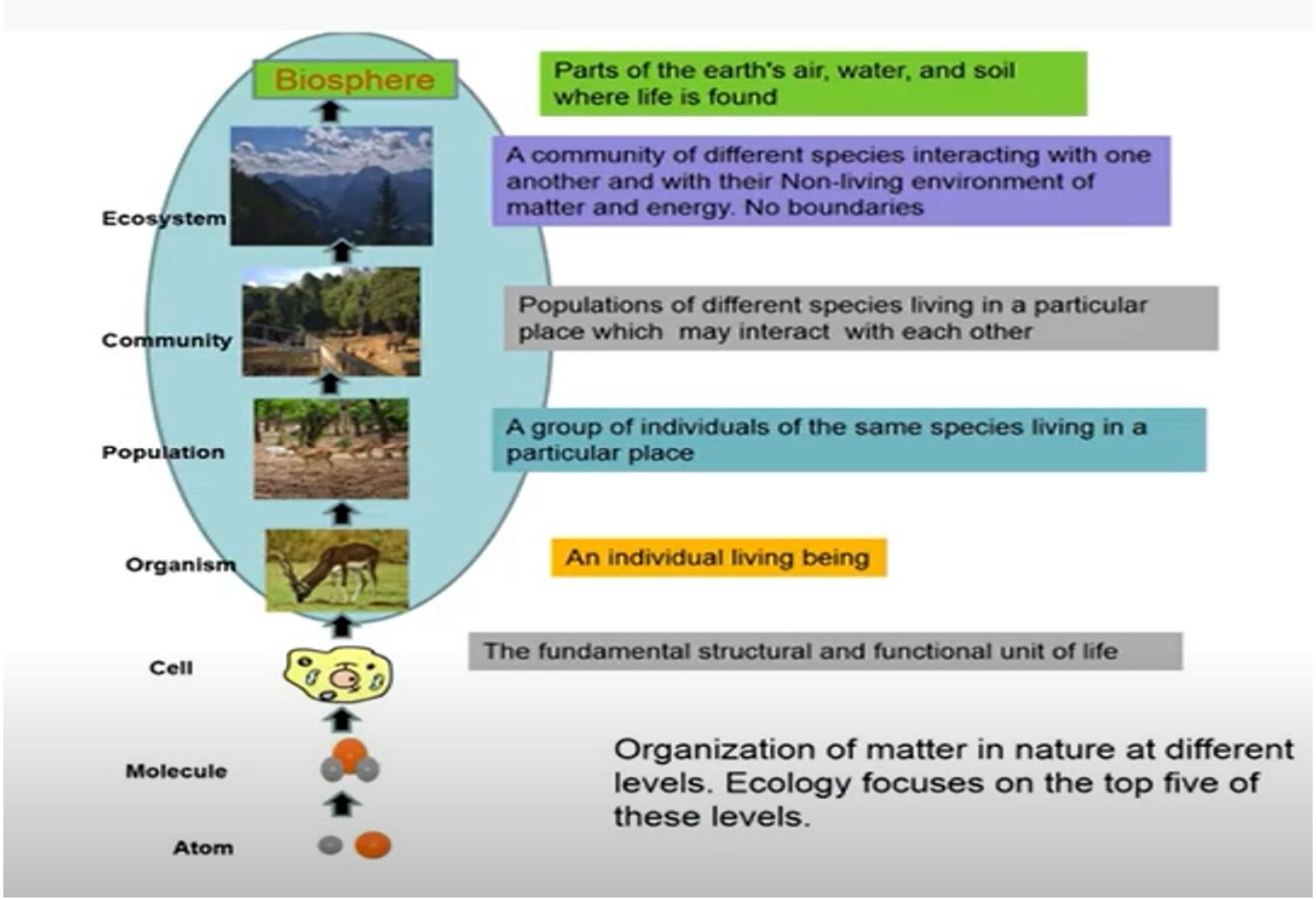
Decomposer is an organism that breaks down organic materials from dead organisms to obtain energy. These organisms are basically living recycling plants. **Fungi**, worms, and **bacteria** are all examples

