UNIT 2: NATURAL RESOURCES

RENEWABLE AND NON-RENEWABLE RESOURCES

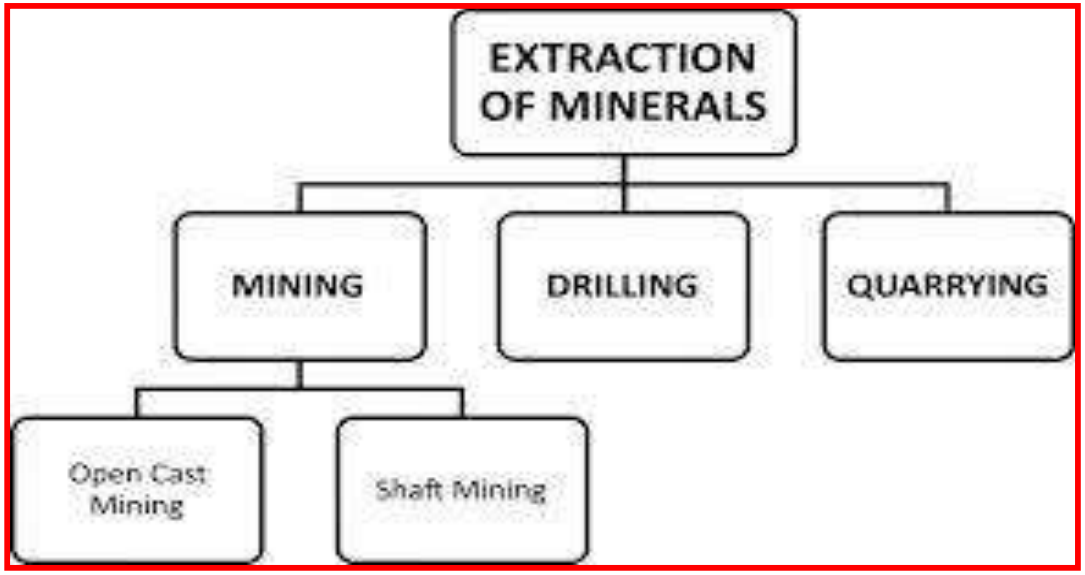
- Life on this planet earth depends upon a variety of goods and services provided by the nature, which are known as **Natural Resources.**
- Thus water, air, soil, minerals, coal, forests, crops and wildlife are all examples of natural resources.
- The natural resources are of two kinds:
- **Renewable resources** which are inexhaustive and can be regenerated within a given span of time. Eg. Forests, wildlife, wind energy, biomass energy, tidal energy, hydro power etc.
- **Non-renewable resources:** which cannot be regenerated. e.g. Fossil fuels like coal, petroleum, minerals etc.
- It is very important to protect and conserve our natural resources and use them in a judicious manner so that we do not exhaust them.
- In this unit we shall discuss the major natural resources and associated problems.
- Forest resources, water resources, mineral resources, food resources, energy resources and land resources.

Mineral Resources

MINERALS: are naturally occurring elements or compounds in the Earth's crust

ORES: naturally occurring solid material from which a metal or valuable mineral can be extracted profitably.

TYPES OF MINERALS		
Metallic		**Non-metallic**
Ferrous (minerals like iron ore, manganese and chromites contain iron)	Nonferrous (iron is absent but may contain some other metals such as gold, silver, copper or lead)	Eg. Limestone, mica, gypsum, coal and petroleum
Generally, metallic minerals are **found in igneous and metamorphic rock**		Found in **Sedimentary rock**



MINING

DRILLING

QUARRYING

- **Uses and Exploitation:** minerals find use in a large number of ways in everyday in domestic, agricultural, industrial, and commercial sectors and thus form a very important part of any nations economy.
- Development of industrial plants and machinery
- Generation of energy. For example, coal, lignite, uranium
- Construction, housing and settlements
- Defence equipments. For example weapons and armaments
- Transportation means communication. For example, telephone wires, cables, electronic devices.
- Medicinal system. Ayurvedic system
- Formation of alloys for various purposes (steel alloys)
- Jewellery. For example gold, silver, platinum and diamond.

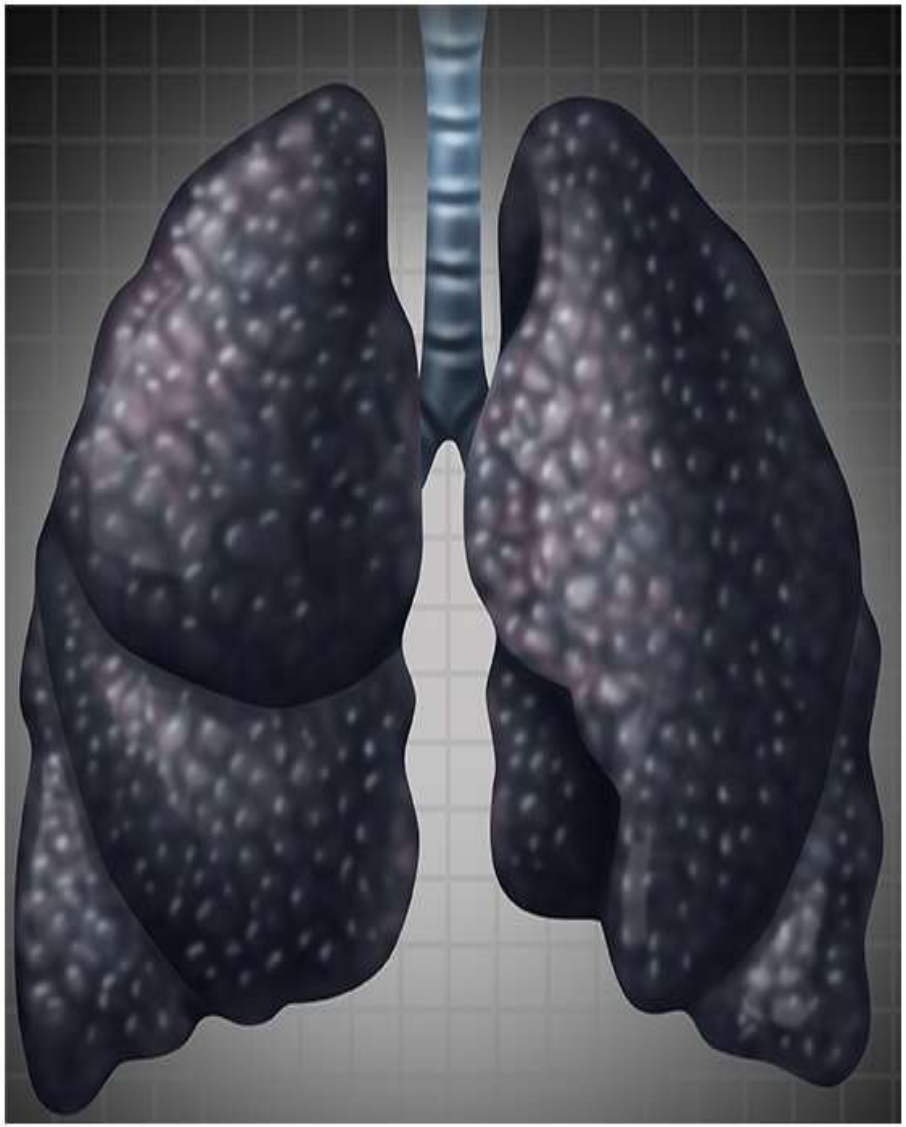
EFFECTS OF EXTRACTION OF MINERAL RESOURCES

LUNG Diseases (occupational diseases):

a) Black lung disease (pneumoconiosis)

b) Silicosis

c) Lung cancer – Radium (radioactive metal)

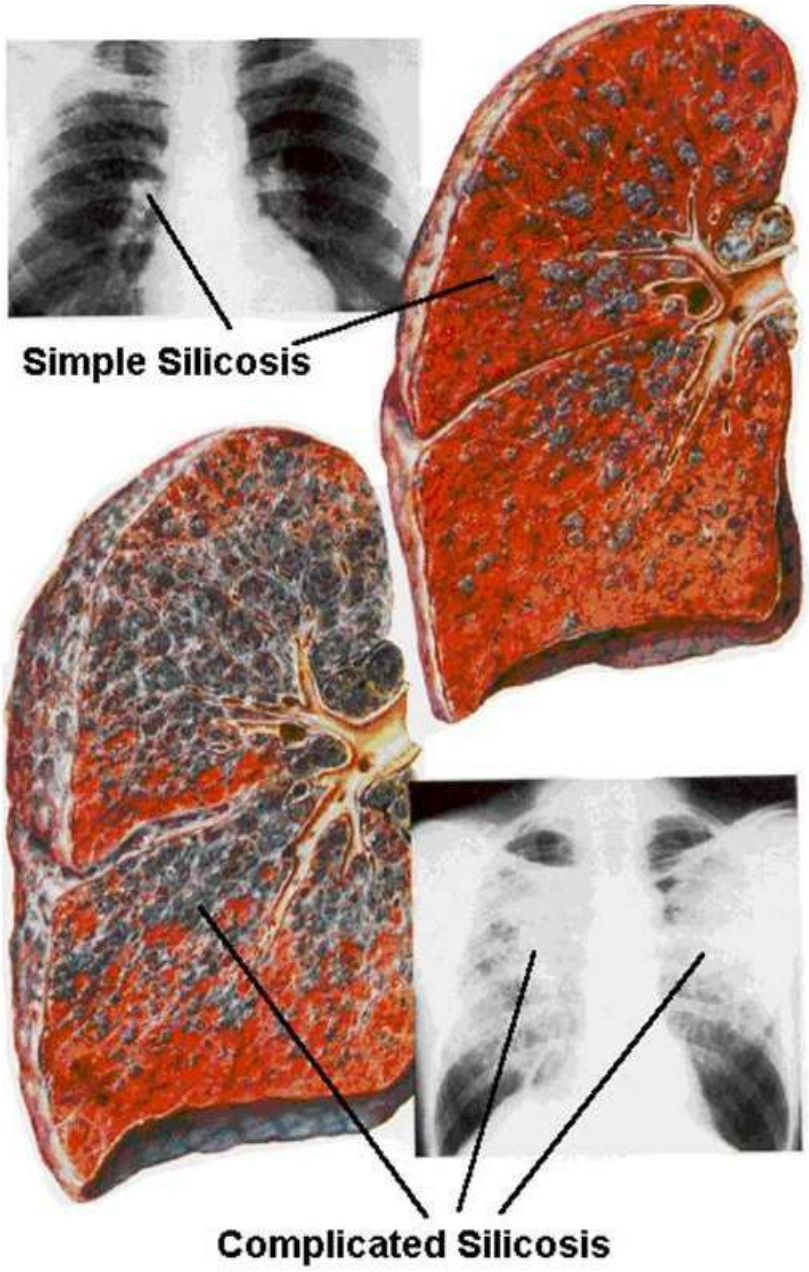


"**Black Lung Disease**" or **Coal Workers' Pneumoconiosis (CWP)** occurs when coal dust is inhaled.

Symptoms:

1) Chronic bronchitis (inflammation of bronchi)
2) Chronic obstructive pulmonary disease (COPD), an inflammatory disease that blocks airflow from the **lungs**.

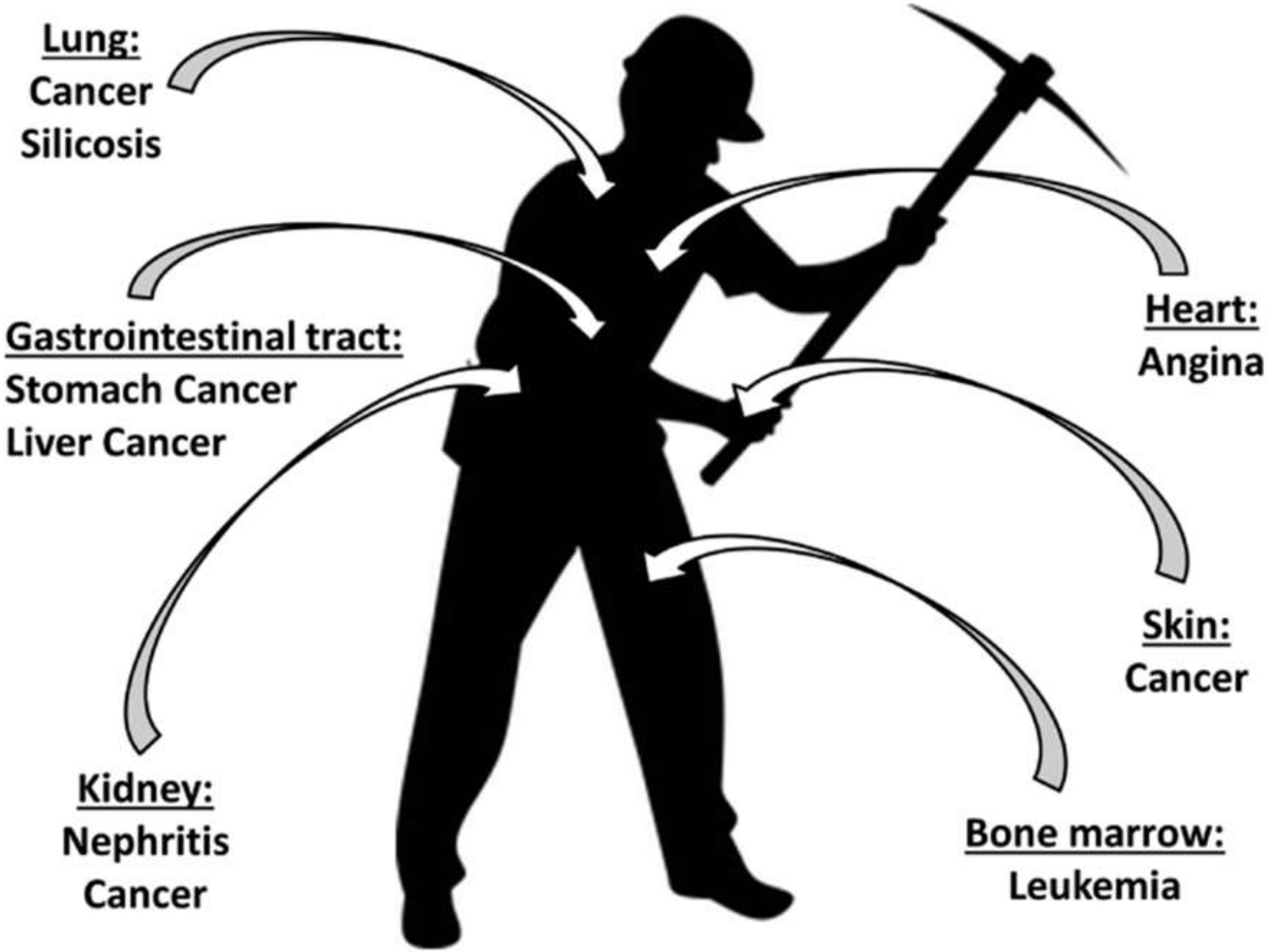
No cure. Only symptomatic treatment



Silica- is a tiny crystal found in sand, rock or mineral ores like quartz

Silicosis is a lung disease. caused by inhalation of the dsut containing silica

Symptoms:
cough, phlegm, trouble breathing, chest pain, fever, swollen legs,
blue lips



