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UIET

**UTKAL INSTITUTE OF
ENGG & TECHNOLOGY**
LECTURER NOTES

ON

(TH.5)

ENVIRONMENTAL STUDIES

Diploma in ETC Engineering.

(3rdSemester)

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Designation:LECTURER IN ETC ENGG

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SYLLABUS
GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING

LTPC
3 003

OBJECTIVES:

To the study of nature and the facts about environment.

- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 12

Definition, scope and importance of Risk and hazards; Chemical hazards, Physical hazards, Biological hazards in the environment – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – Oxygen cycle and Nitrogen cycle – energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 10

Definition – causes, effects and control measures of: (a) Air pollution (Atmospheric chemistry- Chemical composition of the atmosphere; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, oxygen and ozone chemistry;- Mitigation procedures- Control of particulate and gaseous emission, Control of SO₂, NO_x, CO and HC) (b) Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters – physical, chemical and biological; absorption of heavy metals - Water treatment processes. (c) Soil pollution - soil waste management: causes, effects and control measures of municipal solid wastes – (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – role of an individual in prevention of pollution – pollution case studies – Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Energy Conversion

processes– Biogas– production and uses, anaerobic digestion; case studies– Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Introduction to Environmental Biochemistry: Proteins – Biochemical degradation of pollutants, Bioconversion of pollutants. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT

7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air act – Water act – Wildlife protection act – Forest conservation act – The Biomedical Waste (Management and Handling) Rules; 1998 and amendments- scheme of labeling of environmentally friendly products (Ecomark). enforcement machinery involved in environmental legislation- central and state pollution control boards- disaster management: floods, earthquake, cyclone and landslides. Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT

6

Population growth, variation among nations – population explosion – family welfare programme– environment and human health– human rights– value education– HIV/AIDS – women and child welfare– Environmental impact analysis (EIA)- -GIS-remote sensing-role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environmental issues at infant stage.
- Ignorance and incomplete knowledge has led to misconceptions
- Development and improvement in std. of living has led to serious environmental disasters

TEXT BOOKS:

1. Gilbert M. Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.

REFERENCES:

1. Trivedi. R. K., "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol. I and II, Enviro Media, 3rd edition, BPB publications, 2010.
2. Cunningham, W. P. Cooper, T. H. Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, "Environmental law", Prentice hall of India PVT LTD, New Delhi, 2007.
4. Rajagopalan, R, "Environmental Studies- From Crisis to Cure", Oxford University Press, 2005.

UNIT-I ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY

ENVIRONMENT

Environmental science is the study of nature and the facts about environment. Environment can be defined as "all the social, economical, physical and chemical factors that surround man" or "all abiotic and biotic components around man—all living and non living things surround man".

PREREQUISITE DISCUSSIONS

The word environment is derived from the French word ‘environ’ which means to ‘encircle or surround’.

Objective of this course is to develop concern for our own environment which will lead us to act at our own level to protect the environment we all live in.

Ever since people first recognized that their health and well-being were related to the quality of their environment, they have applied thoughtful principles to attempt to improve the quality of their environment.

There are three reasons for studying the state of the environment.

The first is the need for information that clarifies modern environmental concepts like equitable use of natural resources, more sustainable life styles etc.

Second, there is a need to change the way in which we view our own environment, using practical approach based on observation and self learning.

Third, there is a need to create a concern for our environment that will trigger pro-environmental action; including simple activities we can do in our daily life to protect it.

CONCEPTS

According to ancient man the environment was the Panchaboodhas (i.e.) air, water, land, sky and energy.

The human were disciples of nature. They were able to protect themselves from harmful one and protect the others. But according to modern man the environment is only air land and water.

Exploitation of various earth resources to satisfy the increasing needs of human population has resulted in 1) depletion of various resources of earth 2) pollution. Principles of environmental education:

- Examine the major environmental issues
- Discover the root cause
- Develop problem solving skills
- Promote co-operation in solving problems
- Emphasize active participation in prevention and solution to problems

SCOPE OF ENVIRONMENTAL SCIENCE

- Studying the interrelationship between the components of environment.
- Carrying out impact analysis and Environmental Audit
- Preventing pollution from existing and new industries
- Stopping the use of biological and nuclear weapons
- Managing unpredictable disasters etc.

PUBLIC AWARENESS

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection.

- Public awareness of environmental issue is at infant stage
- 30-40% of public of developing country are aware of environmental. Problems but they do not bother about it.
- Ignorance and incomplete knowledge has led to misconceptions.
- Development and improvement in std. of living has led to serious environmental disasters.
- Debates on environmental issues are treated as anti-developmental.

APPLICATION

- Environmental science is essentially the application of scientific methods and principles to the study of environmental issues, so it has probably been around in some forms as long as science itself.
- Environmental science is often confused with other fields of related interest, especially ecology, environmental studies, environmental education and environmental engineering.
- Environmental science is not constrained with any one discipline and it is a comprehensive field.