Structure Components of ecosystem

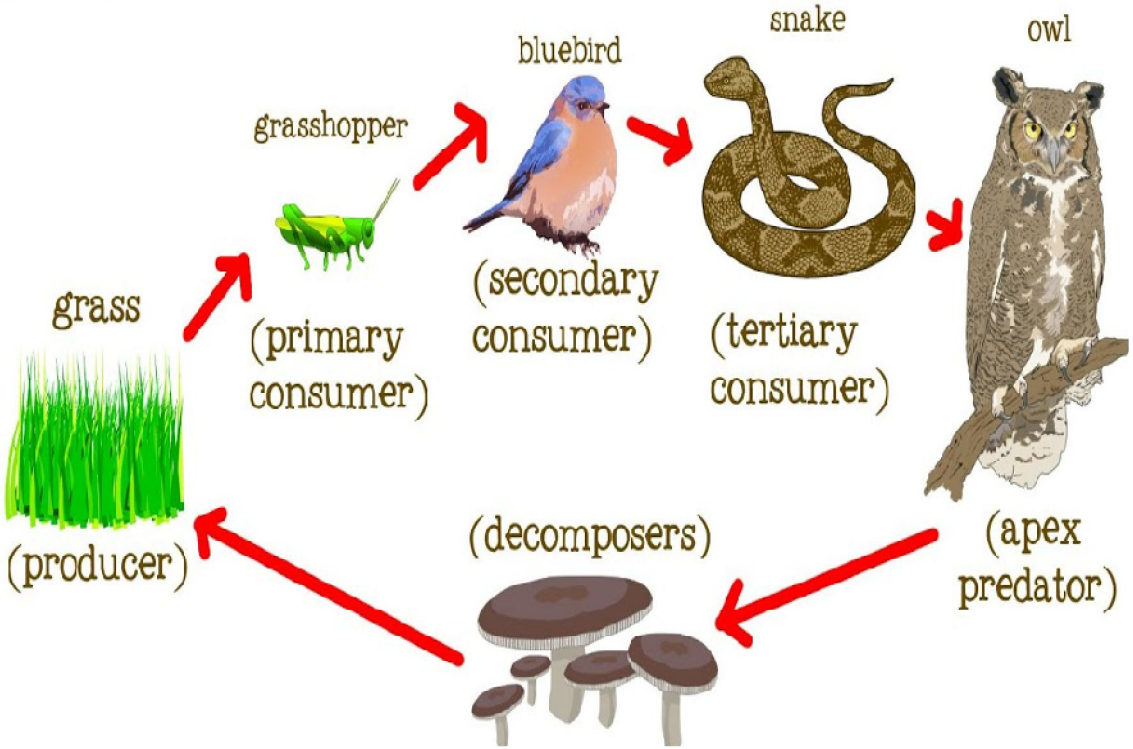


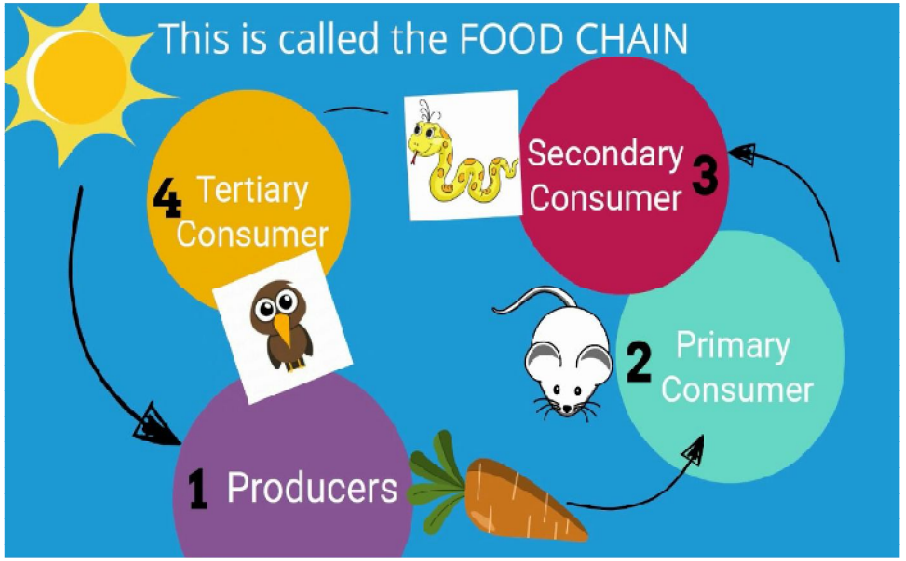


Levels of ecosystem

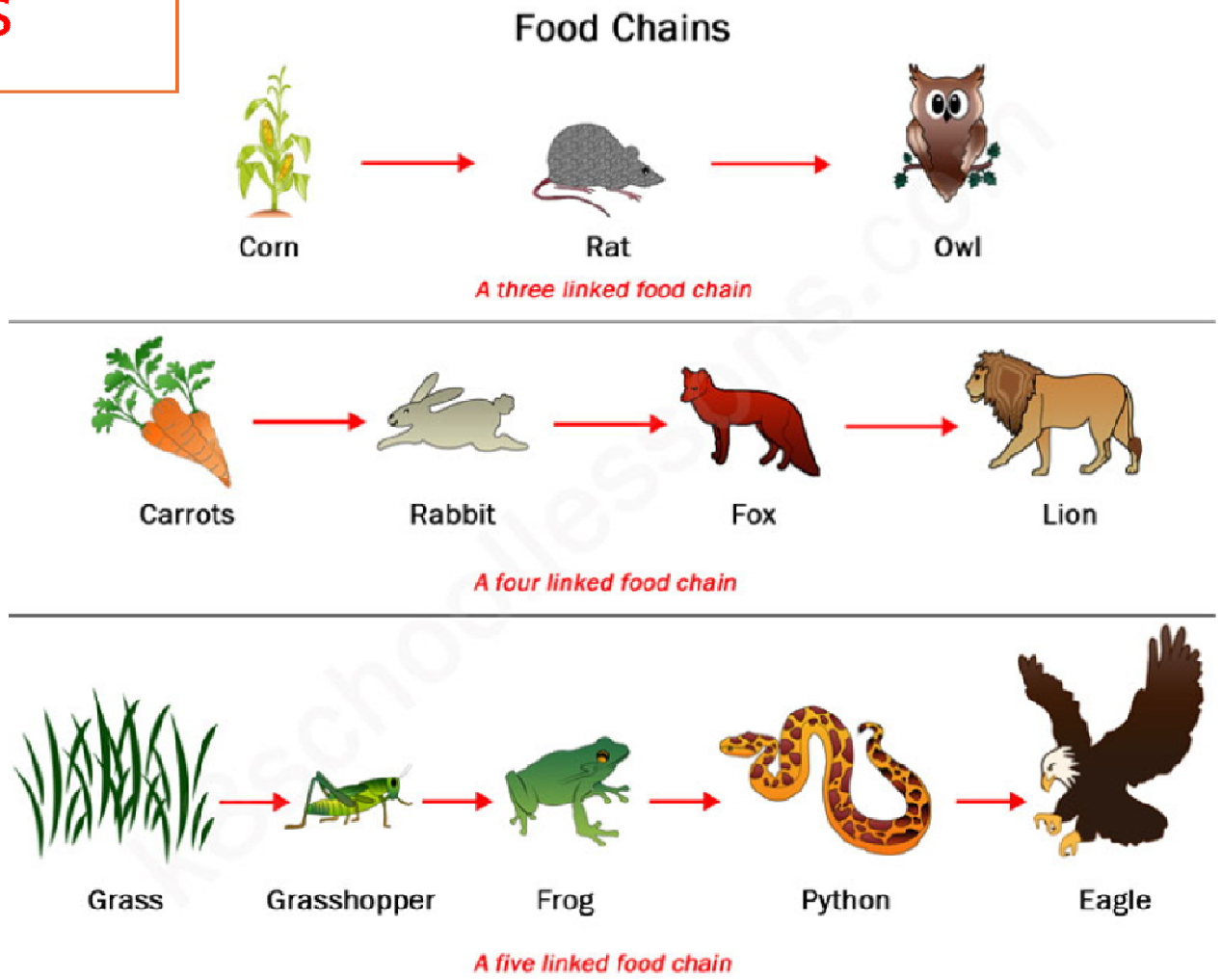


Food Chains

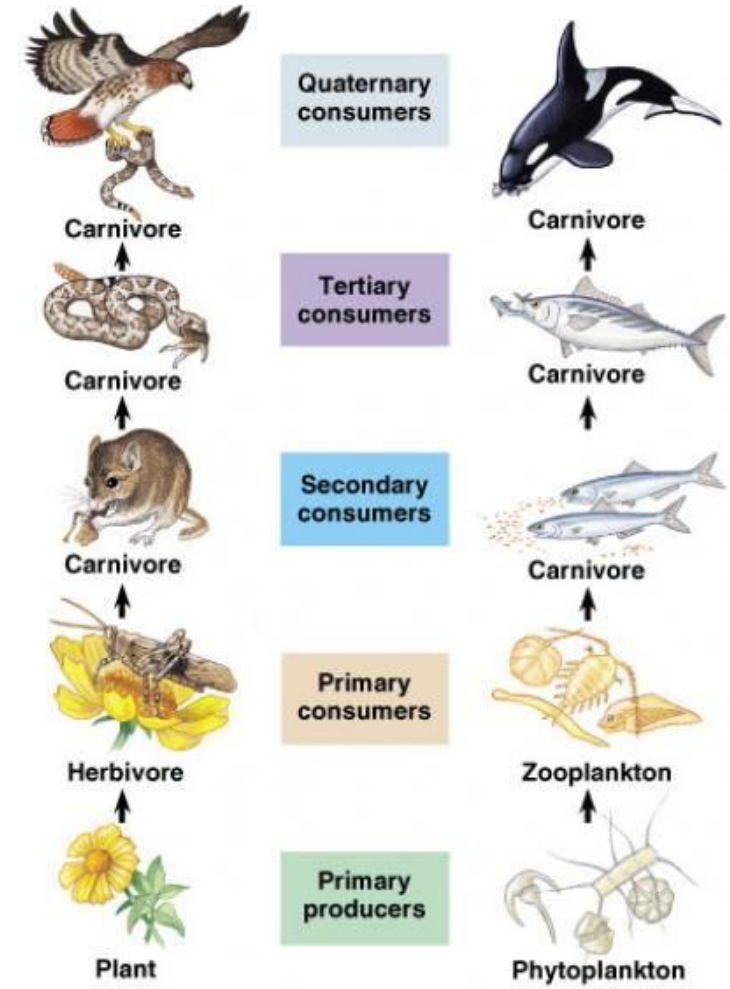

grass
(producer)
grasshopper
(primary consumer)
bluebird
(secondary consumer)
snake
(tertiary consumer)
owl
(apex predator)
(decomposers)

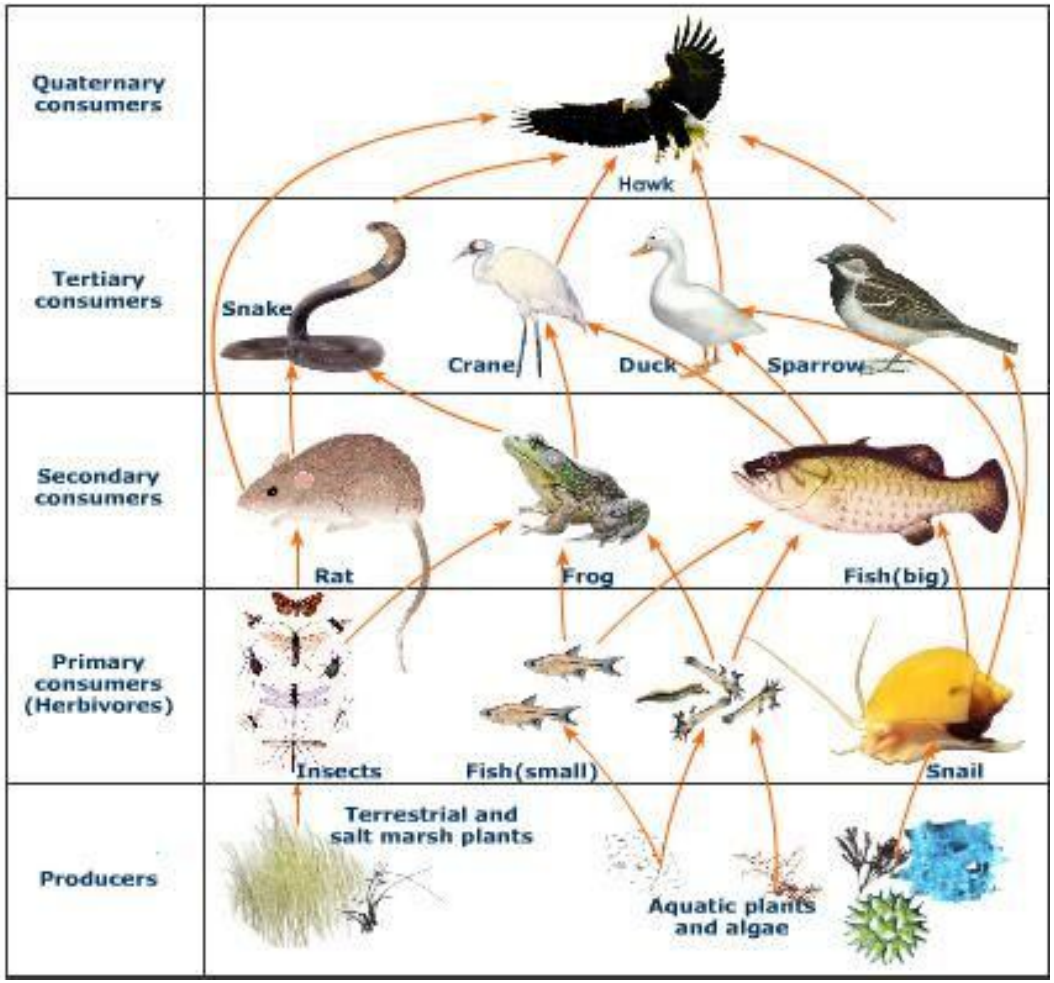

This is called the FOOD CHAIN
4 Tertiary Consumer
Secondary Consumer 3
2 Primary Consumer
1 Producers

Food Chains


Food Chains
Corn
Rat
Owl
A three linked food chain
Carrots
Rabbit
Fox
Lion
A four linked food chain
Grass
Grasshopper
Frog
Python
Eagle
A five linked food chain

Food Chains

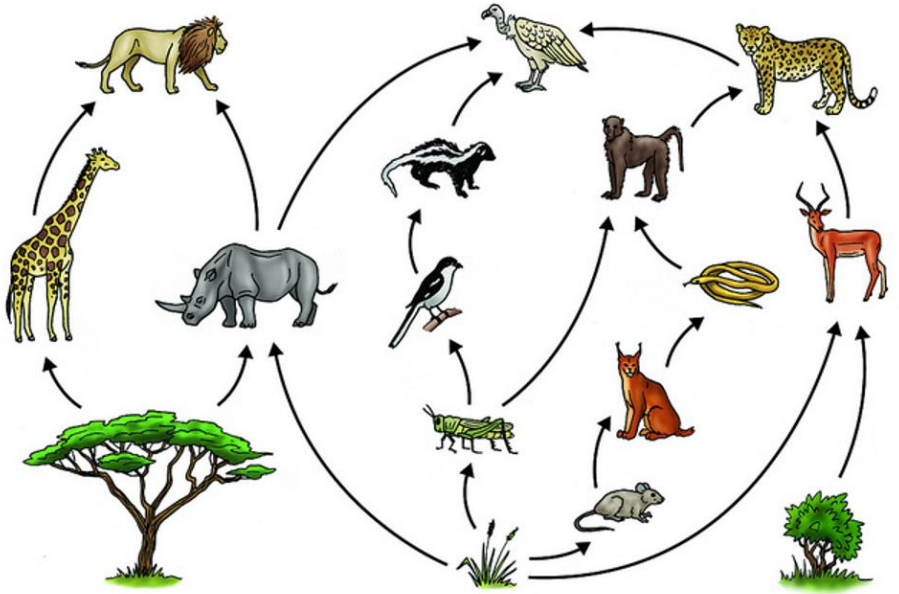




Food chain

Food Chain:

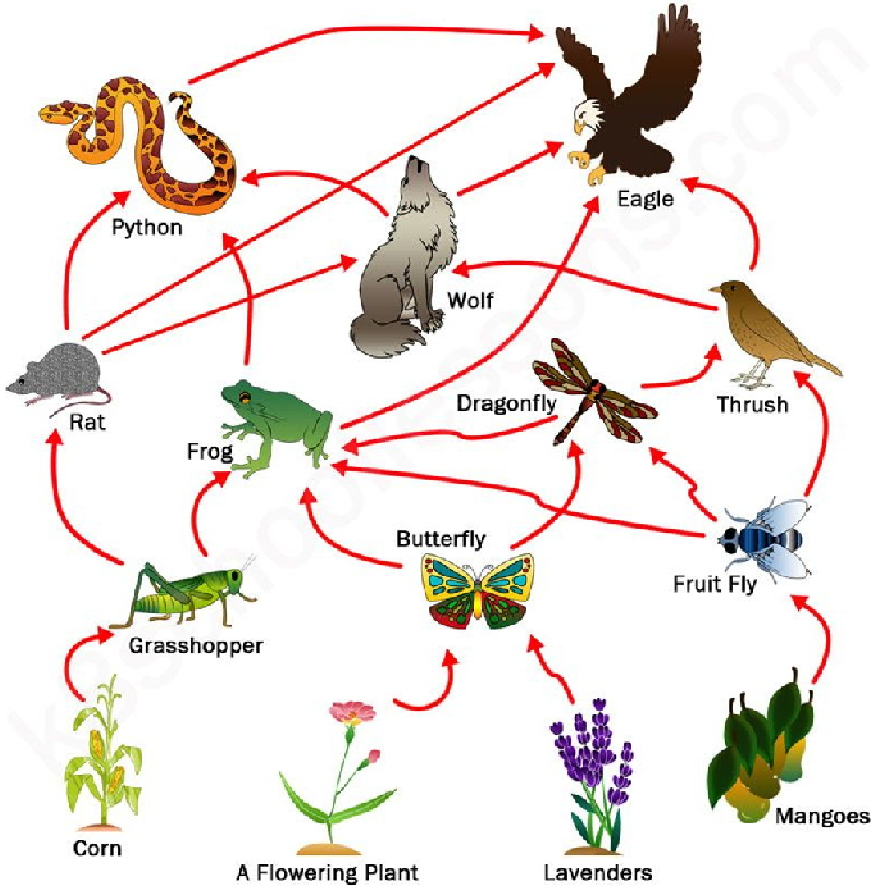
- In food chain every organism eats the smaller organism and is eaten by the larger one. All those organisms which are interlinked by means of food together formulate food chain.
- Various species in a food chain are known as trophic levels. Every food chain has three principle trophic levels viz. producers, consumers and decomposers.



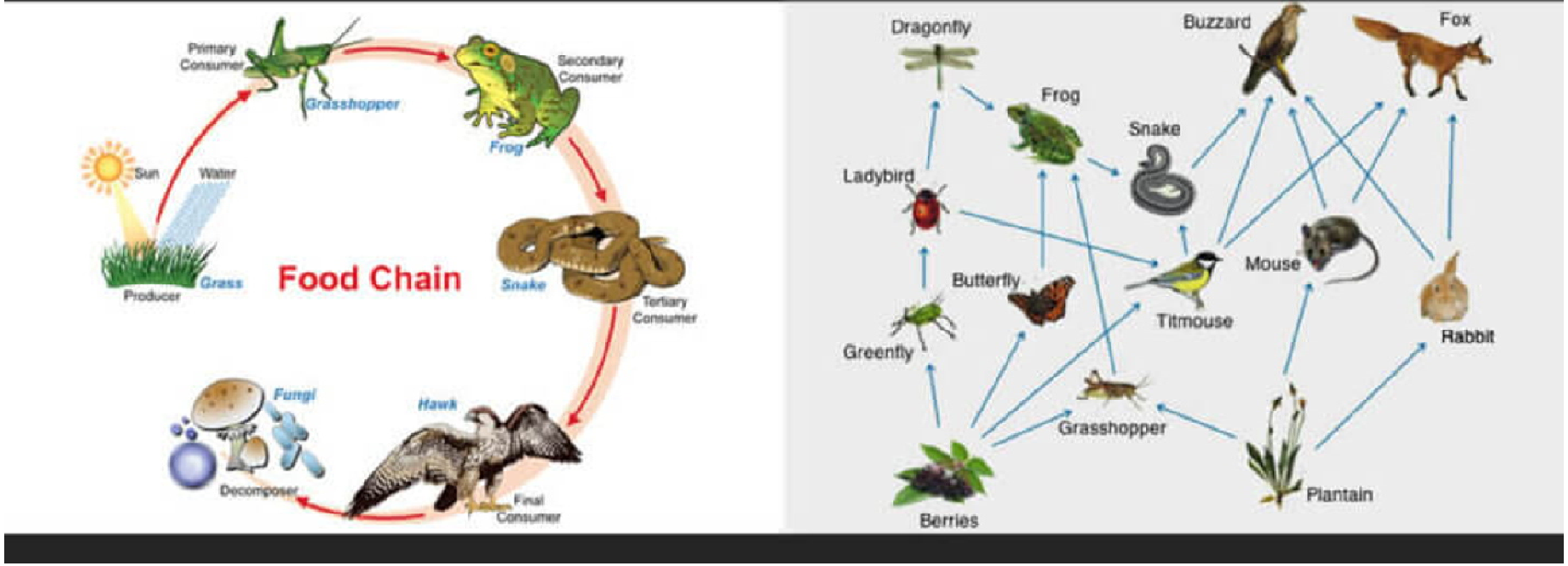
Food Web

Food Web:

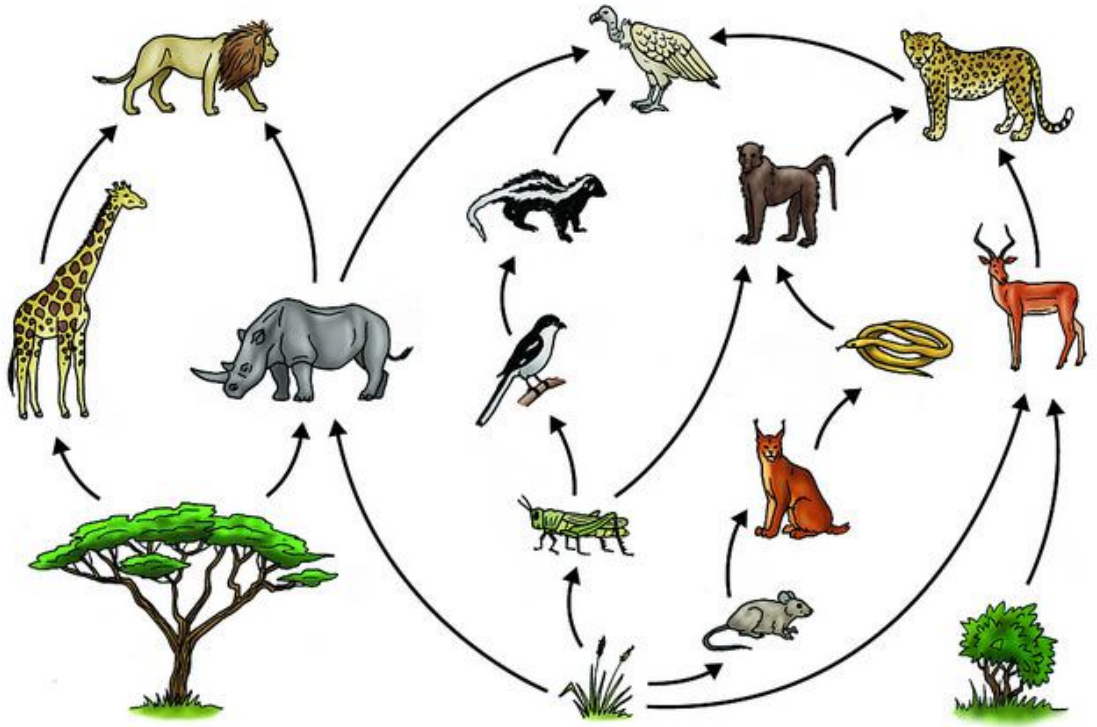
- Different food chains are usually linked at various trophic levels to form complex interaction amongst various species from the point of view of food. This network like interaction is known as the food web.
- If any intermediate stage of food chain is removed then succeeding links of the food chain will be affected.
- The food web provides greater than one alternatives of food to majority of the organisms in an ecosystem, thus, increases their chances of survival.