Radiation health hazards of uranium miners

- **Environmental Impacts of Mining Activities:**
- **Ecological Impacts**
- Deforestation and devegetation
- Loss of flora and fauna
- Ecosystem degradation
- **Physical Impacts:**
- Land subsidence
- Underground fires
- Landscape destruction and soil erosion
- **Positive Socio-economic impacts:**
- Employment
- Infrastructure facilities
- Economic gains
- **Negative Socio-economic impacts:**
- Encroachment and evacuation
- Resettlement and Rehabilitation issues

- **Environmental Pollution:**
- Air pollution
- Water pollution
- Soil pollution
- Noise pollution
- **Occupational Health Impacts:**
- Health hazards due to long term exposure to hazardous chemicals
- Accidents
- **OTHER EFFECTS OF MINING:**

➢ Acid mine drainage (Contamination of ground and surface water)

➢ Depletion of available land

➢ Pollution of Land, water and air by industrial wastes

➢ Deforestation & Loss of biodiversity

- Remedial measures:
- To adopt eco-friendly mining technology.
- The biological method is helpful from economic as well as environmental point of view.
- Restoration of mined areas by re-vegetating them with appropriate plant species, stabilization of the mined lands, gradual restoration of flora.
- Prevention of toxic drainage discharge and conforming to the standards of air emissions are essential for minimizing environmental impacts of mining.

- **ACID MINE DRAINAGE**
- If air, water, and sulfur-containing rocks mix, chemical reactions can lead to the formation of sulfuric acid and iron hydroxide. This acid runoff dissolves certain heavy metals (e.g., copper, lead, and mercury) which contaminate waterways. Acid mine drainage can also affect the pH of water. Water with an extremely high or low pH is deadly. Water with relatively low pH (acidic) may reduce the hatching success of fish eggs, irritate fish and aquatic insect gills, and damage membranes.

Acid Mine Drainage (AMD) is formed when pyrite (an iron sulfide) is exposed and reacts with air and water to form sulfuric acid and dissolved iron. The acid runoff further dissolves heavy metals such as copper, lead, and mercury into groundwater or surface water.

Conservation of Mineral Resources

Minerals are a non-renewable resource.
It takes thousands of years for the formation and concentration of minerals. The rate of formation is much smaller than the rate at which the humans consume these minerals.

- Use of minerals in a planned and sustainable manner (to reduce wastage).
- Recycling of metals
- Use of alternative renewable substitutes.
- Technology should be improved to use the low-grade ores profitably.

UNIT 2

FOREST RESOURCES

- Forests are one of the most important natural resources on this earth.
- Covering the earth like a green blanket these forests not only produce innumerable material goods, but also provide several environmental services which are essential for life.
- Uses of Forests: forests are of immense value to us. They are not only useful for industry but also for rural economic growth.
- Commercial Use: forests provide us a large number of commercial goods which include timber, firewood, pulp wood, food items, gum, resins, non-edible oil, rubber, fibers, lac, bamboo canes, fodder, medicine, drugs and many more items.
- Ecological Uses:

✓ Production of oxygen
✓ Reducing global warming
✓ Wildlife habitat
✓ Regulation of hydrological cycle
✓ Soil conservation
✓ Pollution moderators

- **Over Exploitation of Forests:** Exploitation of forests has taken place to meet human demands in the following ways:
- Due to wood cutting and large scale logging for raw materials like timber, pulp wood, fuel wood etc.
- Deforestation due to road construction
- Cleaning of forests to create more agricultural lands to meet the food demands of growing population.
- Encroachment of forests leading to destruction of about 1.36 million hectares of forests.
- About 78% of forest area is under heavy grazing.
- Mining activities lead to clearing of forests.
- Big hydropower projects result in large scale destruction of forests.
- In India, **Joint Forest Management** has come up as an innovative approach involving community participation, so that the rural economy is strengthened as well as forest resources are conserved through public involvement.

- **Deforestation:** deforestation involves a loss in the area covered by forests.
- **Major causes of Deforestation:**
- Shifting cultivation
- Fuel requirements
- Raw materials for industrial use
- Development projects
- Growing food needs
- Overgrazing
- Forest fires
- **Major consequences of Deforestation:**
- It threatens the existence of many wildlife species due to destruction of their natural habitat.
- Biodiversity is lost and along with that genetic diversity is eroded.
- Hydrological cycle gets affected, thereby influencing rainfall.
- Problems of soil erosion and loss of soil fertility increase.
- In hilly areas it often leads to landslides.
- More carbon is added to the atmosphere and global warming is enhanced.

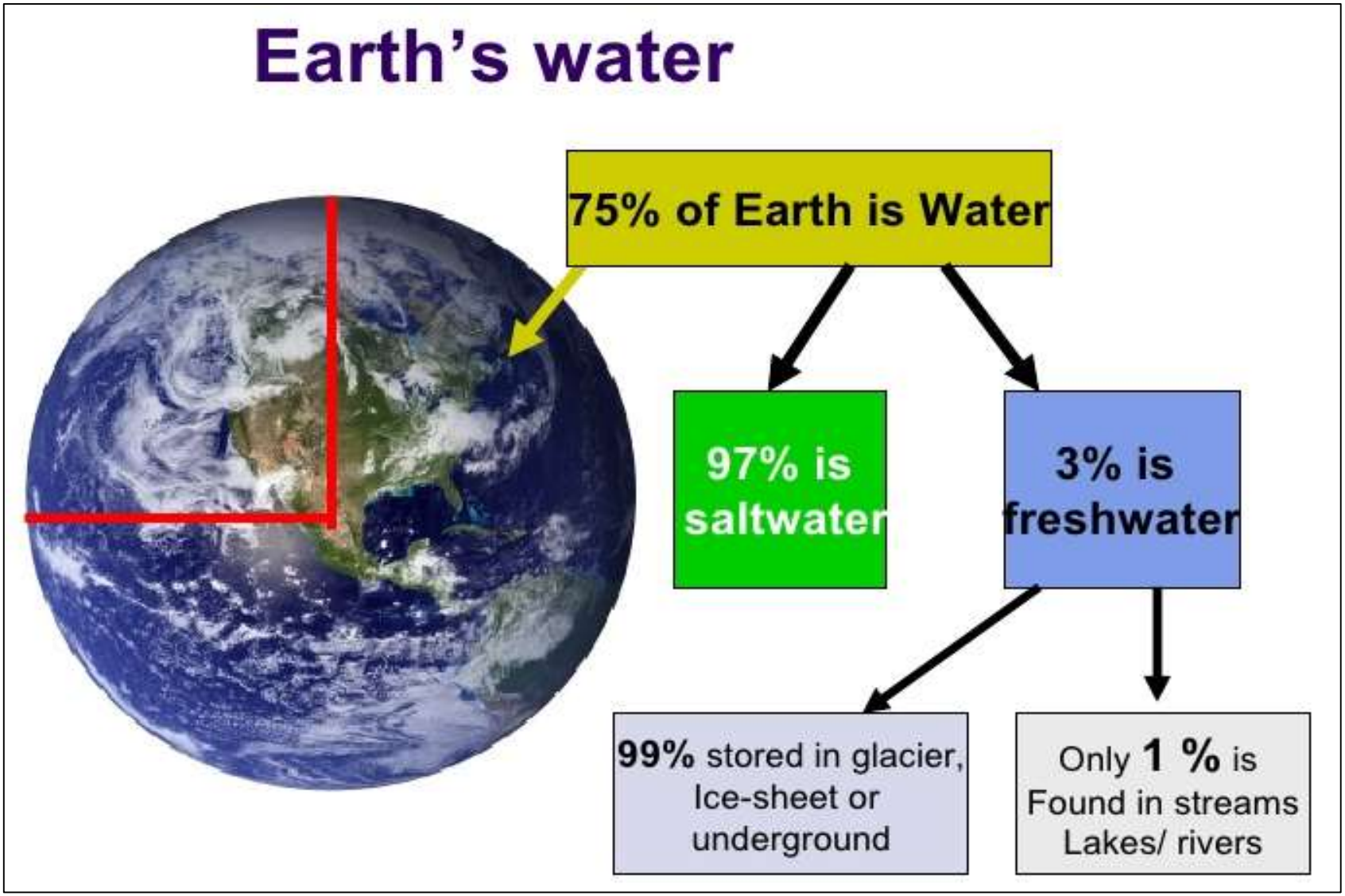
- **Major activities in forests:**
- Timber extraction and Mining
- **Dams and their Effects on Forests and Tribal People:** Big dams and river valley projects have multi-purpose uses and have been referred as “Temples of modern India”. However these dams are also responsible for the destruction of vast areas of forests.
- Big dams have been in sharp focus of various environmental groups all over the world which is mainly because of several ecological problems including deforestation and socio-economic problems related to tribal or native people associated with them.
- For building big dams, large scale devastation of forests takes place which breaks the natural ecological balance of the region.
- Floods, droughts and landslides become more prevalent in such areas.
- Serious impact on reverine ecosystems.
- Dislodging animal populations, damaging their habitat and cutting off their migratory routes.
- Disruption of fishing, water logging.

- **A Case Study of Sardar Sarovar Dam:**
- The dam is situated on river Narmada and is spread over three states of Gujarat, Maharashtra and Madhya Pradesh.
- The project is aimed at providing irrigation water, drinking water and electricity to the three states, the environmental impacts of the project have raised challenging questions.
- A total of 1,44,731 ha of land is submerged by the dam, out of which 56,547 ha is forest land.
- A total of 573 villages are submerged by the Narmada dam.
- Submergence of about 40,000 ha of forest under Narmada Sagar, 13,800 ha under sardar sarovar and 2,500 ha under Omkareshwar would further create pressure on remaining forest areas in adjoining areas.
- Submergence area is very rich in wildlife. Many of these species are listed in schedule I and II of wildlife protection act.
- As per the estimates of the Institute of Urban Affairs, New Delhi, the Narmada valley project will lead to eventual displacement of more than one million people, which is probably the largest rehabilitation issue ever encountered as per the World Bank.

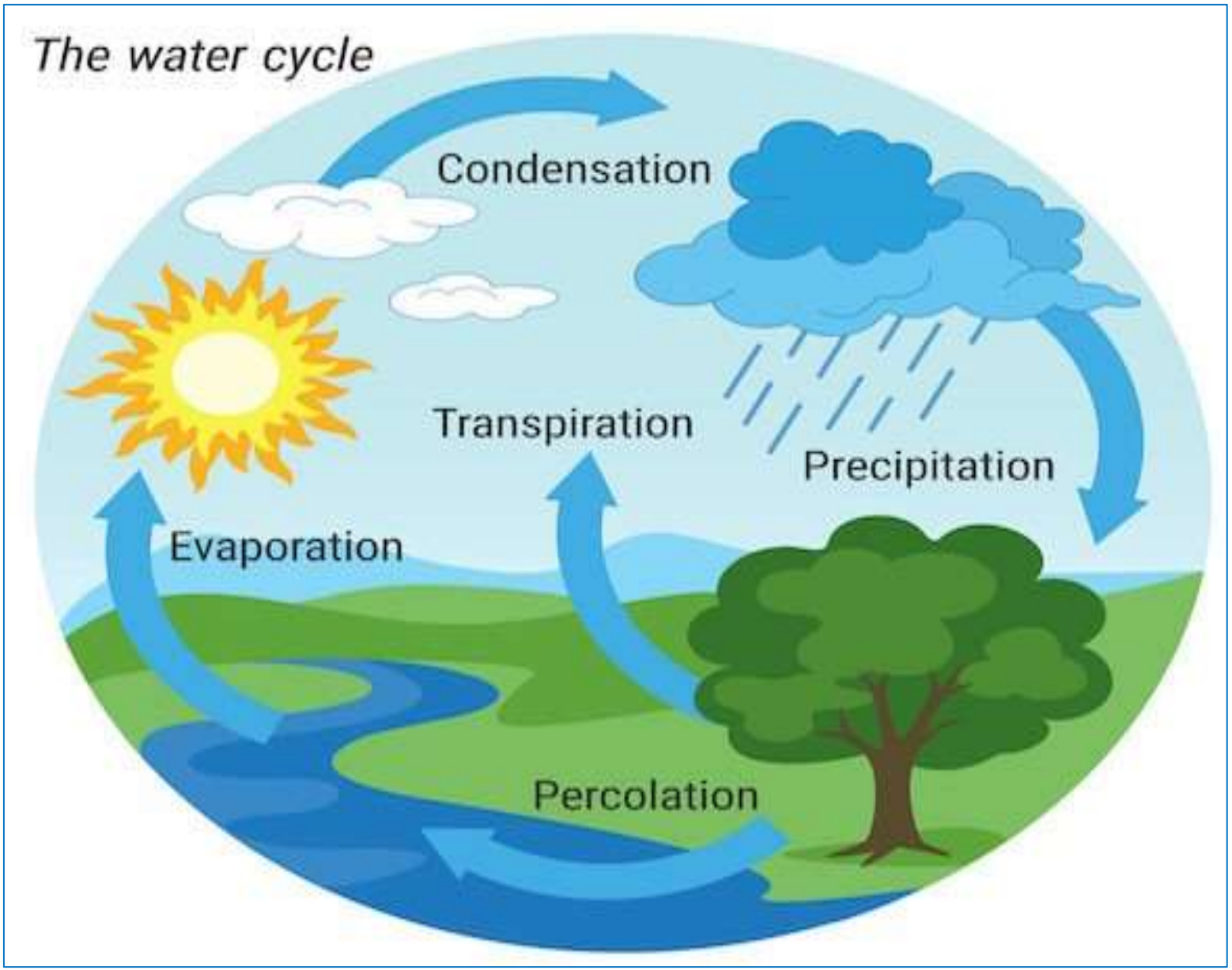
Unit 2

WATER RESOURCES

Water resources



- Water is an indispensable natural resource on this earth on which all life depends.
- **Water use and over exploitation:**
- water use by humans is of two types: **water withdrawal:** taking water from ground water or surface water resources and **water consumption:** the water which is taken up but not returned for reuse.
- With increasing human population and rapid development, the world water withdrawal demands have increased many folds and a large proportion of the water withdrawn is polluted due to anthropogenic activities.
- **Ground water:** about 9.86% of the total fresh water resources is in the form of ground water and it is about 35050 times that of surface water supplies.
- **Surface water:** the water coming from through rainfall, snow. In form of streams, lakes, ponds, wetlands or artificial reservoirs known as surface water.