RISK AND HAZARDS IN THE ENVIRONMENT

Environmental risk due to various environmental hazards is an important topic for environmental engineers to recognise and understand in order to protect human society and ecosystems from harms or damages at local, regional or global scales. For example, to deal with contaminated soil and ground water at a brown field, risk and exposure assessment help engineers choose an optimal solution to either treat the hazard (e.g., to remove the contaminants from the soil and water) or reduce the exposure (e.g., to cover up the land with a barrier).

A hazard is a threat to life, health, property, or ecosystems, i.e., it involves something that could potentially be harmful. Therefore, when a dormant hazard comes to fruition, it will cause physical damage or destruction, loss of life, or drastic change to the environment, and result in an incident, accident, emergency event, or disaster. Hazards may be classified into:

- Chemical hazards – Combustion of Fossil fuels, industrial effluence, pesticides heavy metals.
- Physical hazards – Radioactive and UV radiations, Global warming, Chlorofluoro carbons, Noise etc.
- Biological hazards – Bacteria, Viruses, Parasites.

ECOSYSTEM

Living organisms cannot be isolated from their non-living environment because the latter provides materials and energy for the survival of the former.

An ecosystem is therefore defined as a natural functional ecological unit comprising of living organisms and their non-living environment that interact to form a stable self supporting system.

PREREQUISITEDISCUSSIONS

EO Wilson is an entomologist who envisioned that biological diversity was a key to human survival on Earth. He wrote 'Diversity of life' in 1993, which was awarded a prize for the best book published on environmental issues.

He emphasised the risks to mankind due to manmade disturbances in natural ecosystems that are leading to the rapid extinction of species at the global level.

An Indian ornithologist and naturalist, Salim Ali known as the "birdman of India", was among the first Indians to conduct systematic bird surveys across India.

He was instrumental in creating the Bharatpur bird sanctuary (Keoladeo National Park) and prevented the destruction of what is now the Silent Valley National Park. He was awarded India's second highest civilian honour, the Padma Vibhushan in 1976.

His autobiography, **Fall of a sparrow**, should be read by every nature enthusiast. He was our country's leading conservation scientist and influenced environmental policies in our country for over 50 years.

CONCEPTS

Ecology is the study of the distribution and abundance of organisms, the flows of energy and materials between abiotic and biotic components of ecosystems.

Structure of Ecosystem

1. Abiotic or non-living components or physical components
2. Biotic or Living components
3. Energy components

Function of organisms in an ecosystem

- Producer (autotrophy): make food; plants, algae
- Consumer (heterotrophy): eat other organisms
- Decomposer: eat dead organic matter; bacteria and fungi

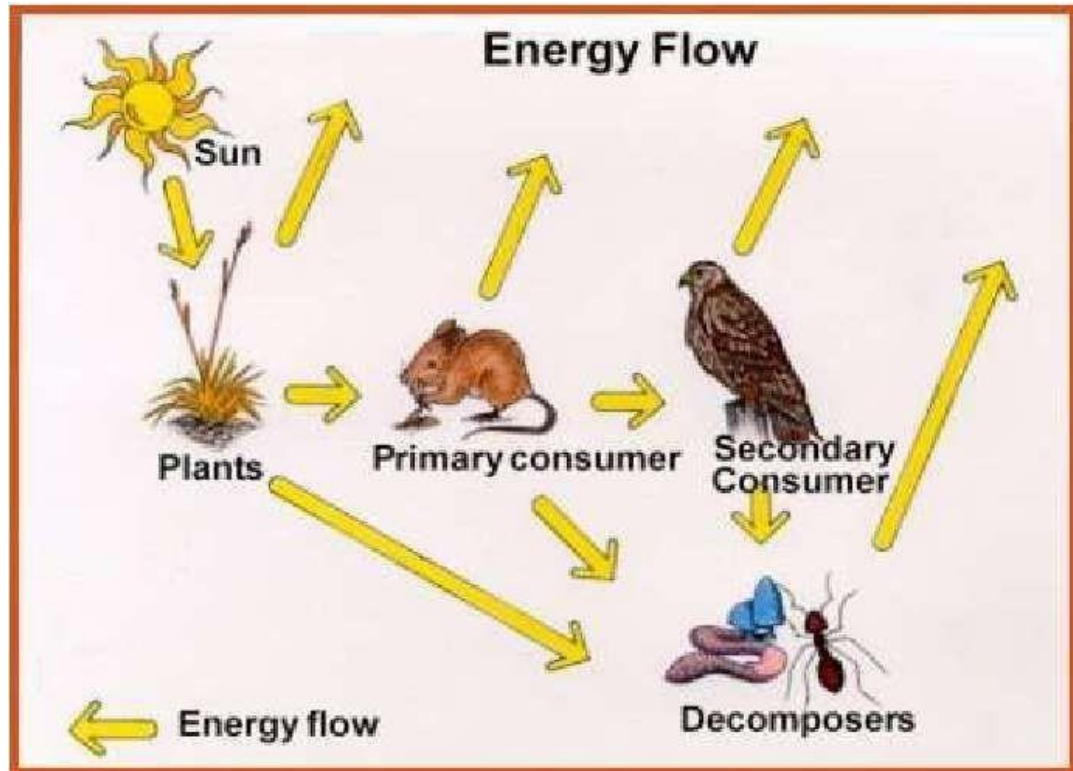
Classes of Consumers

- Herbivore—primary consumer—eats plants
- Carnivores—secondary—meat eaters; eat herbivores
- Tertiary—feed on carnivores
- Omnivores—eat plants/animals