Food Chain VS Food Web



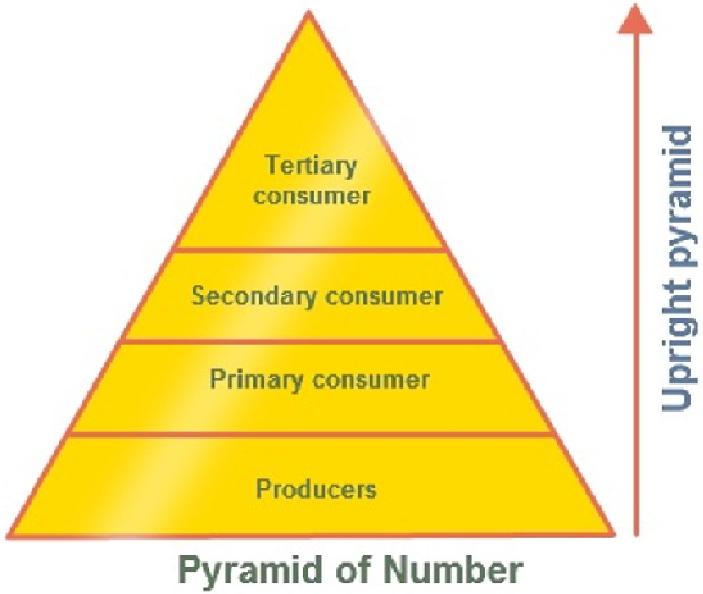
Food Chain and Web



Ecological Pyramids

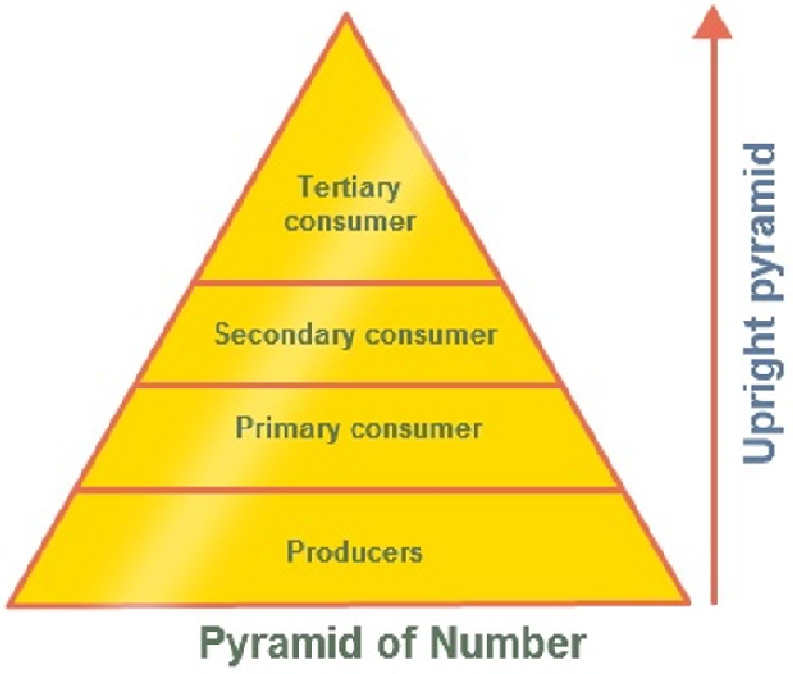
- Graphic representation of trophic structure and function of ecosystem, starting with producers at the base and successive trophic levels at the apex is known as ecological pyramid
- They are of 3 types:

1) Pyramids of numbers
2) Pyramids of Biomass
3) Pyramids of Energy



Pyramids of Numbers

- It represents the **number of individual** organisms at each trophic level of a food chain per unit area at any time
- Generally represented by number per sq.m
- It can be upright or inverted depending upon type of ecosystem and food chain



Drawbacks

- The pyramid does not take into account **size of individual organism** i.e all organisms are considered equal in size
- **Number of individuals** in a trophic level depends upon the **availability of biomass**
- For example, a tree supports several insects but several trees will support a single elephant or herbivore

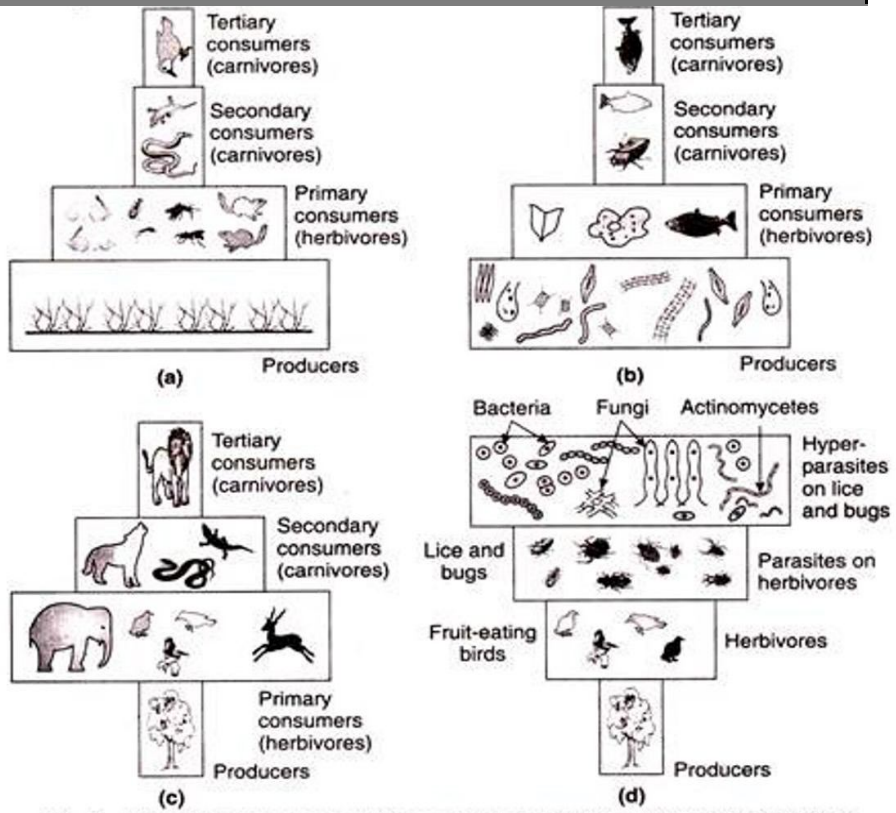
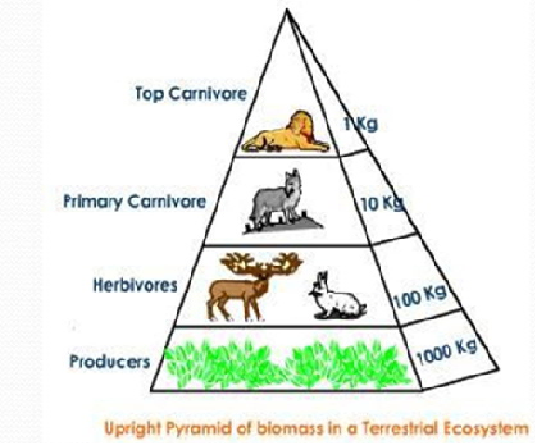


Fig. 6. Pyramid of numbers (a) Grassland ecosystem, (b) Pond ecosystem, (c) Forest ecosystem and (d) Parasitic food chain.

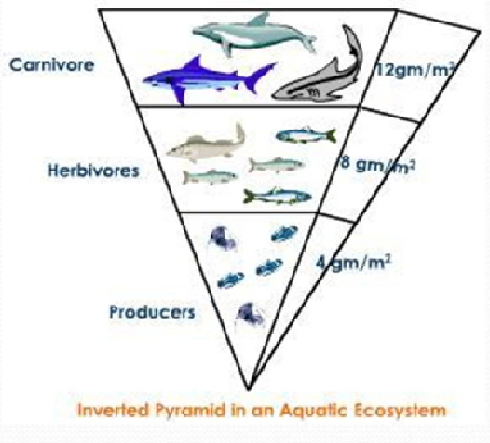
Pyramid of Biomass

- It is based upon the total biomass at each trophic level in the food chain
- It can also be **inverted or upright**
- It is represented by grams/ sq.m i.e dry matter available

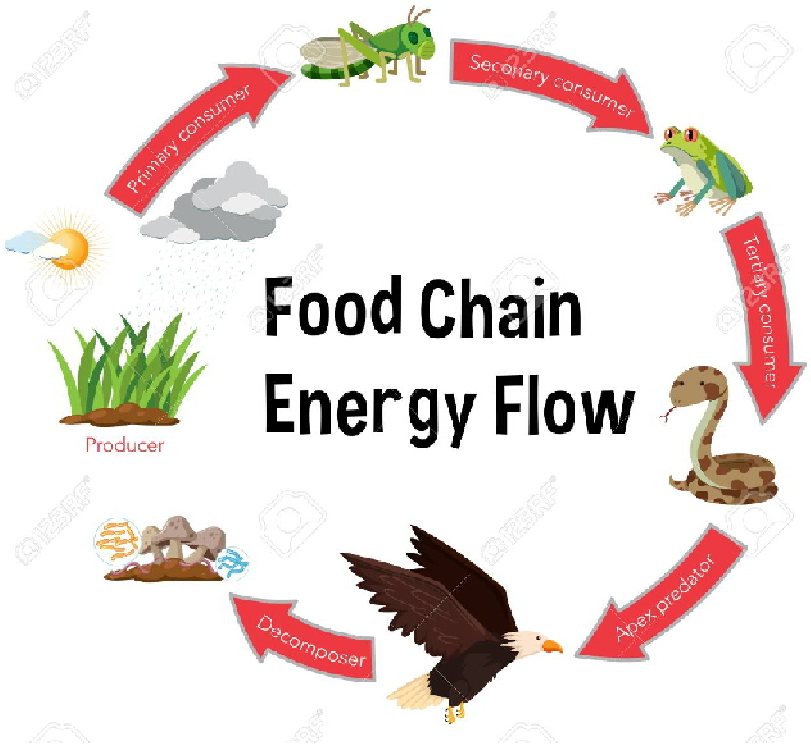
Pyramids of Biomass cont.