The water cycle (hydrologic cycle), is the continuous movement of water from the earth's surface to the atmosphere and then back to the ground.

Factors affecting the hydrological conditions:

1) Global climate change

Global warming due to **GREEN HOUSE EFFECT** is leading to increasingly erratic and unpredictable climatic effects.

unprecedented storms or long droughts

2) Floods

- Destruction of **WETLANDS** (Wetlands are - nature's flood control systems)
- **DEFORESTATION** (causes- floods and soil erosion)

3) Drought

rains are unpredictable. This leads to periods when there is a serious **scarcity of water** to drink, use in farms, or provide for urban and industrial use.

4) Overutilization and pollution of surface and groundwater by

Agriculture & Aquaculture 1) over usage of water 2) Pollution by pesticides & fertilizers	**Industry –** Pollution by Solid waste	**Power Generation-** Hydroelectric power plants – thermal pollution

FLOODS

- In some countries like India and Bangladesh rainfall does not occur throughout the year, rather 90% of it is concentrated into a few months.
- Heavy rainfall causes floods in the low-lying coastal areas.
- Prolonged downpour can also cause the over-flowing of lakes and rivers resulting into floods.
- Floods have been regular features of some parts of India and Bangladesh causing huge economic loss as well as loss of life.
- **Causes:**

✓ Overgrazing

✓ Mining

✓ Rapid industrialization

✓ Global warming

❑ Networking of rivers is being proposed at national level to deal with the problems of floods.

DROUGHTS

- When annual rainfall is below normal and less than evaporation, drought conditions are created.
- Ironically, the drought hit areas are often having a high population growth which leads to poor and land use and makes the situation worse.
- **Anthropogenic causes:**
- Drought is a meteorological phenomenon, but due to several anthropogenic causes like overgrazing, deforestation, mining etc. there is spreading of the deserts tending to convert more areas to drought affected areas.
- Erroneous and intensive cropping pattern, increased exploitation scarce water, over exploitation of water for sugarcane crop leads to drought prone areas.
- **Remedial Measures:**
- To select the appropriate crop or plantation depending upon the climate, soil type and its water requirements.
- Social forestry and wasteland development.
- Mixed cropping.

- **Impacts of Big Dams:** Big dams are often referred as a symbol of national development.
- However, there are several other issues and problems related to these.
- **Positive Ecological Impacts:**

✓ Reduction in drought

✓ Prevention of floods

✓ Promotion of productivity in lower areas

- **Negative Ecological Impacts:**
- Deforestation and loss of Biodiversity
- Water logging and salinity
- Flash floods
- Change in water flow and siltation
- Reservoir induced seismicity

- **Positive Socio-economic Impacts:**
- Employment
- Electricity generation
- Irrigation water supply
- Drinking water supply
- Promotion of navigation
- Promotion of fisheries
- **Negative Socio-economic Impacts:**
- Submergence of villages & Fertile lands
- Displacement of native people
- Resettlement issues
- Outbreak of vector bone diseases


Focus on Conserving Groundwater
5 WATER CONSERVATION INTERVENTIONS
IDENTIFIED UNDER JAL SHAKTI MISSION
Water conservation &
rainwater harvesting
Intensive
afforestation
Renovation of
traditional and other
water bodies/tanks
Watershed
development
Reuse &
recharge bore
well structures

Unit 2- FOOD RESOURCES

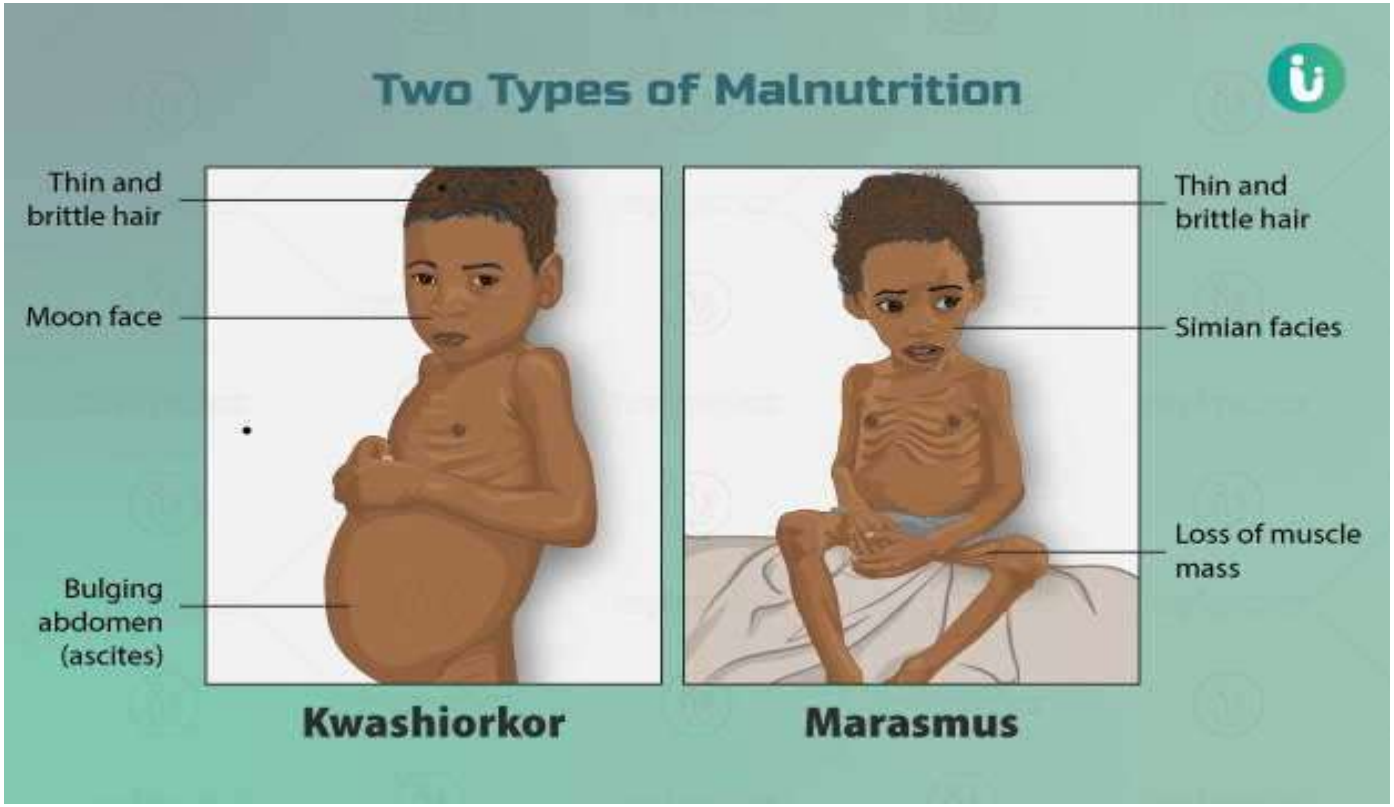
- We have thousands of edible plants and animals over the world out of which only about 3 dozen types constitute the major food of humans.
- The Food and Agricultural Organization (FAO) of United Nations estimated that on an average the minimum caloric intake on a global scale is 2,500 calories/day.
- People receiving less than 90% of these minimum dietary calories are called **undernourished** and if it is less than 80% they are said to be **seriously undernourished**.
- Deficiency or lack of nutrition often leads to **malnutrition** resulting in several diseases.

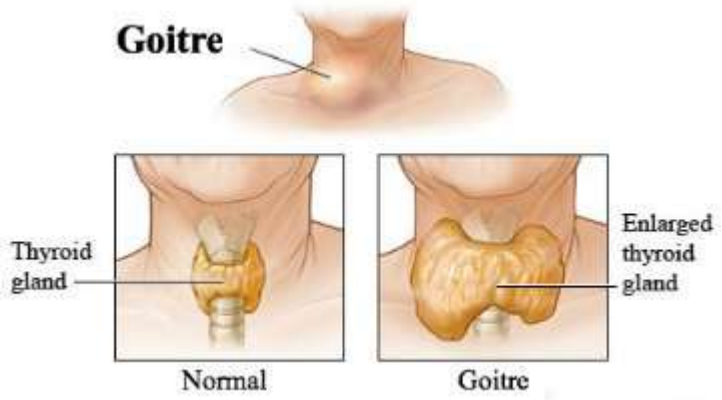
✓ Proteins and calories ---------- stunted growth, K**washiorkor**, **Marasmus**

✓ Iron ---------- **Anaemia**

✓ Iodine ---------- **Goiter, Cretinism**

✓ Vitamin A ---------- **Blindness**


Two Types of Malnutrition
Thin and brittle hair
Moon face
Bulging abdomen (ascites)
Kwashiorkor
Thin and brittle hair
Simian facies
Loss of muscle mass
Marasmus


Goitre
Thyroid gland
Normal
Enlarged thyroid gland
Goitre

- **World Food Problems:** During the last 50 years world grain production has increased almost three times, there by increasing per capita production by about 50%
- But, at the same time population growth increased in less developed countries.
- Every year 40 million people die of undernourishment and malnutrition.
- Although India is the third largest producer of staple crops, an estimated 300 million Indians are still undernourished.
- **The world food summit, 1996** has set the target to reduce the number of undernourished to just half by 2015, which still means 690 million people undernourished on the earth.
- **Effects of Modern Agriculture:**
- It makes use of hybrid seeds of selected and single crop variety, high-tech equipments and lots of energy subsidies in the form of fertilizers, pesticides and irrigation water.
- The food production has increased tremendously, evidenced by “green revolution” also gave rise to several problems.

- **1. Impacts related to high yielding varieties:** The uses of HYVs encourage monoculture (same genotype).
- In case of any attack by some pathogen, there is total devastation of the crop by the disease due to exactly uniform conditions, which help in rapid spread of the disease.
- **2. Fertilizer related problems:**
- **A. Micronutrient imbalance:** most of the chemical fertilizers used in modern agriculture have N,P,K which are essential macronutrients.
- Formers usually use these fertilizers indiscriminately to boost up crop growth.
- Excessive use of fertilizers cause **micronutrient imbalance**.
- **B. Nitrate Pollution:** the nitrates get concentrated in the water and when their concentration exceeds 25 mg/L, they become the cause of a serious health hazard called **"Blue Baby Syndrome"** or **methaemoglobinemia**.
- **C. Eutrophication:** A large proportion of nitrogen and phosphorus used in crop fields is washed off and along with runoff water reach the water bodies causing over nourishment of the lakes.

- **3. Pesticide related problems:**
- **A. creating resistance in pests and producing new pests:** Some individuals of the pest species usually survive even after pesticide spray called **super pests**
- **B. Death of non-target organisms:** Many insecticides are broad spectrum poisons which not only kill the target species but also several non-target species that are useful to us.
- **C. Biological Magnification:** Many of the pesticides are non-biodegradable and keep on accumulating in the food chain, a process called biological magnification.
- **4. Water logging:** Over irrigation of croplands by farmers for good growth of their crop usually leads to water logging.
- **5. Salinity Problems:** At present one third of the total cultivable land area of the world is affected by salts.
- A major cause of salinization of soil is excessive irrigation. About 20% of the world's croplands receive irrigation with canal water or ground water which unlike rainwater often contains dissolved salts.

LAND RESOURCES

LAND AS A RESOURCE

Land is a natural resource of utmost importance. It supports

1) Natural vegetation
2) Wild life
3) Human life
4) Economic activities
5) Transport and communication systems

Various landforms include- **hills**, mountains, **valleys**, **plains**, **river basins, coasts, forests, grasslands** and **wetlands.**

Equally importantly, man needs to protect wilderness area in forests, grasslands, wetlands, mountains, coasts, etc. to protect our vitally valuable biodiversity. These include **sacred groves**, **national park** and **wildlife sanctuaries.**

LAND UTILISATION

Land resources in India are used for several purposes:

- Agriculture
- For growing forests
- For grazing animals
- For mining
- For installing industries and for construction of houses, roads, railways
- For sustainable development and prosperity of any country, the proper and wise use of the land is required.

CAUSES OF LAND DEGRADATION

Deforestation – deforestation for urbanization and population explosion leads to soil erosion and land destruction.

Overcutting of vegetation - Rural people cut natural forests, woodlands and shrub lands to obtain timber, fuel wood and other forest products. Such cutting becomes unsustainable where it exceeds the rate of natural regrowth.

Overgrazing - It leads directly to decreases in the quantity and quality of the vegetation cover. This is a leading cause not only of wind erosion, but also of water erosion in dry lands.