ENERGY FLOW IN ECOSYSTEM

- All organisms must obtain a supply of energy and nutrients from their environment in order to survive.
- The transformations of energy in an ecosystem begin first with the input of energy from the sun.
- Because, it is the first step in the production of energy for living things, it is called "Primary production".
- Photosynthesis—Chemical reaction where green plants use water & carbon dioxide to store the sun's energy in glucose.
- ENERGY is stored in glucose.
- Glucose is stored as starch in plants
- The majority of autotrophs are photoautotrophs that harness the energy of the sun and pass some of this energy onto consumers through feeding pathways.
- The energy contained within producers and consumers is ultimately passed to the decomposers that are responsible for the constant recycling of nutrients.

- Thus, there is a one-way flow of energy through the biotic community and a cycling of nutrients between the biotic and abiotic components of the ecosystem
- Energy flow cannot occur in reversed direction.



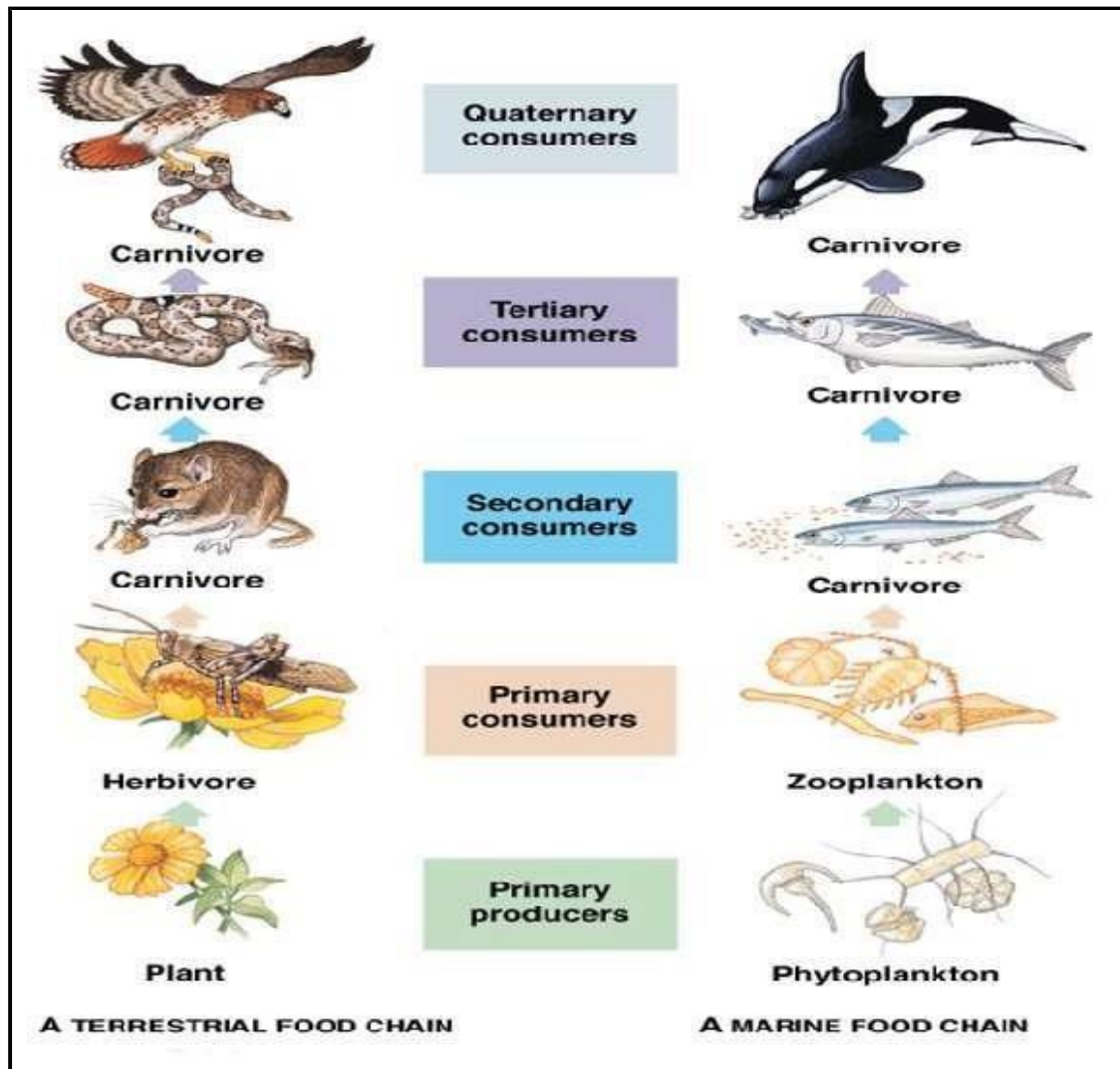
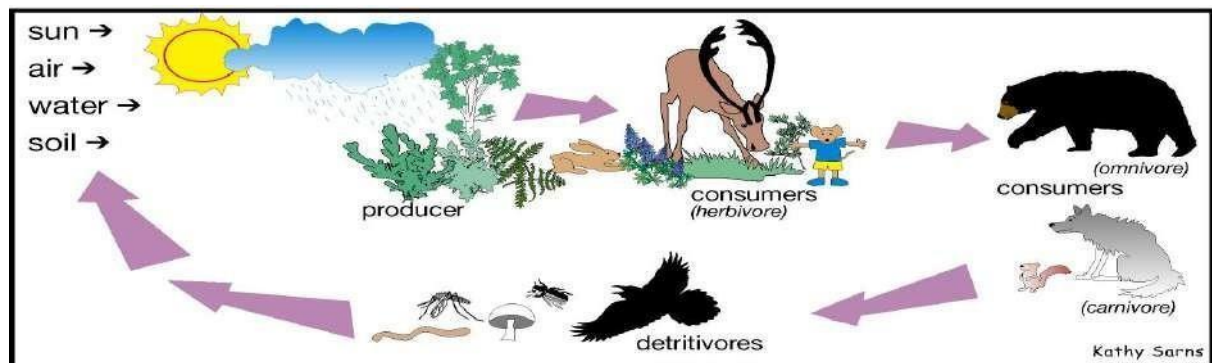
EnergyFlow