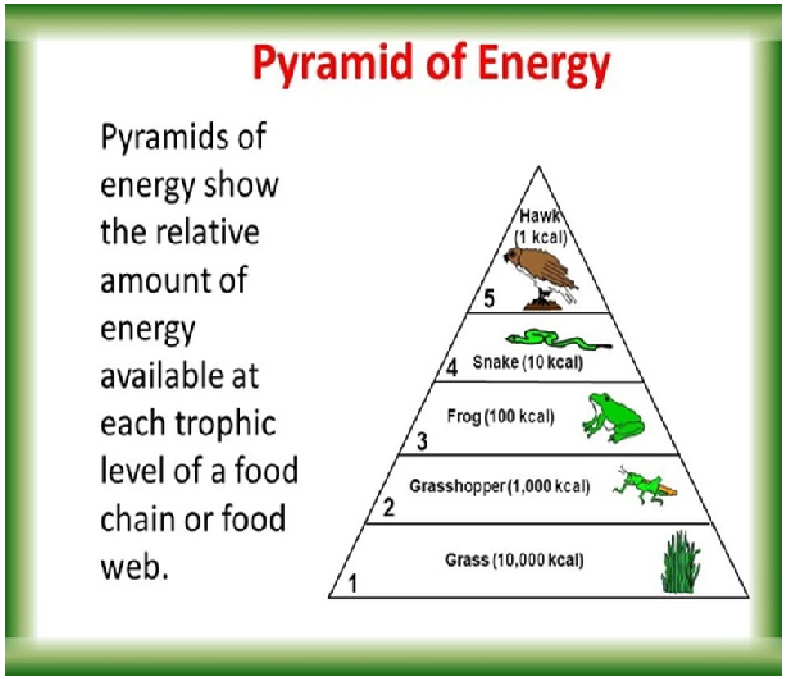


Upright



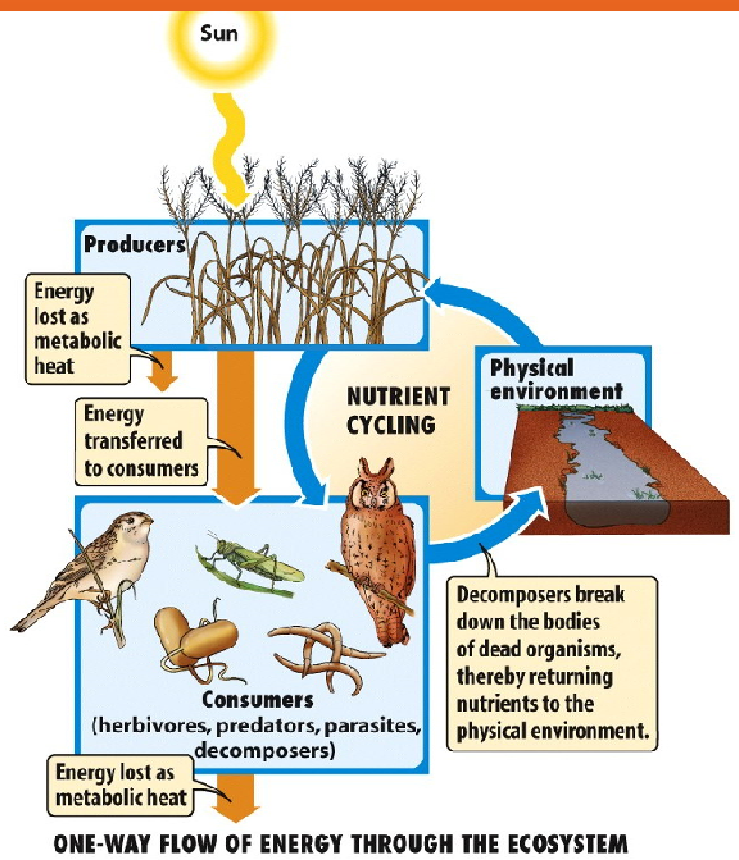
Inverted

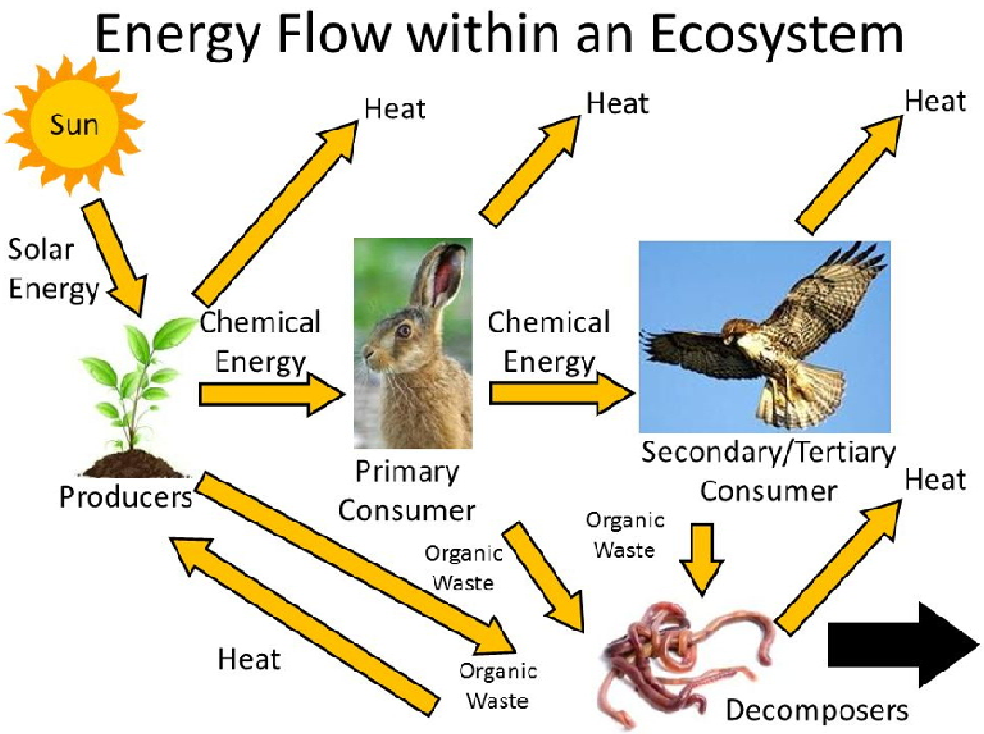




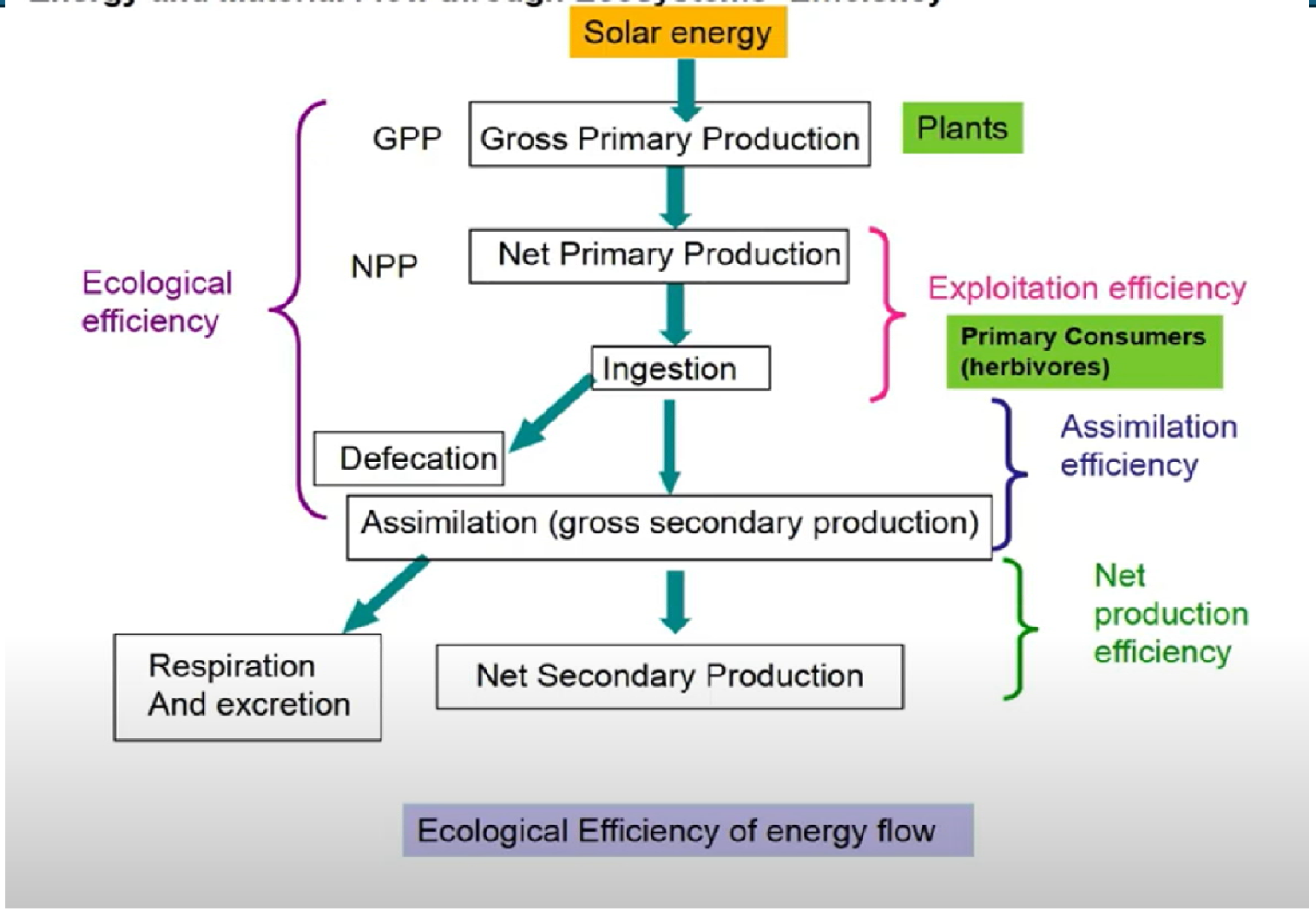
- Energy Pyramid
- The greatest amount of energy is found at the base of the pyramid.
- The least amount of energy is found at top of the pyramid.
- **Energy pyramids can never be inverted.**