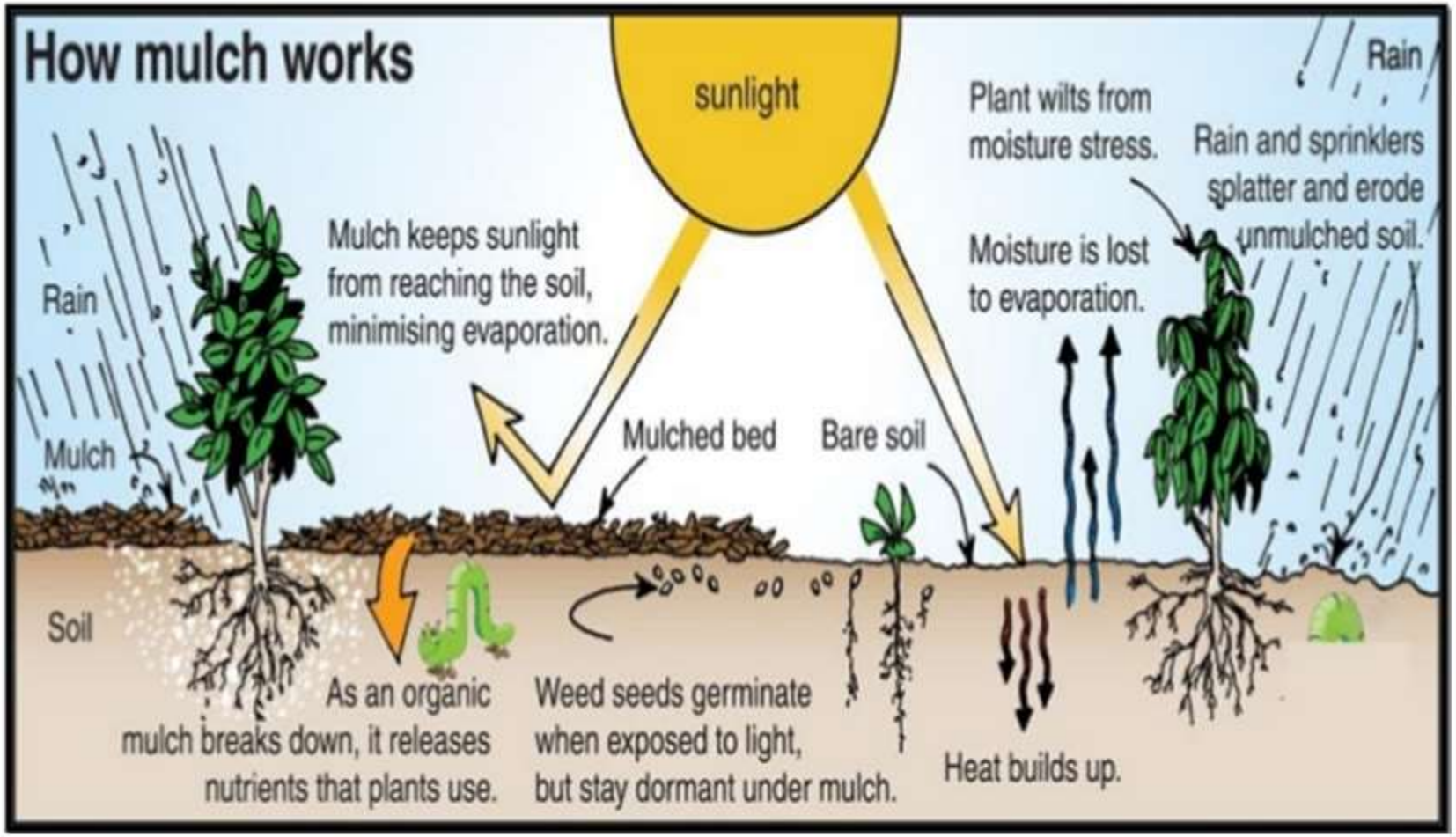
Improper crop rotations - As a result of population growth, land shortage and economic pressures, farmers in some areas have adopted cereal-based, intensive crop rotations, based particularly on rice and wheat, in place of the more balanced cereal-legume rotations that were formerly found. This is a contributory cause of soil fertility decline.

Unbalanced fertilizer use - There has been a steady increase in the ratios of nitrogen to phosphorus, and nitrogen to all other nutrients, in the region. Where phosphate deficiencies have been recognized and counteracted by phosphatic fertilizer, deficiencies of other nutrients, including sulphur and zinc, have been reported.

Problems arising from planning and management of canal irrigation Application of water in excess of natural rainfall led to a progressive rise in the water table from the 1930s onward. Where the water table has reached close to the surface, water logging occurs leading, through evaporation of water containing salts, to salinization.

Over pumping of groundwater In areas of non-saline ('sweet') groundwater, the technology of tube wells has led to abstraction of water in excess of natural recharge by rainfall and river seepage. This has progressively lowered the water table,

CONSERVATION OF LAND RESOURCES



MULCHING: The bare ground between plants is covered with a layer of organic matter like straw. It helps to retain soil moisture, add organic matter and provide nutrients.

ROCK DAM: Rocks are piled up to slow down the flow of water. This prevents gullies and further soil loss.

TERRACE FARMING: Broad flat steps or terraces are made on the steep slopes so that flat surfaces are available to grow crops. They reduce surface run-off and soil erosion.

SHELTER BELTS: In the coastal and dry regions, rows of trees are planted to check the wind movement to protect soil cover

INTERCROPPING: Different crops are grown in alternate rows and are sown at different times to protect the soil from rain wash.

CONTOUR PLOUGHING: Ploughing parallel to the contours of a hill slope to form a natural barrier for water to flow down the slope.

Afforestation - It is the planting or adding of trees in an area where there was never a forest or plantation. This is a method to create a new forest. **Reforestation** is the replanting of trees in an area where there was once a forest which was destroyed or damaged.

Land reclamation

Regulated use of chemical pesticide and fertilizers

Prevention of overgrazing

UNIT 2
ENERGY RESOURCES

Power or energy plays a vital role in our lives. We also need power for industry, agriculture, transport, communication and defense. Power resources may be broadly categorized into 2 types:

Conventional sources of energy	**Non-conventional sources of energy**
Oil	Solar energy
Natural gas	Wind energy
Firewood	Nuclear energy
Coal	Geothermal energy
Hydel power	Tidal energy
	Biogas

PETROLEUM (Latin Petra (rock), oleum (oil)

It is found between the layers of rocks and is **drilled** from oil fields located in off-shore and coastal areas. This is then sent to **refineries** which process the **crude oil** and produce a variety of products like **diesel, petrol, kerosene, and lubricants.** Petroleum and its derivatives are called **Black Gold** as they are very valuable.

The chief petroleum producing countries are Iran, Iraq, Saudi Arabia and Qatar.

NATURAL GAS

Natural gas is found with petroleum deposits and is released when crude oil is brought to the surface. It can be used as a domestic & industrial fuel.

It consists primarily of **methane (70-90%),** ethane, propane and butane.

Russia, Norway, UK and the Netherlands are the major producers of natural gas.

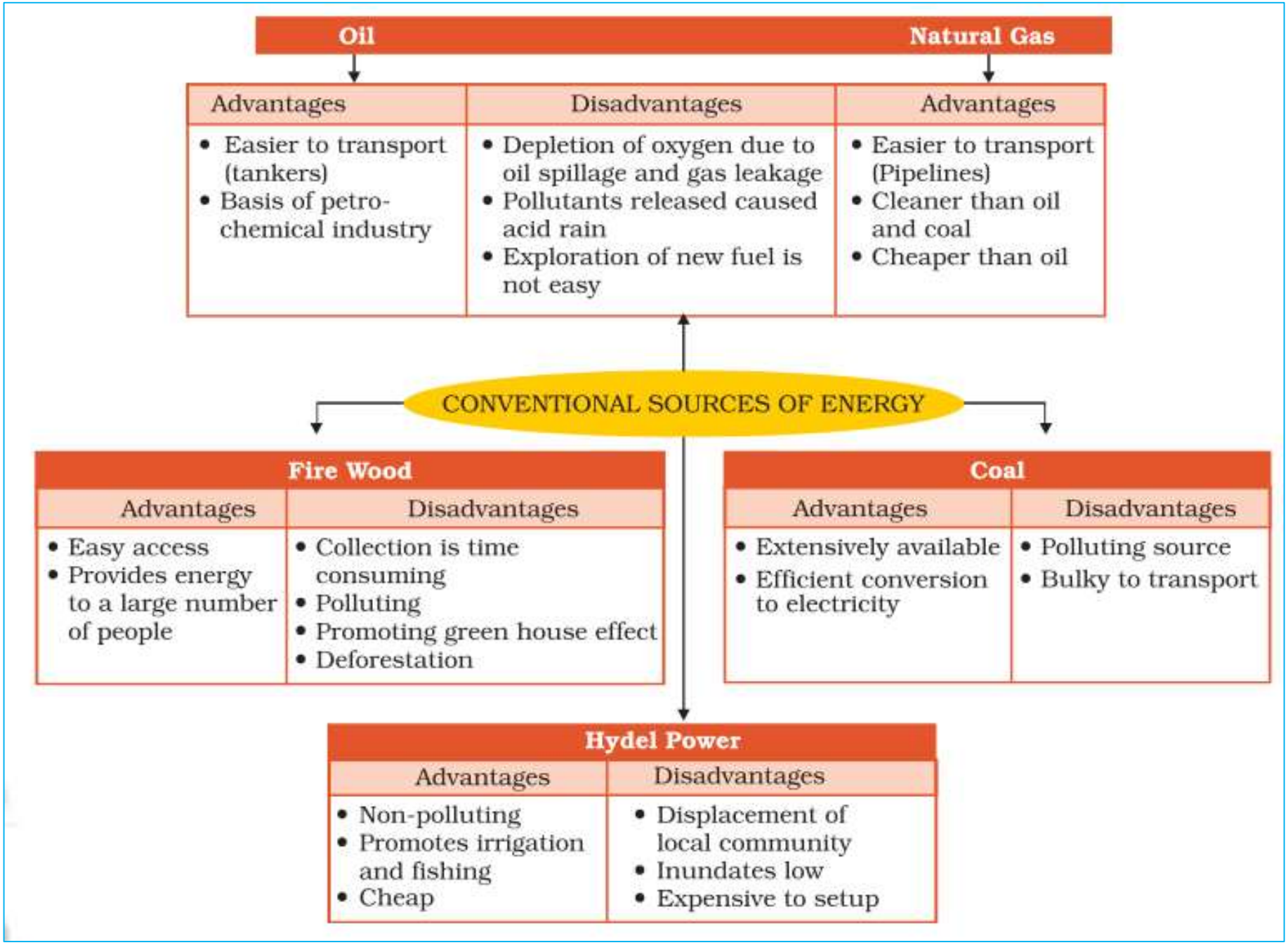
FIREWOOD

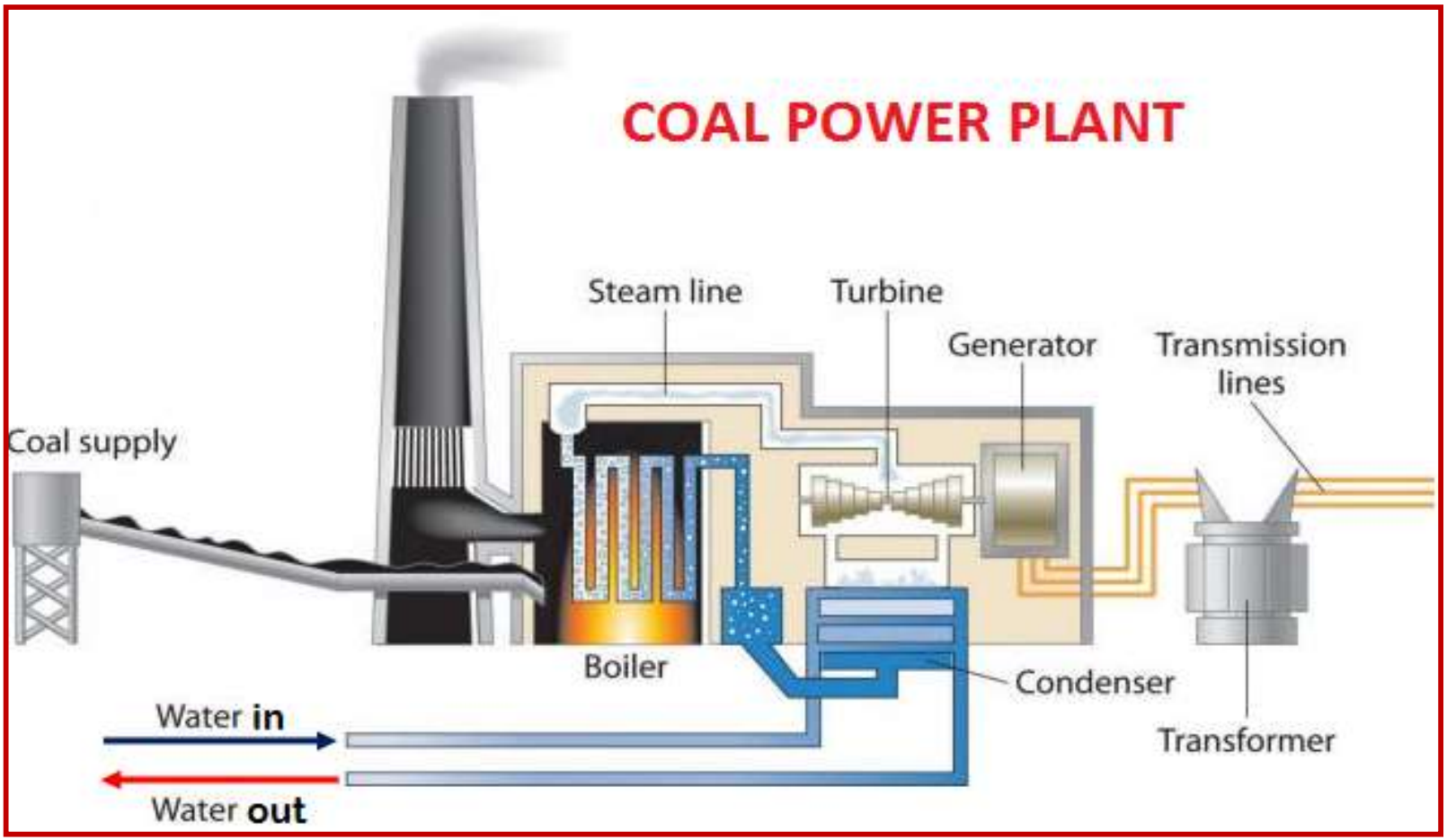
It is widely used for **cooking** and **heating**. In our country more than fifty per cent of the energy used by villagers comes from fire wood.

COAL

This is the most abundantly found fossil fuel. The coal which we are using today was formed millions of years ago when giant ferns and swamps got buried under the layers of earth. Coal is therefore referred to as **Buried Sunshine**.