- Starts from autotrophs (the producer level, i.e., first trophic level) to Heterotrophs including plant eaters or Herbivores (second trophic level) and so on.
- The amount of energy decreases with successive trophic levels.
- Only About 1% of energy from the sun is used by green plants & rest remains unutilized.
- Similarly, there is loss of energy in each trophic level.
- The transfer of food energy between the organisms in an ecosystem can be tracked by constructing food chains, food webs, pyramids of numbers, biomass and energy and energy flow diagrams.

FOODCHAIN

Plants by photosynthesis convert solar energy into protoplasm. Small herbivores consume the vegetable matter and convert it into animal matter which in turn is eaten by large carnivores.

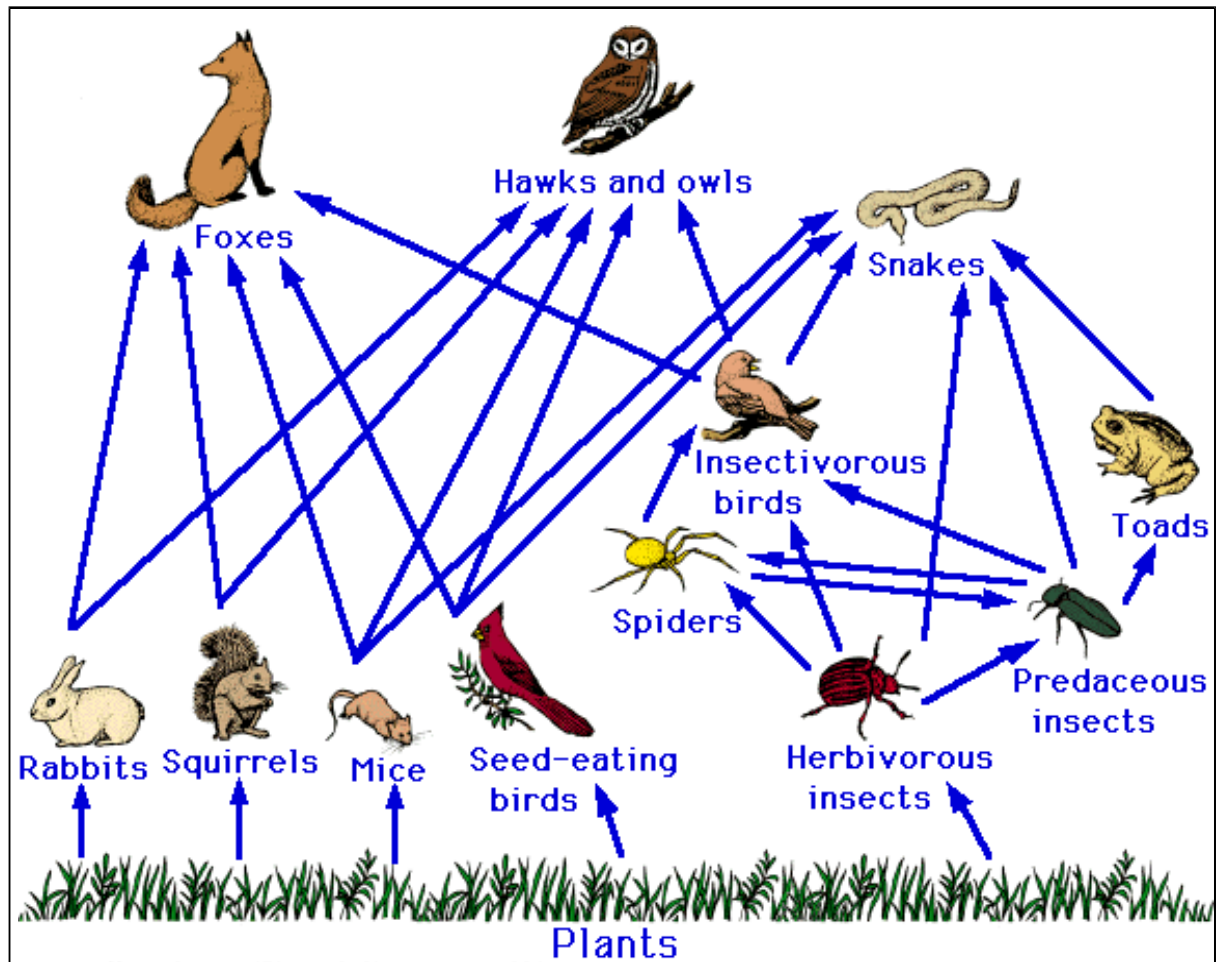
- A food chain may be defined as, "the transfer of energy and nutrients through a series of organisms with repeated process of eating and being eaten".
- In an ecosystem, all the organisms are linked together with one another by food relationship.
- Each organism living or dead is potential food for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