Energy Flow in ecosystem





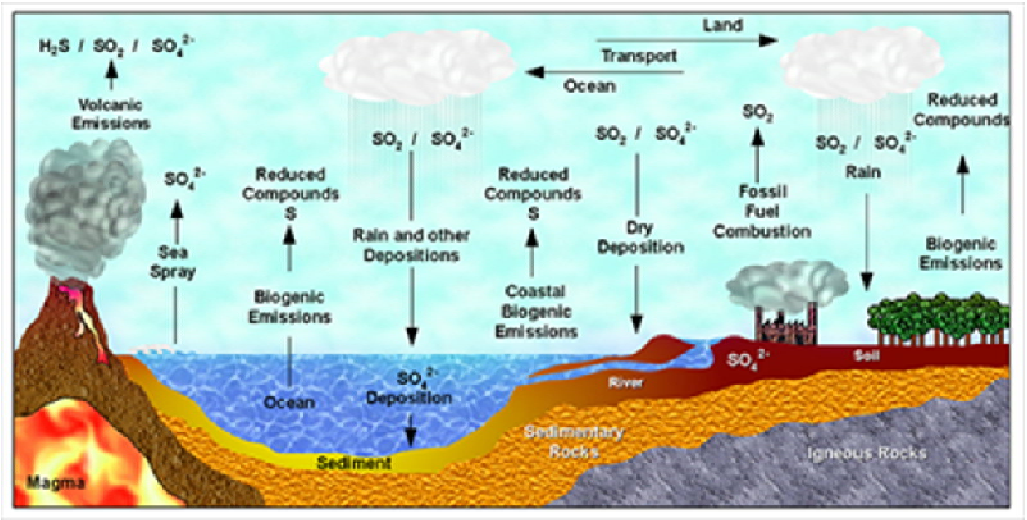
Energy and Material Flow through Ecosystems- Efficiency

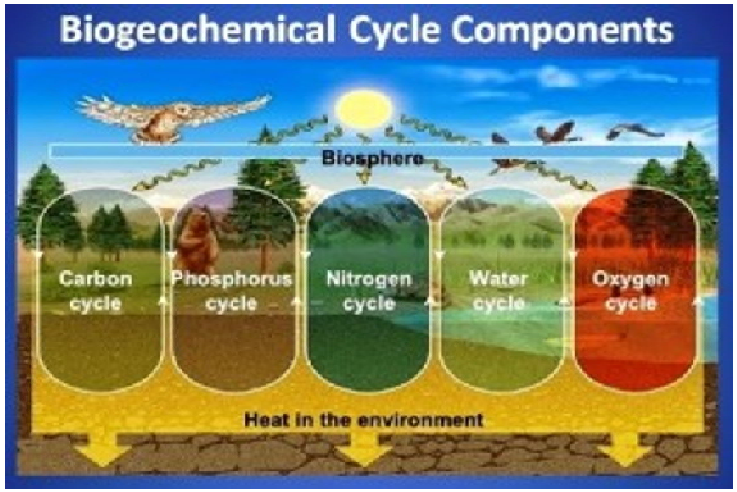


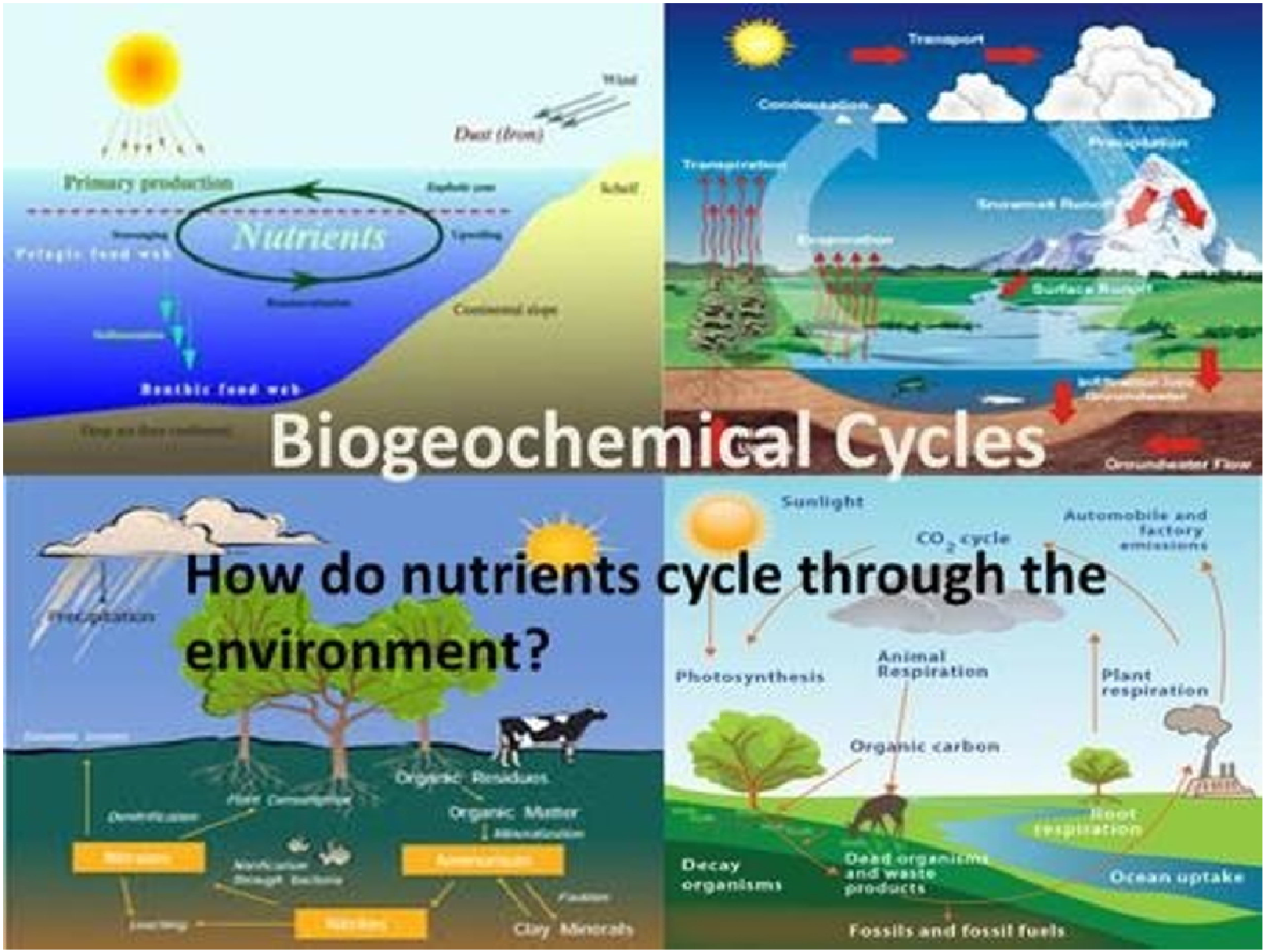
Bio-geochemical Cycle

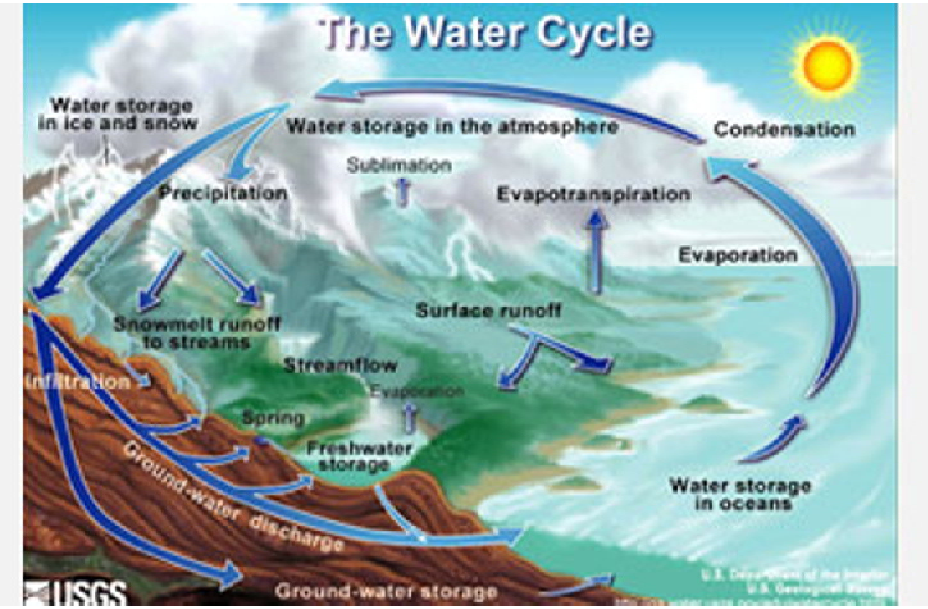
- The cyclic exchange of nutrient materials between living organisms and their non-living environment is called as bio-geochemical cycles
- This cycle includes

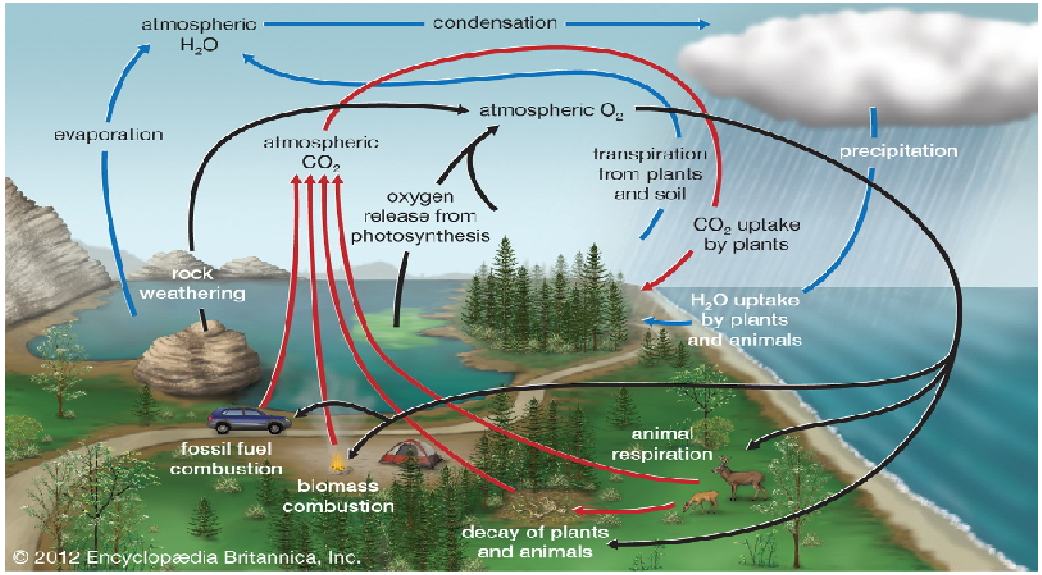
1) Hydrological or Water cycle
2) Gaseous cycle
3) Sedimentary cycle