The leading coal producers of the world are China, USA, Germany


Oil
Natural Gas
Advantages
Disadvantages
Advantages
• Easier to transport (tankers)
• Basis of petro-chemical industry
• Depletion of oxygen due to oil spillage and gas leakage
• Pollutants released caused acid rain
• Exploration of new fuel is not easy
• Easier to transport (Pipelines)
• Cleaner than oil and coal
• Cheaper than oil
CONVENTIONAL SOURCES OF ENERGY
Fire Wood
Advantages
Disadvantages
• Easy access
• Provides energy to a large number of people
• Collection is time consuming
• Polluting
• Promoting green house effect
• Deforestation
Coal
Advantages
Disadvantages
• Extensively available
• Efficient conversion to electricity
• Polluting source
• Bulky to transport
Hydel Power
Advantages
Disadvantages
• Non-polluting
• Promotes irrigation and fishing
• Cheap
• Displacement of local community
• Inundates low
• Expensive to setup



Coal-fired plants produce **electricity** by burning **coal** in a boiler to produce steam. The steam produced, under tremendous pressure, flows into a turbine, which spins a generator to create **electricity**. The steam is then cooled, condensed back into water and returned to the boiler to start the process over.

ADVANTAGES

Affordability - Since coal is abundant & its extraction being inexpensive its price remains low compared to other fuel and energy sources.

Abundance. There are approximately over 300 years of economic coal deposits still accessible. Hence, can be continuously fueled in many years to come.

Known technologies. The production and use of coal as a fuel are well understood, and the technology required is constantly advancing.

Safety. A coal power plant's failure is certainly not likely to cause catastrophic events such as a nuclear meltdown would hence, are more safe. Additionally, the welfare of employees has greatly improved over the years.

DISADVANTAGES

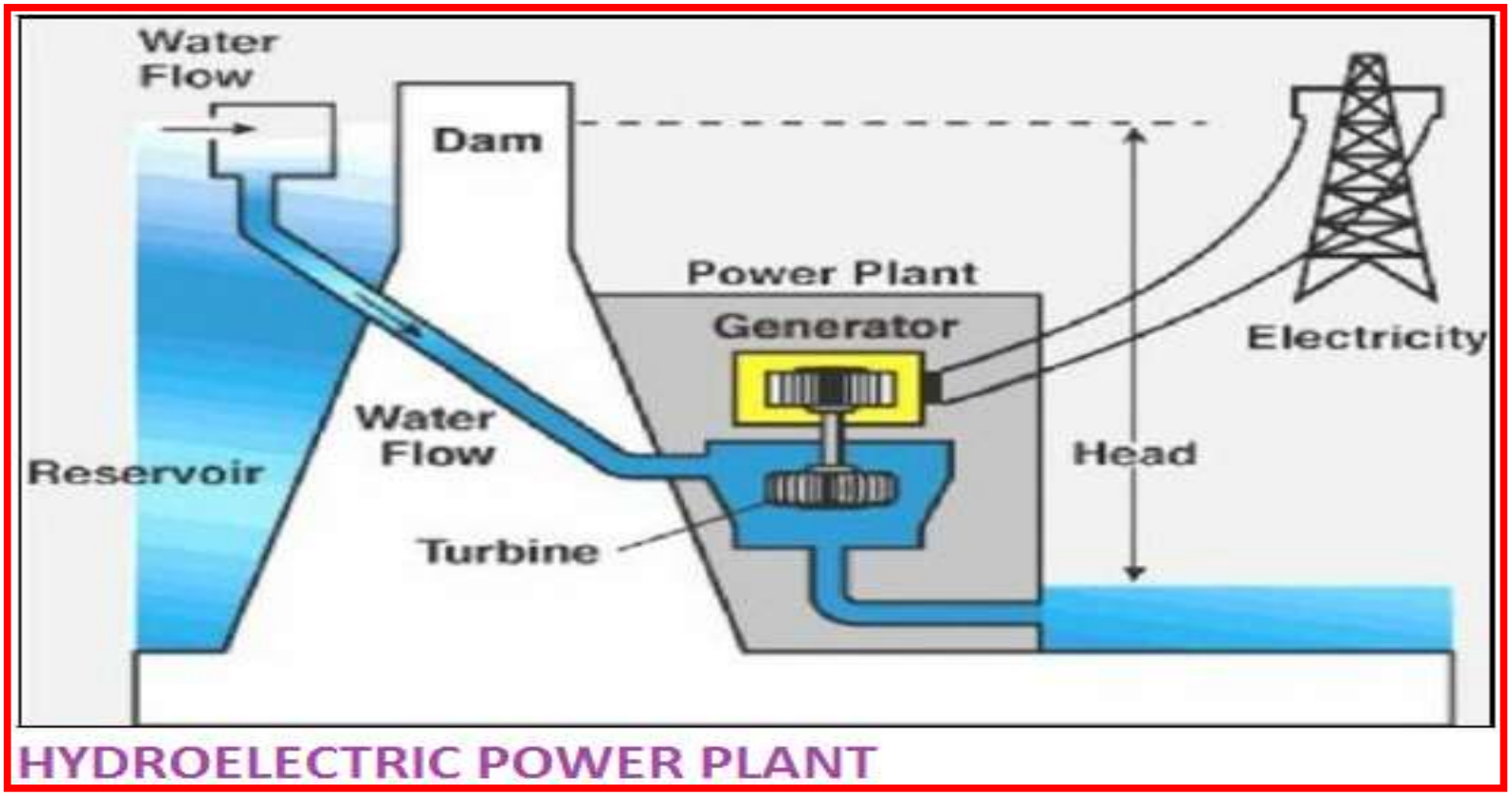
Greenhouse gas emissions. Combustion of coal will emit carbon emissions causing pollution and contribute to global warming.

Mining destruction. Mining will result in the destruction of habitat, scenery, and displaces humans as well.

Generation of millions of tons of waste. Millions of tons of waste products which can no longer be reused are generated from coal fired plants.

Emission of harmful substances. These include mercury, sulfur dioxide, carbon monoxide, selenium, and arsenic. These harmful substances not only cause acid rain but also are very harmful to humans as well.

HYDEL POWER



When water is at a height it has potential energy (PE) stored in it. When this water flows down, its PE is first converted to kinetic energy (K.E) & then to mechanical energy with the help of turbines. With the use of generator, the mechanical energy is transformed into Electrical energy. Hydropower is essential only next to thermal power. Hydropower plants meet nearly 20% of the total power of the world.

Eg. Nagarjunsagar and Damodar valley projects.

ADVANTAGES OF HYDROPOWER PLANTS

1) **Rainwater** is stored in the dam. Thus it is considered to be a renewable source of energy
2) The construction of dams helps in providing **irrigation** to the local farmers; it also helps in controlling floods.
3) Does not produce any **pollution**.
4) Their **operational cost** is very low.

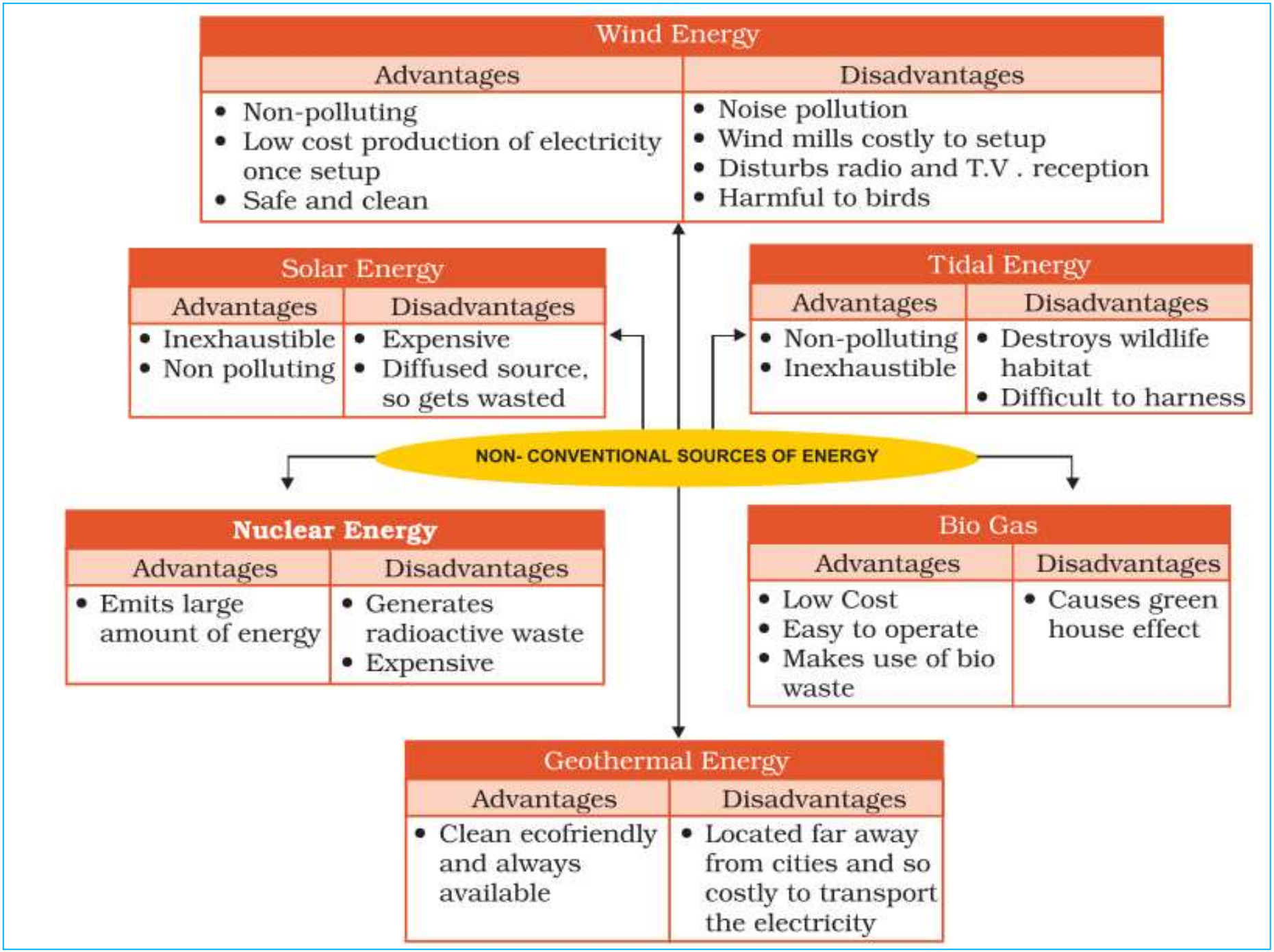
DISADVANTAGES OF HYDROPOWER PLANTS

1) The plants require **high capital** with a low rate of return.
2) Dams can only be built at **specific locations**.
3) A large area of agriculture is **submerged** under water.

Problems associated with use of fossil fuels:

- The increasing use of fossil fuels is leading to its shortage. It is estimated that if the present rate of consumption continues, the reserves of these fuel will get exhausted.
- Moreover, their use also causes environmental pollution.
- Therefore, there is need for using non-conventional sources such as solar energy, wind energy, tidal energy which are renewable.

Non-conventional Sources of Energy


Wind Energy
Advantages
Non-polluting
Low cost production of electricity once setup
Safe and clean
Disadvantages
Noise pollution
Wind mills costly to setup
Disturbs radio and T.V . reception
Harmful to birds
Solar Energy
Advantages
Inexhaustible
Non polluting
Disadvantages
Expensive
Diffused source, so gets wasted
Tidal Energy
Advantages
Non-polluting
Inexhaustible
Disadvantages
Destroys wildlife habitat
Difficult to harness
NON- CONVENTIONAL SOURCES OF ENERGY
Nuclear Energy
Advantages
Emits large amount of energy
Disadvantages
Generates radioactive waste
Expensive
Bio Gas
Advantages
Low Cost
Easy to operate
Makes use of bio waste
Disadvantages
Causes green house effect
Geothermal Energy
Advantages
Clean ecofriendly and always available
Disadvantages
Located far away from cities and so costly to transport the electricity

Solar energy

- Sun's heat and light energy can be felt by us every day.
- Solar energy trapped from the sun can be used in **SOLAR CELLS** to produce electricity. Many of these cells are joined into **SOLAR PANELS** to generate power for heating and lighting purpose.
- The technology of utilizing solar energy benefits a lot of tropical countries that are blessed with abundant sun shine.
- Solar energy is also used in **solar heaters**, **solar cookers**, **solar dryers** besides being used for community lighting and traffic signals.

Solar plane

Solar car

Solar bike

Solar cooker

ADVANTAGES

1) **Renewable Energy Source**
2) **Reduces Electricity Bills**
3) **Diverse Applications -** generate **electricity** (photovoltaics) or **heat** (solar thermal)
4) Low maintenance cost- Solar energy systems generally **don't require a lot of maintenance**. You only need to keep them relatively clean, so cleaning them a couple of times per year will do the job.
5) **Technology development:** Technology in the solar power industry is constantly advancing and improvements will double, or even triple, the electrical input of the solar power systems.

DISADVANTAGES:

1) **Cost -** The **initial cost** of purchasing a solar system is fairly high. This includes paying for solar panels, inverter, batteries, wiring, and the installation.
2) **Weather-Dependent -** the efficiency of the solar system drops during cloudy and rainy days. solar energy cannot be collected during the night.
3) **Solar Energy Storage Is Expensive -** Solar energy has to be used right away, or it can be stored in large batteries which are expensive.
4) **Uses a Lot of Space –** Solar PV panels require a lot of space and **some roofs are not big enough** to fit the number of solar panels that you would like to have.
5) **Associated with Pollution -** use of hazardous materials in manufacturing—can vary greatly depending on the technology, which includes two broad categories: photovoltaic (PV) **solar** cells or concentrating **solar** thermal plants (CSP).

Non-Renewable Energy Sources: These are the fossil fuels like coal, petroleum, natural gas and nuclear fuels. These were formed by the decomposition of the remains of plants and animals buried under the earth million years ago.

Coal: Coal was formed 255-350 million years ago in the hot, damp regions of the earth during the carboniferous age. The ancient plants along the bank of rivers and swamps were buried after death into the soil and due to the heat and pressure gradually got converted into peat and coal over million years of time. There are mainly three types of coal, namely **anthracite (hard coal), bituminous (soft coal) and lignite (brown coal)**. Anthracite coal has maximum carbon and calorific value. Coal is the most abundant fossil fuel in the world.