FoodChain

FOODWEB

The food relationship between various organisms is being depicted by linking all the possible prey and predators of different food level. In an ecosystem linking of feeding habit relations will provide a food web or Interlocking pattern of several interlinked food chains is termed as FOOD WEB.



Foodwebingrasslandecosystem

ECOLOGICALPYRAMIDS

An "Ecological pyramid" is a graphical representation that shows the relative amounts of energy or matter contained within each trophic level in a food chain or food web.

An ecological pyramid shows the relationship between consumers and producers at different trophic levels in an ecosystem.

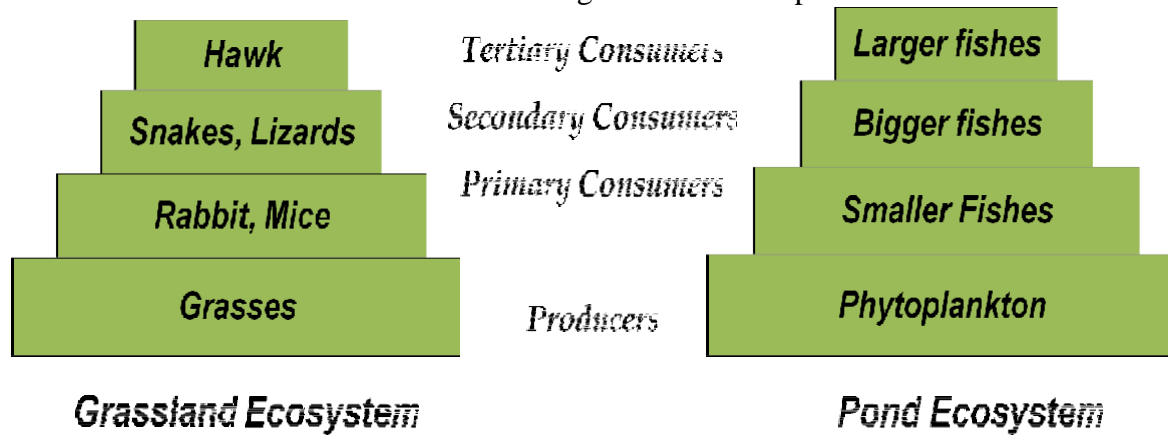


EcologicalPyramid

Types of Ecological Pyramids

Pyramid of Numbers

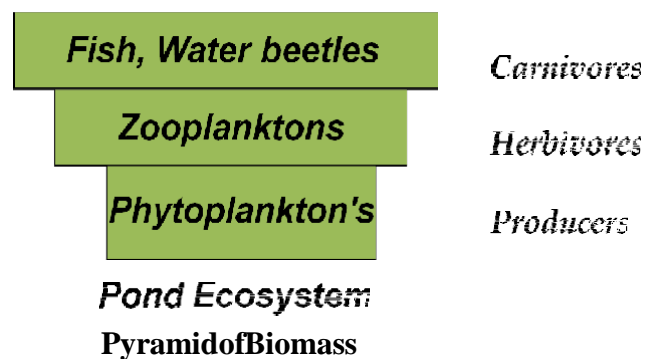
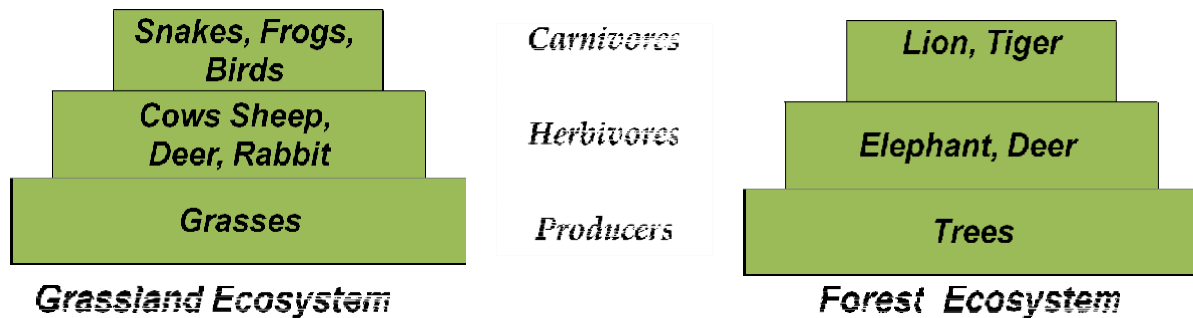