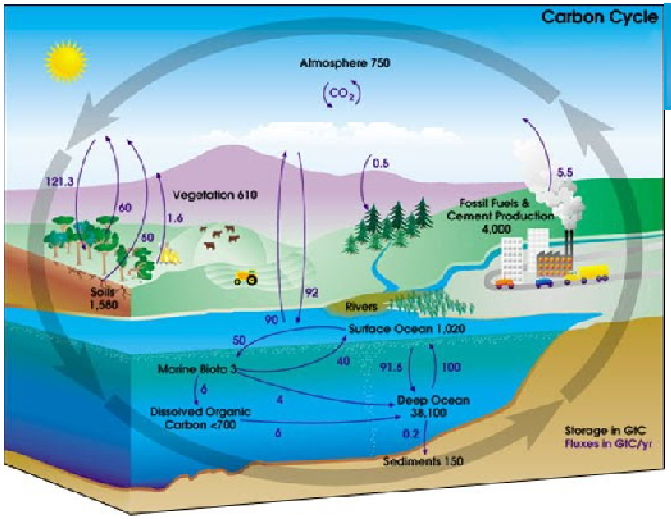





Dust (Iron)
Primary production
Nutrients
Benthic food web
Transport
Condensation
Precipitation
Transpiration
Evaporation
Surface Runoff
Groundwater Flow
Biogeochemical Cycles
How do nutrients cycle through the environment?
Precipitation
Organic Residues
Organic Matter
Clay Minerals
Sunlight
CO_2 cycle
Automobile and factory emissions
Photosynthesis
Animal Respiration
Plant respiration
Organic carbon
Root respiration
Decay organisms
Dead organisms and waste products
Ocean uptake
Fossils and fossil fuels



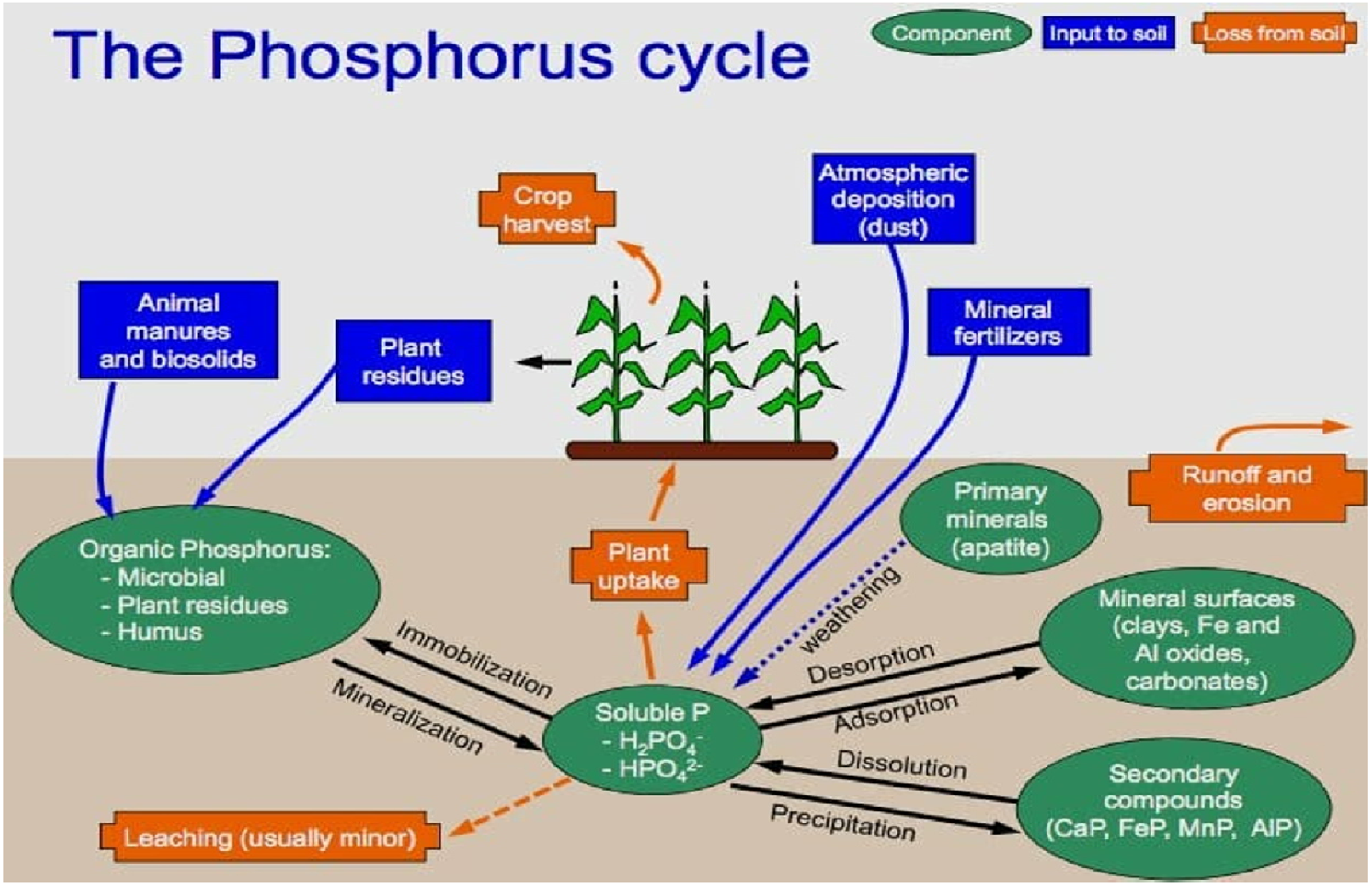




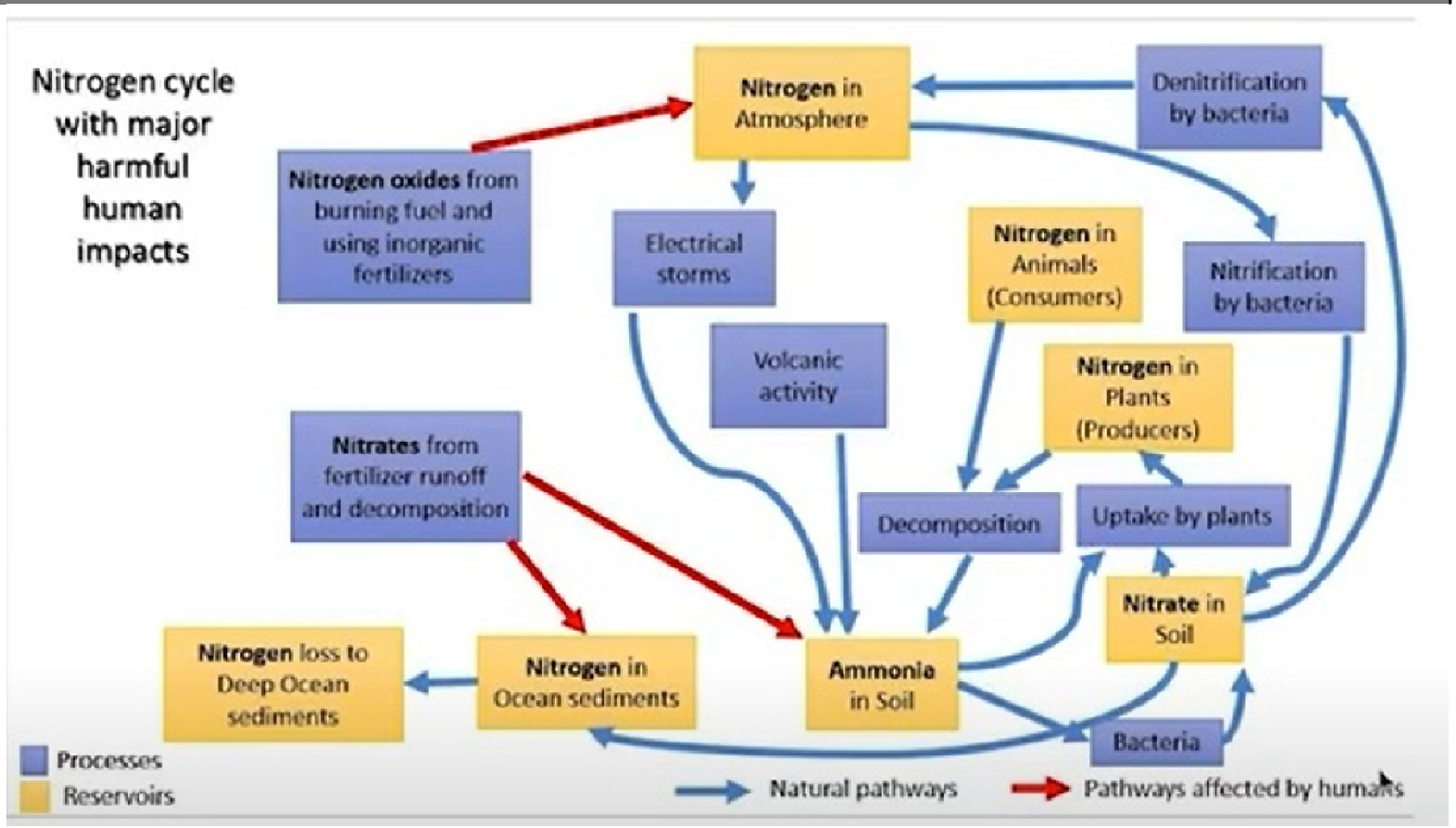
Carbon Cycle

Carbon Cycle

- Carbon in the form of carbon-dioxide is taken up by green plants as raw material for photosynthesis
- The organic matter synthesized are passed from producers to consumers
- During respiration, plants and animals release carbon back to the surrounding as carbon-dioxide
- The dead bodies of plants and animals as well as the body waste which accumulates carbon compounds are decomposed by micro-organisms and releases carbon-dioxide