All the present rate of usage, the coal reserves are likely to last for about 200 years and if its use increases by 2% per year, then it will last for another 65years.

When coal is burnt it produces carbon dioxide, which is a green house gas responsible for causing enhanced global warming. Coal also contains impurities like sulphur and therefore as it burns the smoke contains toxic gases like oxides of sulphur and nitrogen.

Major coal fields in India are Raniganj, Jharia, Bokaro, Singrauli, and Godavari valley. The coal states of India are Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra.

Petroleum: It is the lifeline of global economy. There are 13 countries in the world having 67% of the petroleum reserves which together form the OPEC (organization of petroleum exporting countries)

At the present rate of usage, the world's crude oil reserves are estimated to get exhausted in just 40 years.

Crude petroleum is a complex mixture of alkane hydrocarbons. Hence it has to be purified and refined by the process of fractional distillation, during which process different constituents separate out at different temperatures. We get a large variety of products from this, namely, petroleum gas, kerosene, petrol, diesel, fuel oil, lubricating oil, paraffin was, asphalt, plastic etc.

Petroleum is a cleaner fuel as compared to coal as it burns completely and leaves no residue. It is also easier to transport and use. That is the reason why petroleum is preferred amongst all the fossil fuels.

Oil fields in India are located at Digboi (Assam), Gujarat plains and Bombay high, offshore areas in deltaic coasts of Godavari, Krishna, Kaveri and Mahanandi.

Natural Gas: it is mainly composed of methane (95%) with small amounts of propane and ethane. It is a fossil fuel. Natural gas deposits mostly accompany oil deposits because it has been formed by decomposing remains of dead animals and plants buried under the earth. **Natural gas is the cleanest fossil fuel**. It can be easily transported through pipelines. It can be easily transported through pipelines.

Natural gas is used as a domestic and industrial fuel. It is used as a fuel in thermal power plants for generating electricity. It is used as a source of hydrogen gas in fertilizer industry.

Compressed Natural Gas (CNG): It is being used as an alternative to petrol and diesel for transport of vehicles. Delhi has totally switched over to CNG where buses and auto rickshaws run on this new fuel.

CNG use has greatly reduced vehicular pollution in the city.

Synthetic Natural Gas (SNG): it is a mixture of carbon monoxide and hydrogen. It is a connecting link between a fossil fuel and substituted natural gas.

WIND ENERGY

✓Wind is an **inexhaustible source** of energy. As a renewable resource that won't get depleted through use.

✓The high speed winds have a lot of energy in them as a kinetic energy due to their motion.

✓The driving force of the winds is the sun.

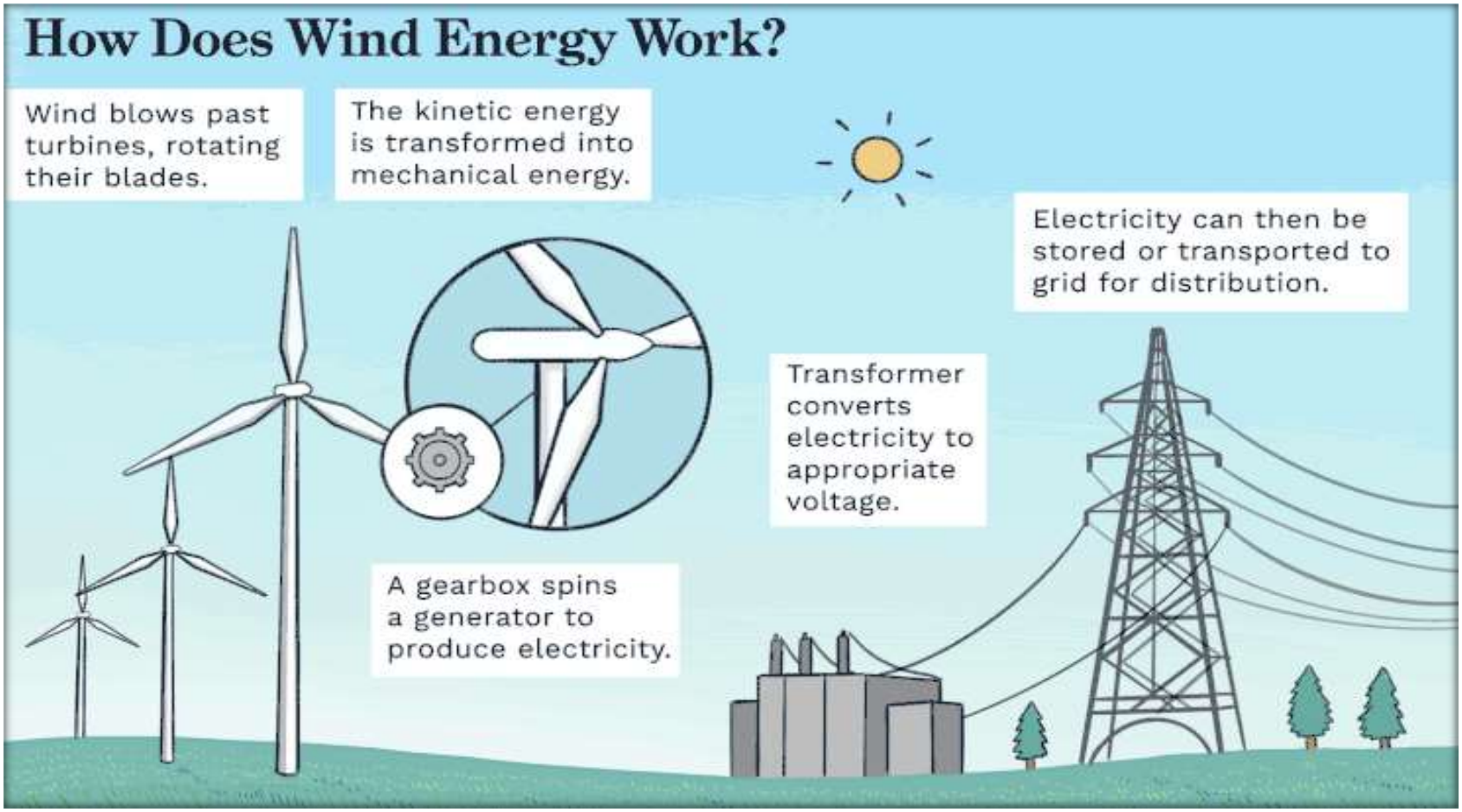
✓The wind energy is harnessed by making use of wind mills.

✓The blades of the wind mill keep on rotating continuously due to the force of the striking wind.

✓A large number of wind mills are installed in clusters called wind farms.

✓These forms are ideally located in coastal regions, open grasslands or hilly regions, particularly mountain passes and ridges where the winds are strong and steady.

✓The minimum wind speed required for satisfactory working of a wind generator is 15km/hr.



Wind turbines convert the **energy** in **wind** to **electricity** by rotating propeller-like blades around a rotor. The rotor turns the drive shaft, which turns an electric generator. Three key factors affect the amount of **energy** a **turbine** can harness from the **wind**: **wind** speed, air density, and swept area. (The area of the circle created by blades as they sweep through the air)

Pros:

- When properly placed, wind energy can produce **low-cost** and **nonpolluting** electricity about 90% of the time.
- There is **minimal waste** generated by a wind farm — nothing needs to be carted away and dumped, no water supply is needed to cool machinery, and there's no effluent to scrub or clean.
- Once installed, wind turbines have a **low operating cost**, as wind is free.
- It's space **flexible**: You can use a small turbine to power a home or farm building, a large turbine for industrial energy needs, or a field of giant turbines to create a power plant-level source of energy for a city.

Cons:

- Wind reliability can vary. In addition, **weak or strong winds** will shut down a turbine and electricity won't be produced at all.
- Turbines can be **noisy** depending on where they are placed, and some people don't like the way they look. Home wind turbines might offend neighbors.
- Wind turbines have been found to **harm** wildlife, especially **birds and bats.**
- They have a **high initial cost**, though they pay for themselves relatively quickly.

Nuclear Power

Nuclear power is obtained from energy stored in the nuclei of atoms of naturally occurring radio active elements like **URANIUM** and **THORIUM**.

These fuels undergo nuclear fission in nuclear reactors and emit large amount of energy through a chain reactions.

In India Rajasthan and Jharkhand have large deposits of Uranium. Thorium is found in large quantities in the Monozite sands of Kerala.

The nuclear power stations in India are located in Kalpakkam in Tamilnadu, Tarapur in Maharastra, Ranapratap Sagar near Kota in Rajasthan, Narora in Uttar Pradesh and Kaiga in Karnataka.

The greatest producers of nuclear power are USA and Europe.

Nuclear Fission Reactions

$$_{92}U^{233} + {}_{0}n^{1} \longrightarrow {}_{92}U^{234} \xrightarrow{94\%} {}_{38}Sr^{94} + {}_{54}Xe^{137} + 3\ {}_{0}n^{1} + 197.9MeV$$

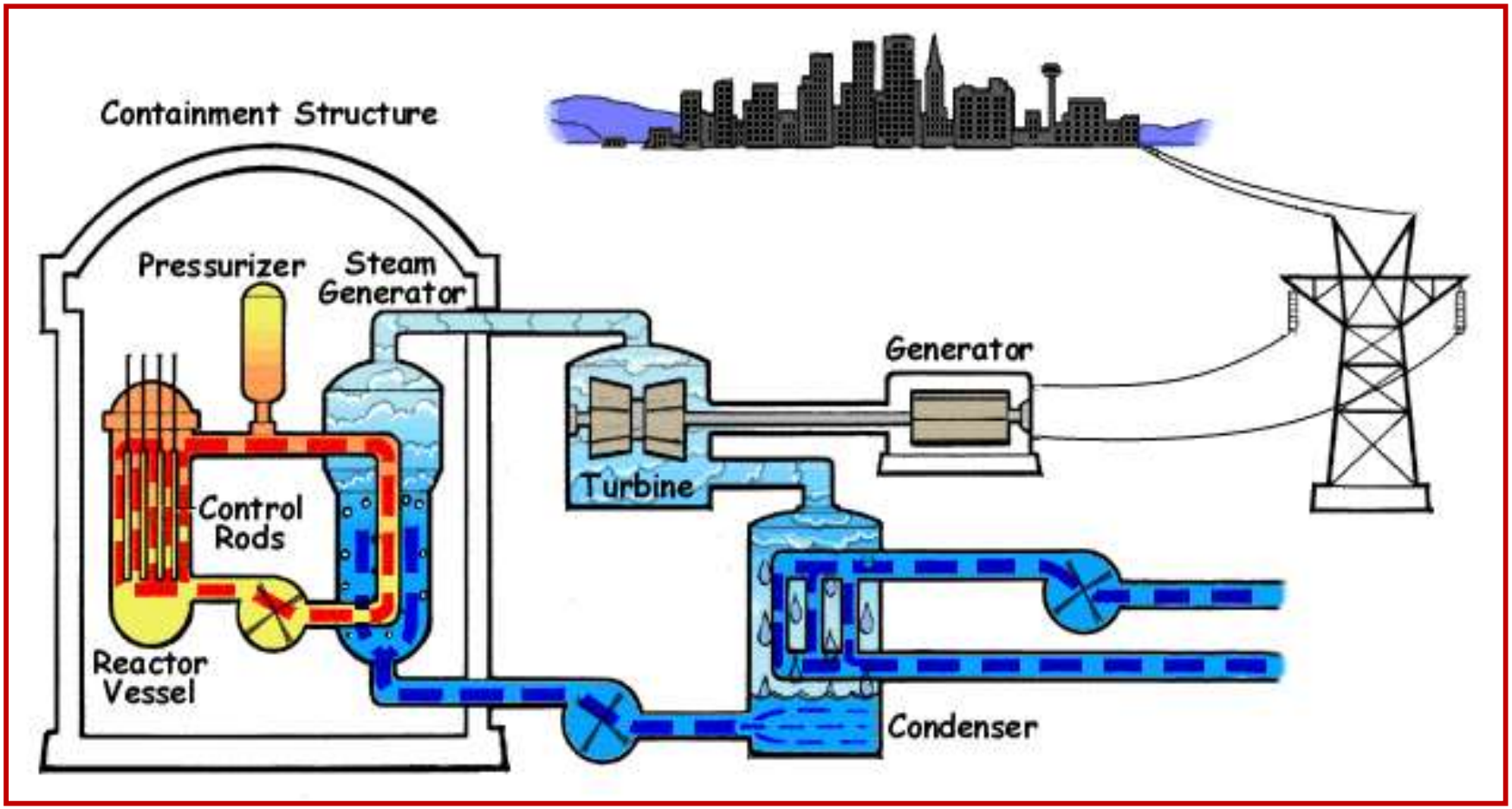
Uranium (Synthetic) | Neutron (Thermal) | Uranium (Unstable) | Strontium | Xenon | Neutrons (Fast) | Energy/atom

$$_{92}U^{235} + {}_{0}n^{1} \longrightarrow {}_{92}U^{236} \xrightarrow{85\%} {}_{36}Kr^{92} + {}_{56}Ba^{141} + 3\ {}_{0}n^{1} + 202.5MeV$$

Uranium (Natural) | Neutron (Thermal) | Uranium (Unstable) | Krypton | Barium | Neutrons (Fast) | Energy/atom

$$_{94}Pu^{239} + {}_{0}n^{1} \longrightarrow {}_{94}Pu^{240} \xrightarrow{73\%} {}_{40}Zr^{103} + {}_{54}Xe^{134} + 3\ {}_{0}n^{1} + 207.1MeV$$

Plutonium (Synthetic) | Neutron (Thermal) | Plutonium (Unstable) | Zirconium | Xenon | Neutrons (Fast) | Energy/atom



In **nuclear power plants**, neutrons collide with uranium atoms, splitting them. In the core of **nuclear reactors**, the fission of uranium atoms releases **energy** that heats water to about 520 degrees Farenheit. This hot water is then used to spin turbines that are connected to generators, producing electricity.