Show the relative number of individual organisms at each trophic level.



Pyramid of Biomass

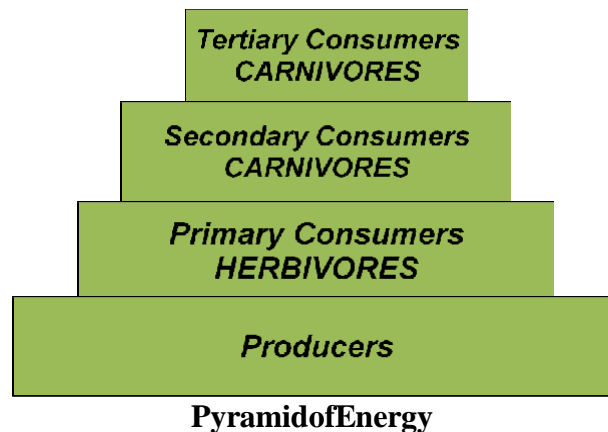
Pyramid of Biomass

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



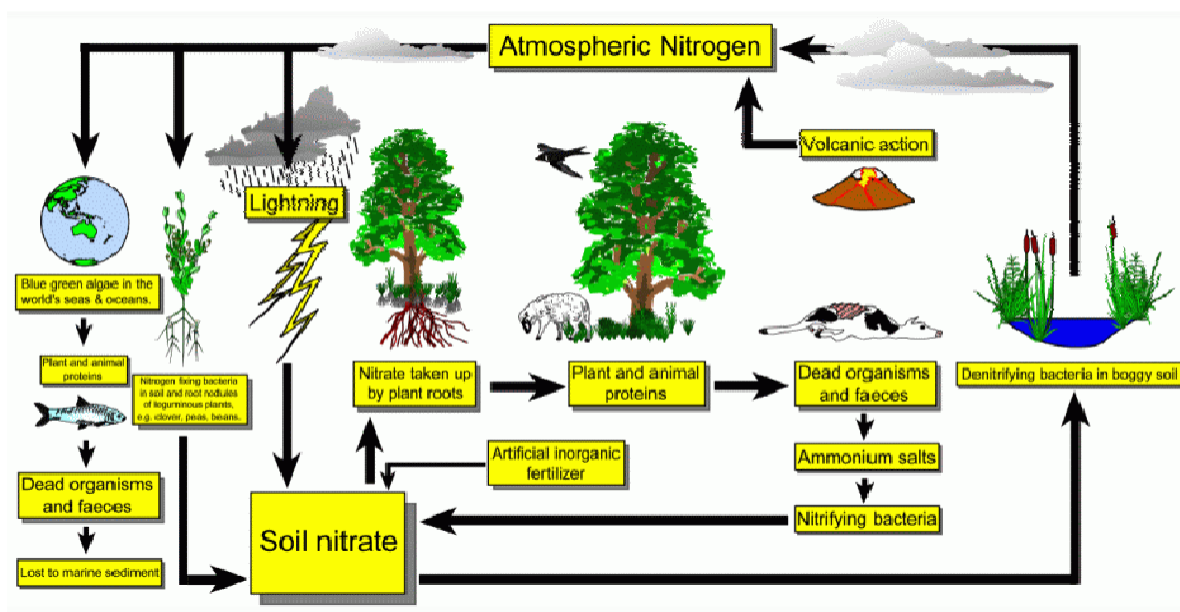
Pyramid of Energy

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



NITROGEN CYCLE

- Nitrogen is crucial for all organisms
 - Nucleic acids
 - Proteins
 - Chlorophyll
- Nitrogen - 78% in Atmosphere
- N_2 is very stable and must be broken apart by organisms, combined with other atoms into a usable form.



Nitrogen Cycle

Nitrogen cycle completes in 5 steps:

1) Nitrogen Fixation

Conversion of $N_2 \rightarrow NH_3$

Combustion, volcanic action, Lightning, Industrial processes (making fertilizer). Bacteria (Azotobacter, Clostridium, Nostoc etc.)