The Phosphorus cycle
Component
Input to soil
Loss from soil
Crop harvest
Atmospheric deposition (dust)
Animal manures and biosolids
Plant residues
Mineral fertilizers
Runoff and erosion
Primary minerals (apatite)
Organic Phosphorus:
- Microbial
- Plant residues
- Humus
Plant uptake
weathering
Immobilization
Mineralization
Desorption
Adsorption
Mineral surfaces (clays, Fe and Al oxides, carbonates)
Soluble P
- $H_2PO_4^-$
- HPO_4^{2-}
Dissolution
Precipitation
Secondary compounds (CaP, FeP, MnP, AlP)
Leaching (usually minor)

Nitrogen Cycle and Human Impact

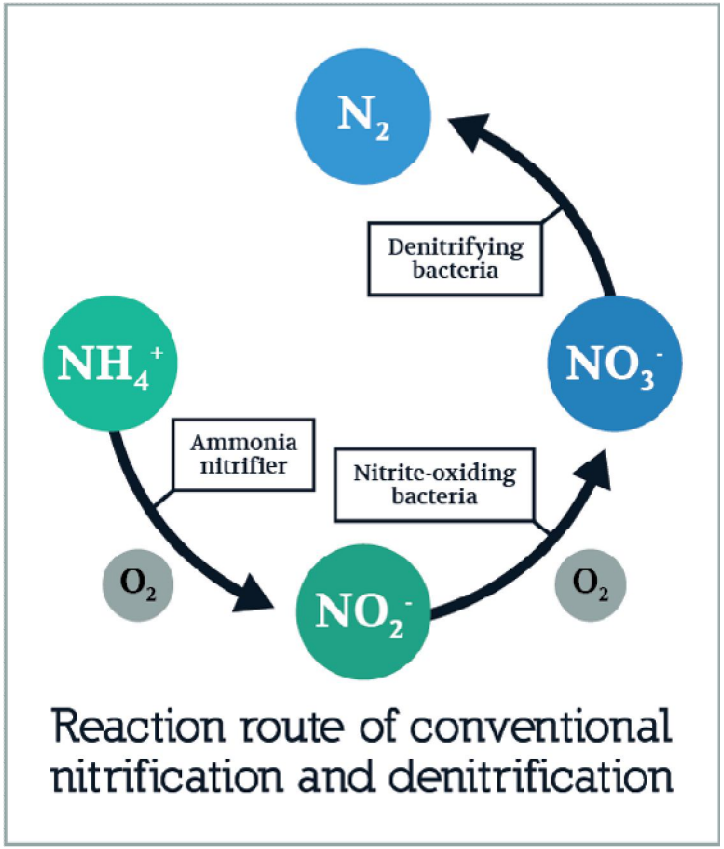


Nitrogen Cycle and Human Impact

- Red arrows indicate in the previous fig are the pathways which are affected by human activities.
- Blue boxes- Nitrogen processes, eg: lightening, volcanic eruption, bacteria
- Yellow boxes- Reservoir or storage of N_2
- E.g: nitrogen oxides which are from burning fuel and using inorganic fertilizers are released into the atmosphere, and that affects again the other natural flow of nitrogen into the environment.

Nitrogen Cycle

- Nitrification: Nitrifying bacteria oxidizes ammonia to nitrite and then to nitrate
- Denitrification: Under anaerobic conditions, denitrifying bacteria converts nitrate to nitrogen gas



Reaction route of conventional nitrification and denitrification

Nitrogen cycle can be affected by man in five major ways:

- Fertilizer production (mainly nitrates and ammonium salts) to grow more food by increasing yields, and replenishing lost nitrogen from the soil.
- Burning of fossil fuels in cars, power plants, and heating which puts nitrogen dioxide into the atmosphere.
- Increasing animals wastes (nitrates) from more people and from livestock and poultry grown in ranches.
- Increased sewage flows from industry and urbanization.
- Increased erosion of and runoff nearby streams, lakes and rivers from cultivation, irrigation, agricultural wastes, mining, urbanization and poor land use.

ECOLOGY

ECOLOGY: OIKOS + LOGOS

Greed word coined by Ernst Haeckel in 1869

OIKOS – house, habitat or place of living

LOGOS – study

Ecology can be defined as the study of the relationships among organisms, between organisms and their environment.

The field of ecology deals with the influence of environmental factors on morphology, physiology, growth, distribution, behaviour and survival of the organisms.

Auto ecology – ecology of individual species and its population

Syn ecology – ecology of communities and their composition

ECOLOGY

Marine Freshwater Stream Grassland Forest Desert

Ecosystem:

An ecosystem can be defined as a grouping of various species of plants, animals and microbes that interact with each other and with their environment to perpetuate their growth.

TYPES OF ECOSYTEM:

(1) Grassland (2) Forest (3) Desert
(4) Aquatic (5) Crop (6) Urban

Three Major Principal of Ecosystem

Nutrient cycling:

Movement of chemical elements from the environment into living organisms and from them back into the environment through organisms live, grow, die and decompose.

Energy flow:

Energy is required to transform inorganic nutrients into organic tissues of an organism.

Energy is the driving force to the work of ecosystem.

Structure

It refers to the particular pattern of inter-relationships that exists between organisms in an ecosystem.

Human Impact on Environment

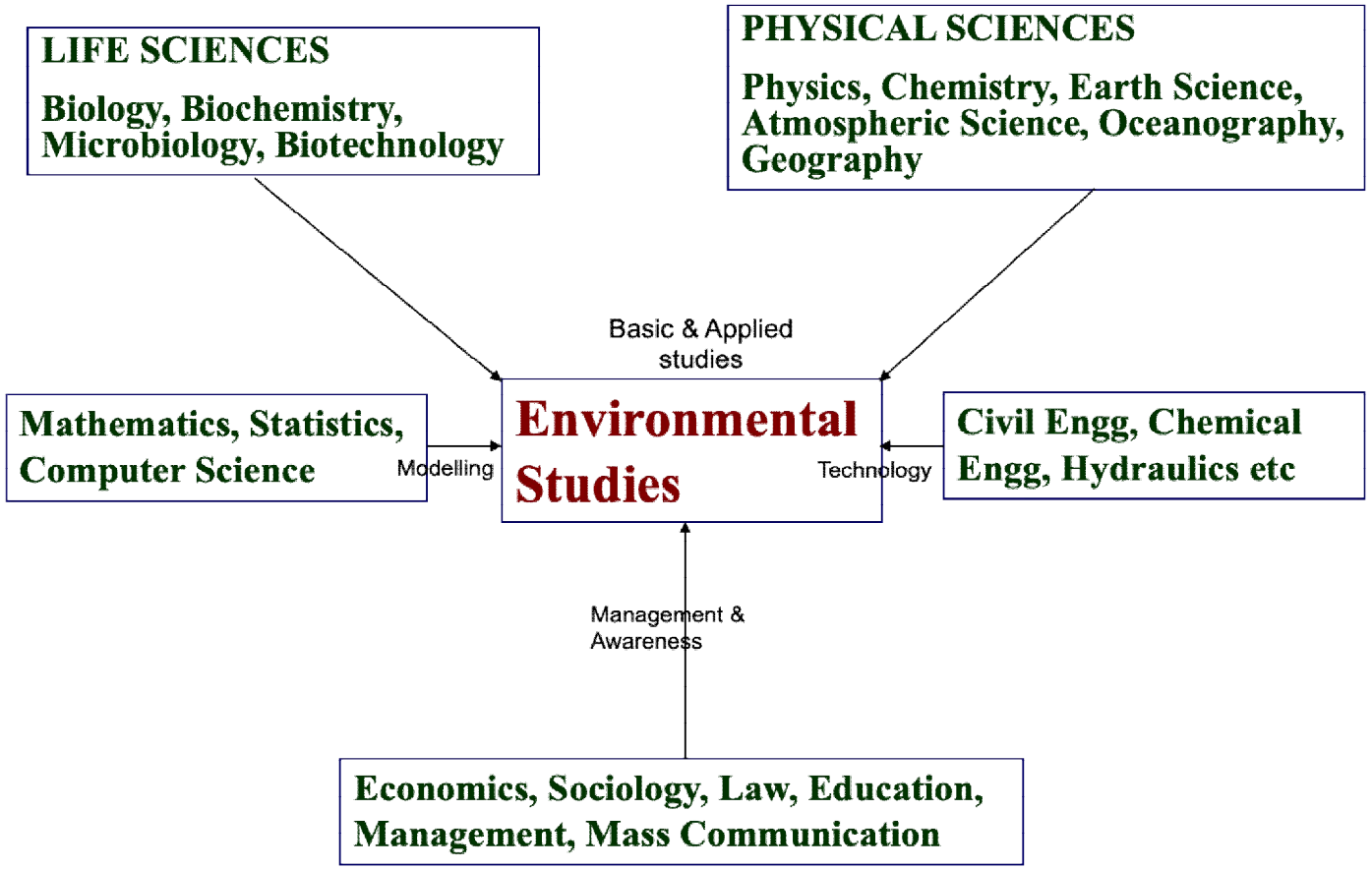
Source: The Hindu

Human Impact on environment

- Buildings in the US consume more than 30% of their total energy and 60% of electricity annually (oil and coal based)
- Average US citizen uses 1,86,000 calories of energy per day (basic need 2,200-3000 cals)
- They consume **18×10^9 litres** of potable water per day to flush toilets.
- For every **100 g** of product, we create **3,200 g** of waste
- On average food travels about **2000 km** from where it is grown/produced to where it is eaten

Carbon foot print

- A carbon footprint is the **total greenhouse gas (GHG)** emissions caused directly and indirectly by an individual, organization, event or product.
- Emissions resulting from every stage of a product or service's lifetime (material production, manufacturing, use, and end-of-life).
- Throughout a product's lifetime, or lifecycle, different GHGs may be emitted, such as **carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), ChloroflouroCarbon etc**
- greater or lesser ability to trap heat in the atmosphere. These differences are accounted for by the global warming potential (GWP) of each gas, resulting in a carbon footprint in units of mass of **carbon dioxide equivalents (CO_2e)**
- A typical U.S. household has a carbon footprint of 48 metric tons CO_2e/yr.



Multidisciplinary nature of Environmental Studies

Thank you