ADVANTAGES

1. **Low-cost energy-** Although building nuclear power plants has a high initial cost, it's relatively cheap to produce energy from them and they have low operating costs.
2. **Reliable-** a nuclear power plant can produce energy nonstop, and you won't have to experience any delays in energy production.
3. **Zero carbon emissions-** Nuclear power reactors do not produce any carbon emissions unlike traditional sources of energy, like fossil fuels, which releases tons of CO_2
4. **Promising future energy supply-** If we can learn to control atomic fusion, we could practically have unlimited energy.

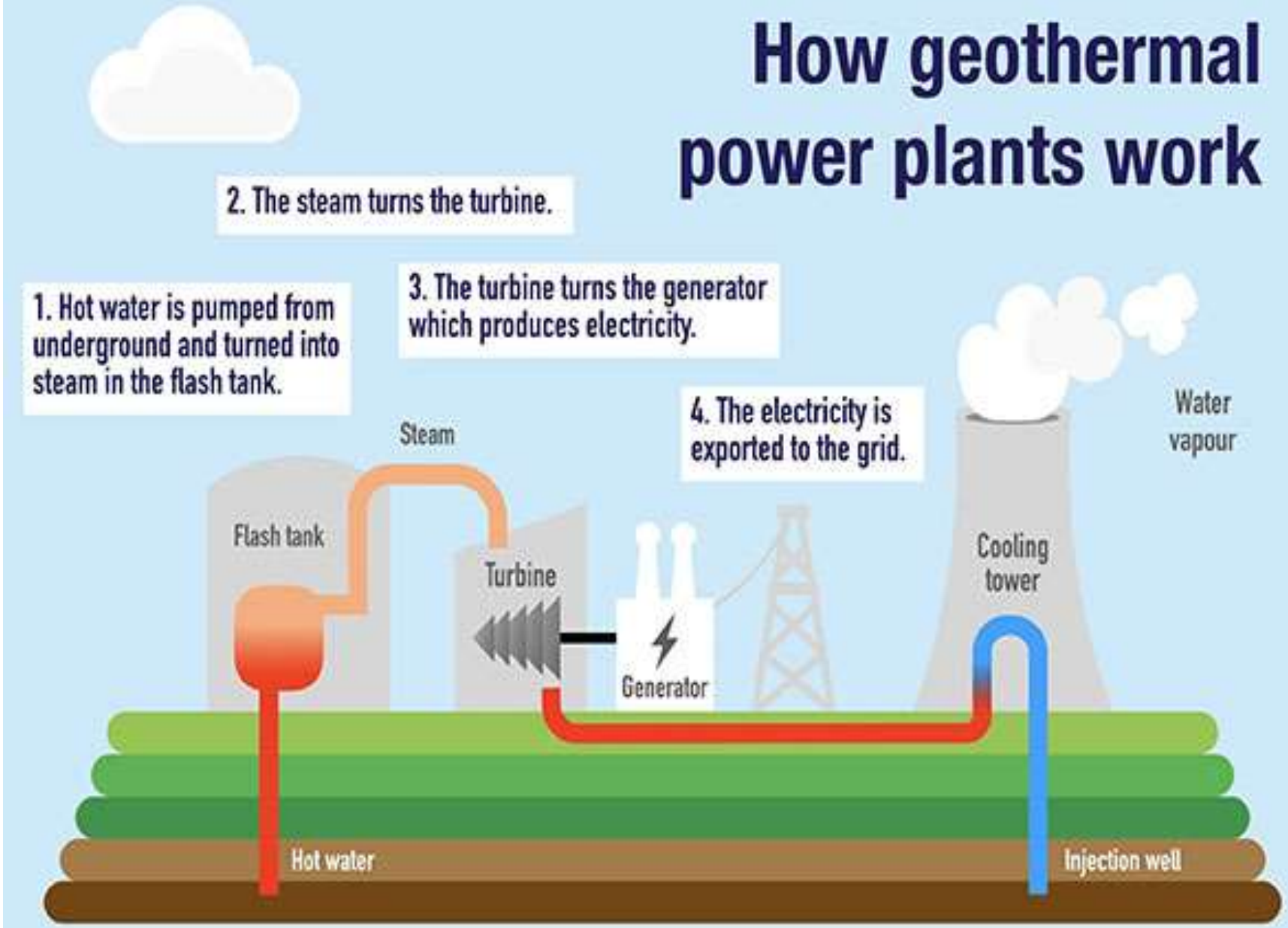
DISADVANTAGES

1. **Environmental impact-** mainly through mining (of uranium etc) and water discharge (thermal pollution).
2. **Intensive water requirement-** Nuclear power plants require a lot of water to produce energy. This could be unsustainable.
3. **Risk of nuclear accidents-** a nuclear meltdown, harmful radiation can leak, which can cause adverse effects on the environment and on human health.
4. **Radioactive waste-** create hazardous waste which remains dangerously radioactive for many years. Many issues arise even for storing these wastes.

Geothermal Energy

- The energy harnessed from the hot rocks present inside the earth is called geothermal energy.
- High temperature and high pressure fields exist below the earth's surface in many places.
- This heat comes from the fission of radioactive material naturally present inside the rocks.
- We can artificially drill a hole up to the rocks and by putting a pipe in it make the steam or hot water gush out through the pipe at high pressure which turns the turbine of a generator to produce electricity.
- In USA and New Zealand, there are several geothermal plants working successfully.

How geothermal power plants work

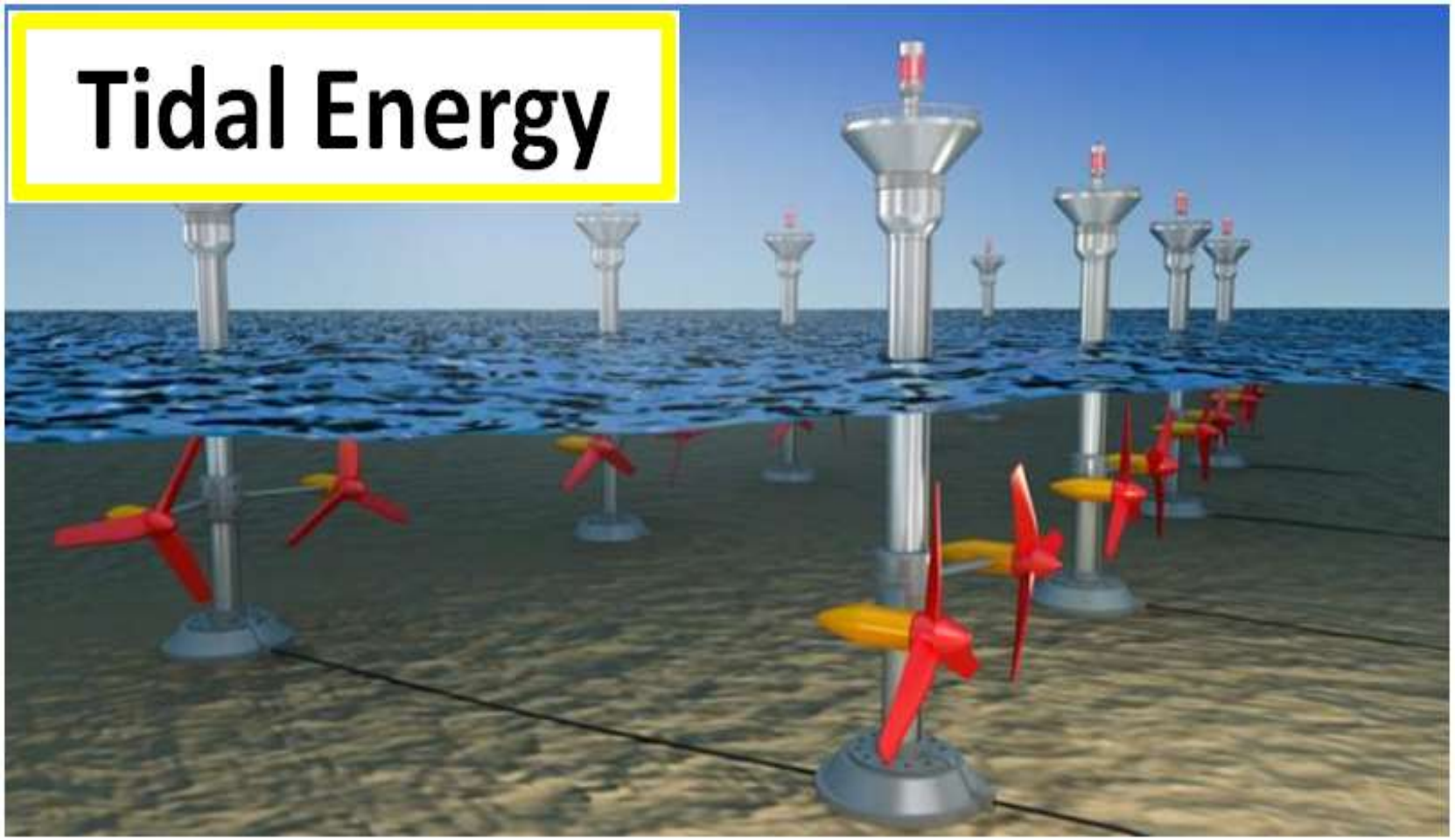


Advantages

- Available all the year around.
- Does not involve any combustion of fuel.
- Independent of weather
- Clean Resource – Very little emissions or overall environmental impact.
- Economically Sound Alternative – The fuel is free, rate / KWh likely to be competitive
- Overall, geothermal energy is a sustainable resource.

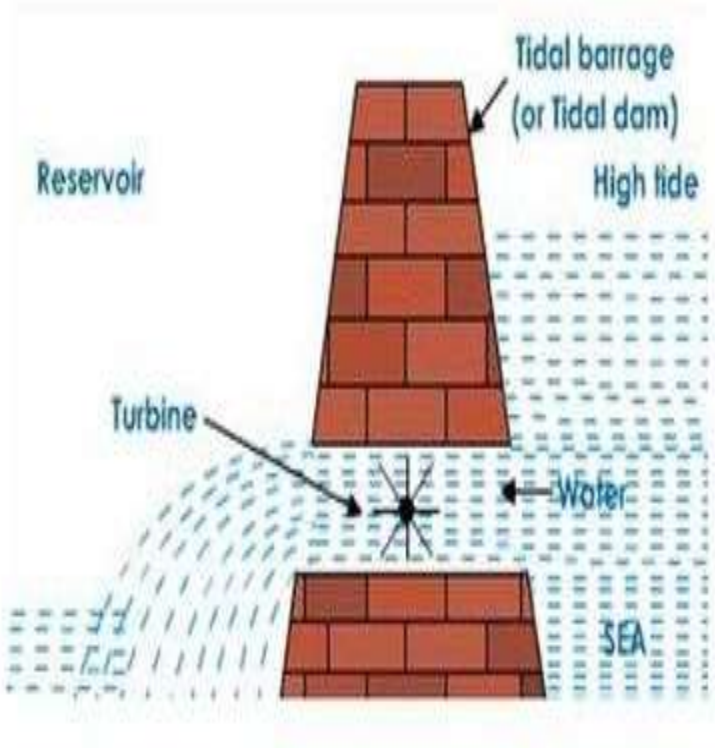
Disadvantages

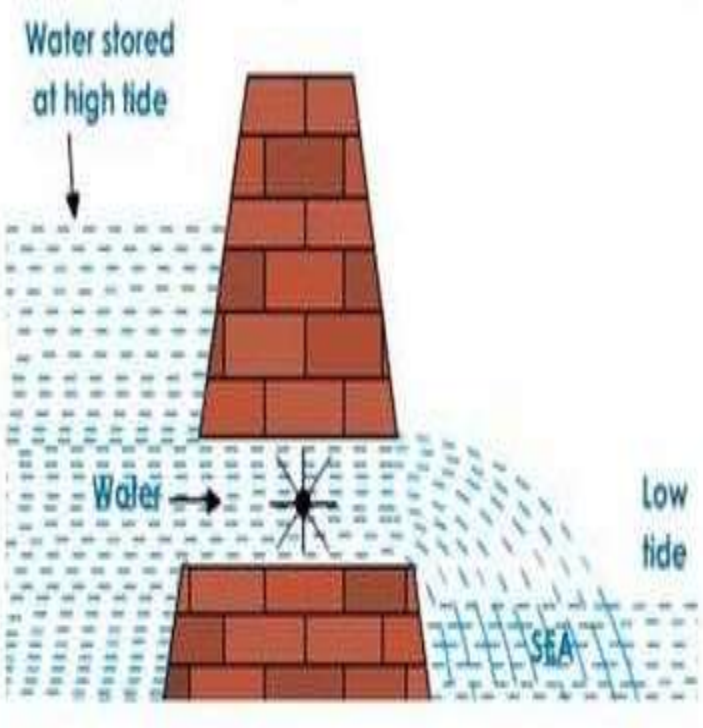
- Not widespread source of energy
- High installation costs
- Can run out of steam
- May release harmful gases
- Transportation



Tidal energy is a form of hydropower which converts the energy obtained from tides into other useful energies (electricity). It is the result of the sun's and the moon's influence over the ocean. The height difference between low and high tides gives rise to tidal currents in coastal areas which drives the turbines.

- Ocean tides produced by gravitational forces of sun and moon contain enormous amounts of energy.
- The high tide and low tide refer to the rise and fall of water in the oceans.
- A difference of several meters is required between the height of high and low tide to spin the turbines.
- The tidal energy can be harnessed by constructing a tidal barrage.
- During high tide, the sea water flows into the reservoir of the barrage and turns the turbine, which in produces electricity by rotating the generators.
- During low tide, when the sea lever is low, the sea water stored in the barrage reservoir flows out into the sea and again turns the turbines.