2) Nitrification

Conversion of $NH_3 \rightarrow NO_3$

Soil bacteria convert in a two-step process.

3) Assimilation

Roots absorb NH_3 , NH_4 , or NO_3 and incorporate them into nucleic acids and protein.

4) Ammonification

Amino acids and nucleotides are broken down into waste products NH_3 or NH_4

5) Denitrification

The reduction of NO_3 to N_2 . Denitrifying bacteria return some of the nitrogen to the atmosphere

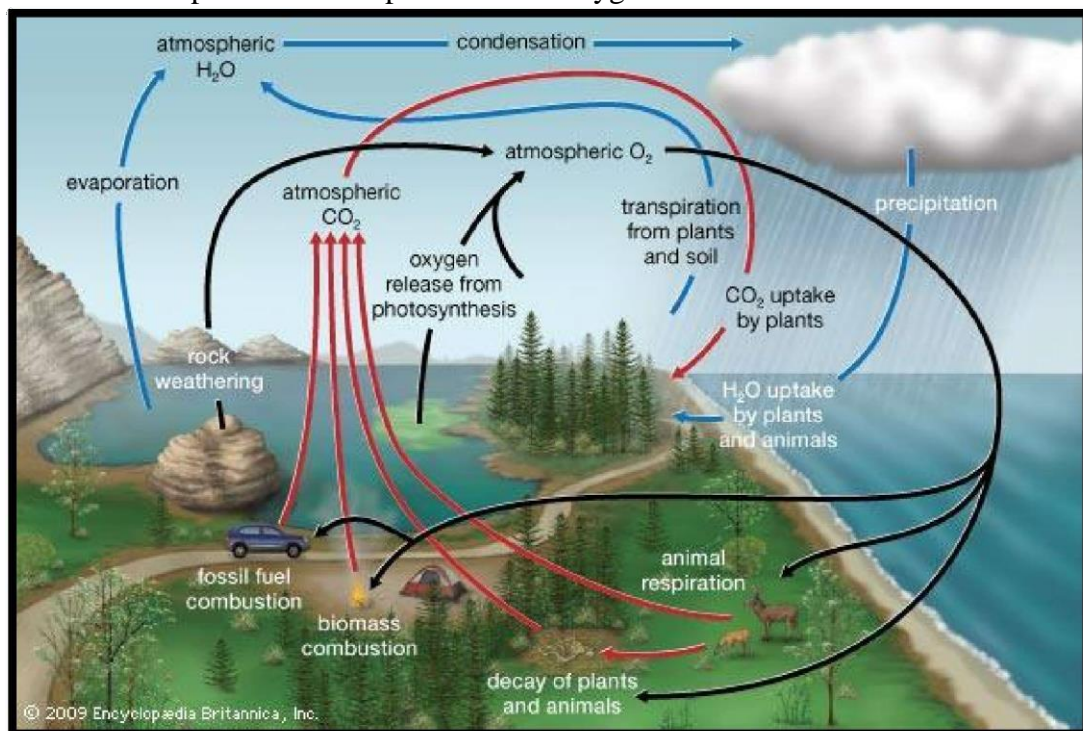
OXYGEN CYCLE

oxygen cycle is the circulation of oxygen in various forms through nature free in the air and dissolved in water.

Oxygen is second only to nitrogen in abundance among uncombined elements in the atmosphere.

Plants and animals use oxygen to respire and return it to the air and water as carbon dioxide (CO_2). CO_2 is then taken up by algae and terrestrial green plants and converted into carbohydrates during the process of photosynthesis, oxygen being a by-product.

The waters of the world are the main oxygen generators of the biosphere; their algae are estimated to replace about 90 percent of all oxygen used.



The generalized oxygen cycle

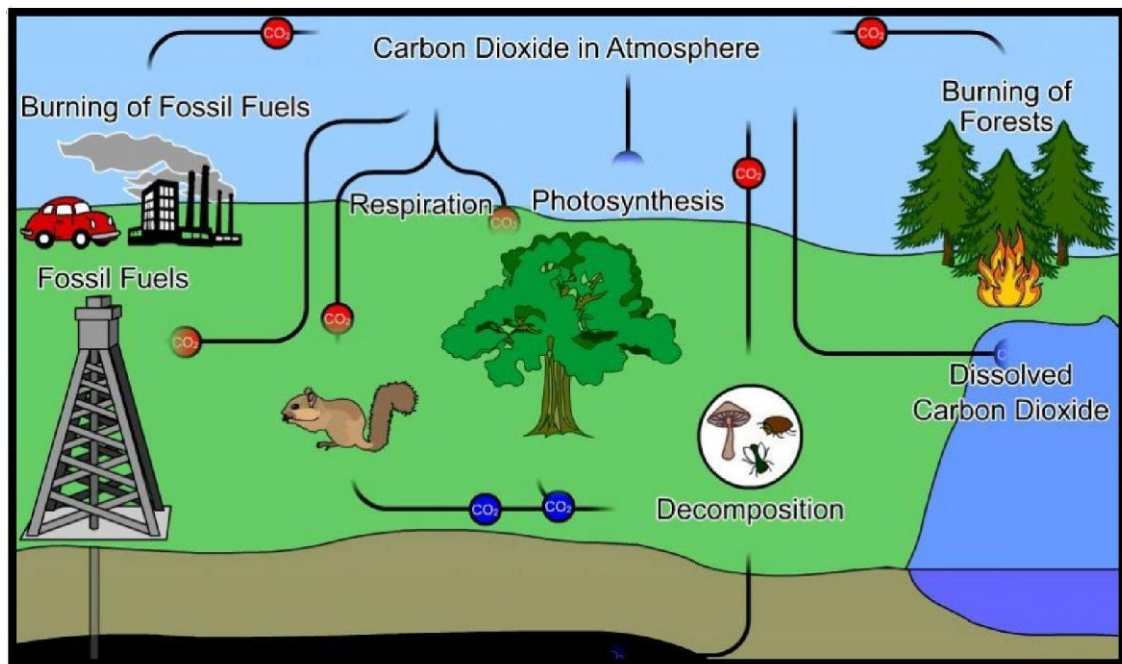
Oxygen is involved to some degree in all the other biogeochemical cycles. For example, over time, detritus from living organisms transfers oxygen-containing compounds such as calcium carbonates into the lithosphere.

Despite the burning of fossil fuel and the reduction of natural vegetation (on land and in the sea), the level of atmospheric oxygen appears to be relatively stable because of the increase in plant productivity resulting from agricultural advances worldwide.

CARBON CYCLE

- Carbon enters plants, etc., as CO_2
 - Bacteria process carbon in a fashion that allows it to be recycled.
 - Obtain energy from the molecules, and convert carbohydrate to carbon dioxide as a result of respiration.
- Photosynthesis removes carbon from the abiotic environment (fixes carbon into organic molecules)
- Carbon moves through food chain through consumption of one organism by another

- Cellular respiration, combustion, and erosion of limestone return carbon to the atmosphere, water and abiotic environment.

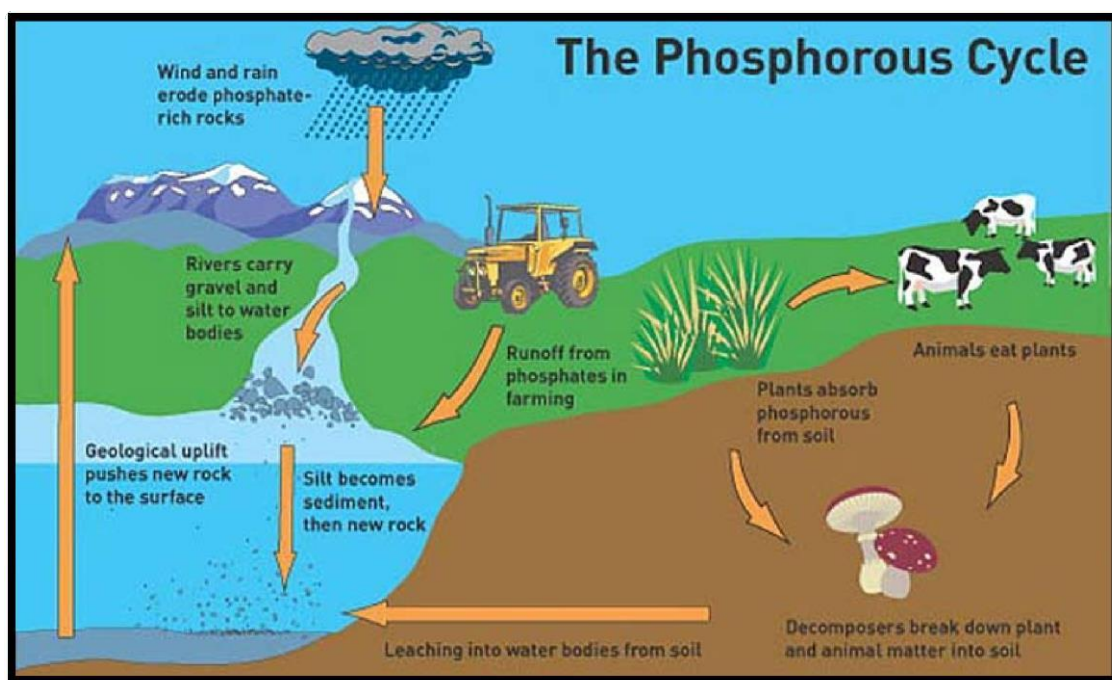


Carbon Cycle

The source of atmospheric carbon dioxide is variable but only plants can utilize atmospheric carbon directly.

PHOSPHOROUS CYCLE

- The only cycle that does not have a gaseous state.
- Inorganic phosphate PO_4^{3-} is released from rocks and sediments through the action of erosion.



Phosphorous Cycle