Tidal barrage
(or Tidal dam)
Reservoir
High tide
Turbine
Water
SEA


Water stored
at high tide
Water
Low
tide
SEA

Advantages:

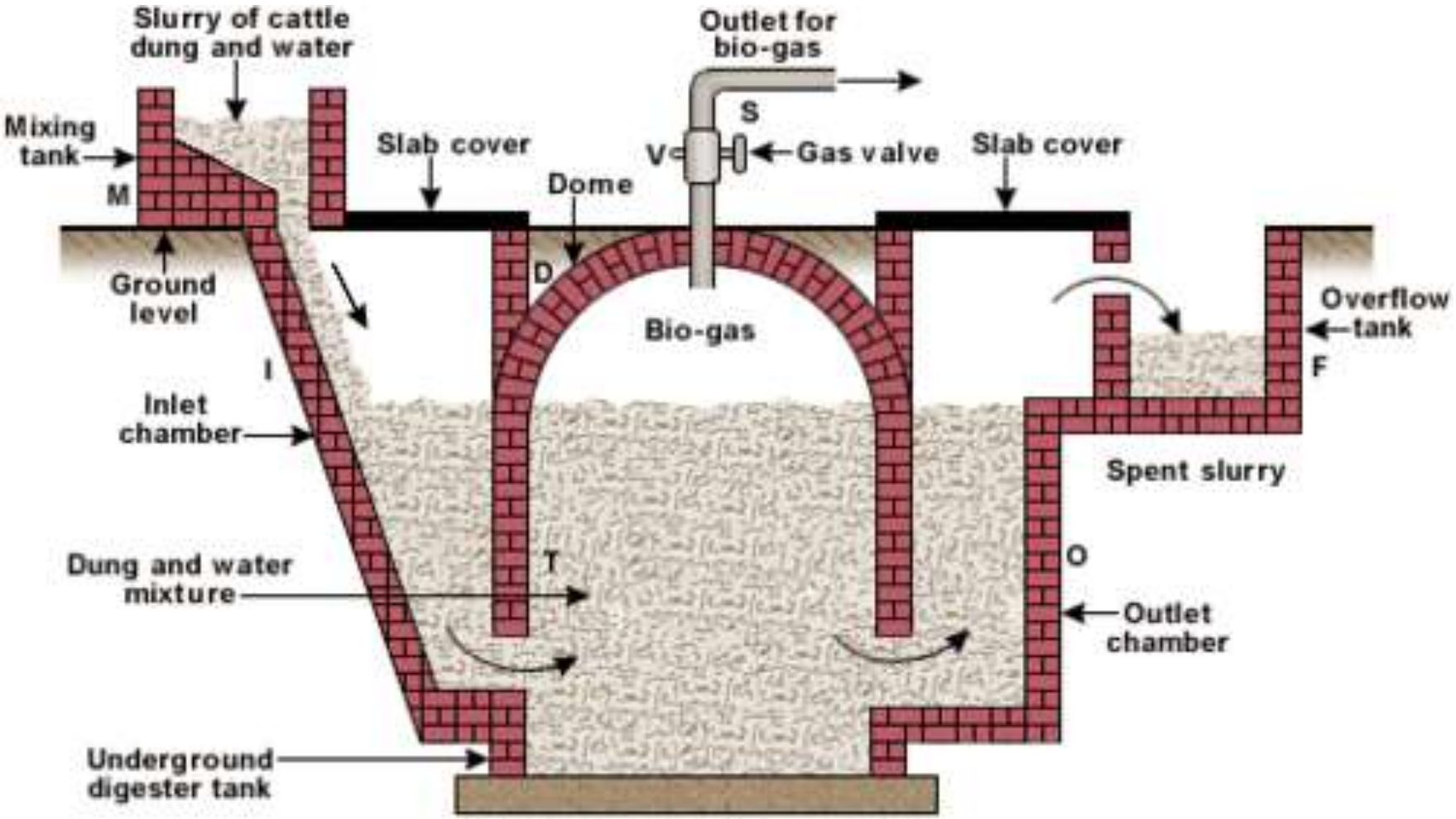
1) **Renewable**
2) **Green** – Environmental friendly source of energy.. It does not produce any harmful gas. It utilizes very small space for energy production.
3) **Effective at low speeds** – possible to generate electricity at very low speeds because the density of water is much more than that of the air.

Disadvantages:

1) **Location restricted**
2) **Expensive**
3) **Earthquakes**
4) **Environmental side effects**

BIOGAS

- Biogas is a mixture of methane, carbon dioxide, hydrogen and hydrogen sulphide, the major constituent being methane.
- Biogas is produced by anaerobic degradation of animal wastes in the presence of water.
- Biogas is a non-polluting, clean and low cost fuel which is very useful for rural areas where a lot of animal waste and agricultural waste are available.
- India has the largest cattle population in the world (240 million) and has tremendous potential for biogas production.
- A sixty cubic feet gobar gas plant can serve the needs of one average family.



Fixed-dome type bio-gas plant.

ADVANTAGES OF BIOGAS

- **Biogas** is a clean, non-polluting and cheap.
- There is direct supply of gas from the plant and there is no storage problem.
- Environmentally friendly recirculation of organic waste from industry and households.

DISADVANTAGES

- Carbon dioxide is made as a product which is a greenhouse gas.
- Leaks of unburned methane are an additional risk, because methane is a potent greenhouse gas.
- The content of toxic hydrogen sulfide presents additional risks and has been responsible for serious accidents.

- **Biofuels:**
- Biomass can be fermented to alcohols like ethanol and methanol which can be used as fuels.
- **Ethanol** can be easily produced from carbohydrate rich substances like sugarcane, corn and sorghum.
- It burns clean and is non polluting. As compared to petrol its calorific value is less and therefore, produces much less heat than petrol.
- **Gasohol:** is a common fuel used in Brazil and Zimbabwe for running cars and buses.
- It is a mixture of ethanol and gasoline.
- **Methanol:** is very useful since it burns at a lower temperature than gasoline or diesel.
- Methanol too is a clean, non polluting fuel. Methanol can be easily obtained from woody plants.

ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES

Role of an Individual

Natural resources like **forests, water, soil, food, minerals and energy resources** play an important role in the economy and development of a nation. Humans can play important role in conservation of natural resources. A little effort by individuals can help to conserve these resources which are a **gift of nature** to the mankind. Brief description of role of individual to conserve different types of natural resources is given below:

ROLES TO CONSERVE WATER

- To minimize the evaporation losses irrigate the crops, the plants and the lawns in the evening, because water application during day time will lead to more loss of water due to higher rate of evapo-transpiration.
- Improve water efficiency by using optimum amount of water in washing machine, dishwashers and other domestic appliances, etc.
- Install water saving toilets which use less water per flush.
- Check for water leaks in pipes and toilets and repair them promptly.
- Don’t keep water taps running while they are not in use.
- Recycle water of washing of clothes for gardening.
- Installing rainwater harvesting structure to conserve water for future use.

Play your part, be water smart!

Wise Water Use

Water your yard and outdoor plants early or late in the day to reduce evaporation

Turn off the water while soaping hands and brushing teeth.

Get an Energy Star labeled washing mashine. Wash only full loads.

Mulch around plants to hold water in the soil.

Take shorter showers - five minutes or less is best.

Install new toiletes that use less than 1.6 gallons per flush.

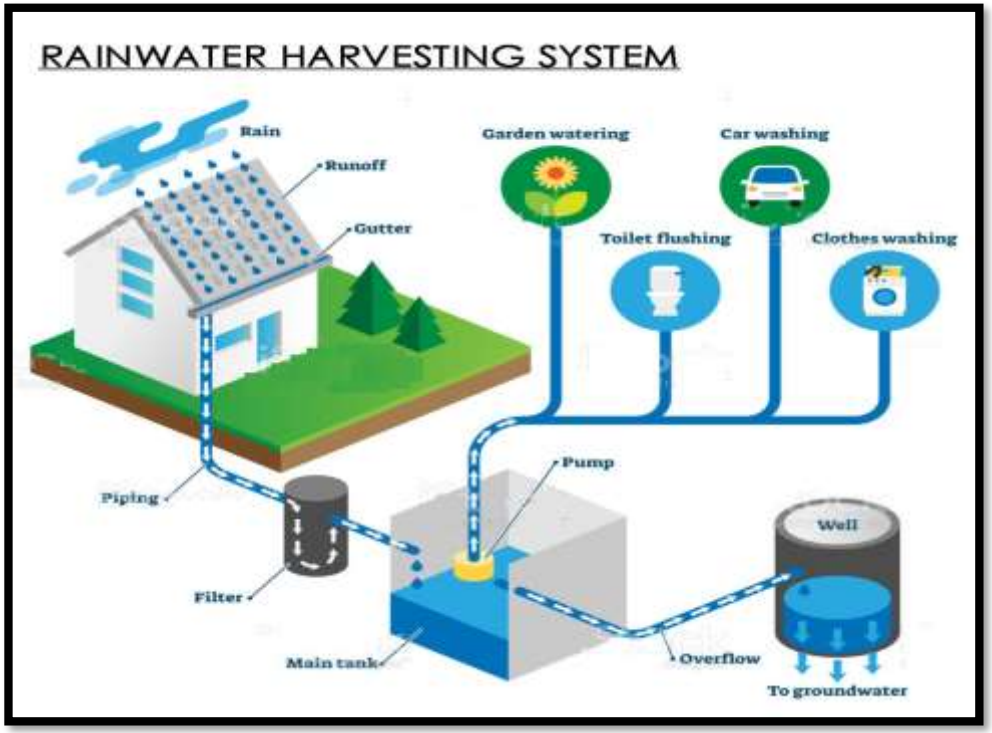
Use plants that require less water.

Turn off sink faucet whle scrubbing dishes and pots.

Use a broom, not a hose, to clean driveways and walkways.

Save it, or do without it!

RECHARGE PIT



ENERGY CONSERVATION FOR FUTURE USE

- **Turn off all electric appliances** such as lights, fans, televisions, computers, etc when not in use.
- **Clean all the lighting sources** regularly because dust on lighting sources decreases lighting levels up to 20-30%.
- Try to harvest energy from natural resources to obtain heat for example **drying the cloths in sun** and avoid drying in washing machine.
- Save liquid petroleum gas (LPG) by using **solar cookers** for cooking.
- Design the house with provision for sunspace to keep the house warm and to provide more light.
- Avoid misuse of vehicles for transportation and if possible share car or **car pooling** journey to minimise use of petrol/diesel. For small distances **walk** down or just use **bicycles**.
- Minimise the use air conditioner to save energy

Tips for Saving Fuel

COVER UP

Use a lid on vessels when cooking and boiling foods or better yet, use a pressure cooker. This will reduce the amount of cooking time required and thus save cooking fuel.

PREP, COOK, EAT

Encourage whoever runs your kitchen to keep ingredients washed, chopped and ready before they switch on the gas to start cooking. Also encourage your family to eat as soon as food in served in order to reduce the need for reheating.

USE PUBLIC TRANSPORT

Using public transport like buses and trains reduces your individual fuel consumption. Using taxis and auto rickshaws is also better than using a private vehicle as they run on CNG, which is less polluting.

CAR POOL

If you can't use your school bus or public transport to get to school or tuitions, try and get together with friends who live close by and car pool instead. This will not only reduce fuel consumption, but will also reduce traffic load on your city's roads. Also encourage your family and friends to carpool when they travel to work or school.

SWITCH OFF

Switching off a vehicle's engine at signals can be achieved by using your vehicle's air-conditioner only when absolutely. Fuel is also conserved if you don't change gears too often and if you drive at speeds between 50 to 70 kms per hour. Make sure to follow these tips yourself and encourage others to follow in your footsteps.

WALK OR CYCLE

If you need to travel short distances (for example, to the local store, market or a friends house), avoid using a fuel - consuming vehicle and choose to walk or cycle instead. Not only is this good for the environment, but it will also keep you fit and healthy!

PROTECT SOIL HEALTH

- Use **organic manure / biofertilizers** to maintain soil fertility
- Use **sprinklers for irrigation** to conserve the soil & prevent erosion.
- Design landscape of **lawn** in large area which will help to bind soil to avoid erosion.
- Provide vegetation cover by growing of **ornamental plant, herbs and trees** in your garden.

PROMOTE SUSTAINABLE AGRICULTURE

- Diversify the existing cropping pattern for sustainability of agriculture
- Cultivate need based crop
- Maintain soil fertility
- Make optimum use of fertilizers, pesticides and other chemicals for production and processing of agriculture products
- Save grains in storage to minimise the losses
- Improve indigenous breeds of milch animals for sustainable dairy production systems.
- Adopt post harvest technologies for value addition

In mixed cropping or diverse cropping two or more crops are grown all at the same time in a field.

Crop rotation - It is practice of growing different crops in regular succession in the same field.

Mixed faarming- integrating both crops and livestock in the same farming operation.

SUSTAINABLE AGRICULTURE

1) Mixed cropping
2) Crop rotation
3) Mixed farming

What can you do to save electricity?

- **Turn off** lights and fans as soon as you leave the room.
- Use **tube lights** and energy efficient **bulbs** that save energy rather than bulbs. A 40- watt tube light gives as much light as a 100 watt bulb.
- Keep the bulbs and tubes **clean**. Dust on tubes and bulbs decreases lighting levels by 20 to 30 percent.
- **Switch off** the television or radio as soon as the program of interest is over.
- A **pressure cooker** can save up to 75 percent of energy required for cooking. It is also faster.
- Keeping the **vessel covered with a lid** during cooking, helps to cook faster, thus saving energy.

EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFESTYLES

In last 50 years, the **consumption** of resource in the society **has increased many folds**. There is a big gap in the consumers lifestyle between developed and developing countries. **Urbanisation** has changed the life style of middle class population in developing countries **creating more stress on the use of natural resources**. It has been estimated that More Developed Countries (**MDC)** of the world constitute only 22% of world's population but they use 88% of natural resources. These countries use 73% of energy resources and command 85% of income and in turn they contribute very big proportion of pollution. On the other hand less developed countries (**LDCs)** have moderate industrial growth and constitute 78% of world's population and use only 12% of natural resources, 27% of energy and have only 15% of global income.

There is a huge gap between rich and poor. In this age of development the rich have gone richer and the poor is becoming more poorer.. This has lead to unsustainable growth. There is an increasing global concern about the management of natural resources. The solution to this problem is to have more equitable distribution of resources and income. **Two major causes** of unsustainability are **over population in poor countries** and **over consumption of resources by rich countries.** A global consensus has to be reached for balanced distribution of natural resources.

For equitable use of natural resources **more developed countries**/rich people **have to lower down their level of consumption** to bare minimum so that these resources can be shared by poor people to satisfy their needs. Time has come to think that it is need of the hour that rich and poor should make equitable use of resources for sustainable development of mankind.

STRUCTURE OF AN ECOSYSTEM

Composition and organization of biological communities and abiotic components constitute the structure of an ecosystem.

1. Biotic Structure:

- The plants, animals and microorganisms present in an ecosystem form the biotic component.
- Theses organisms have different nutritional behavior and status in the ecosystem and are accordingly known as producers, consumers and decomposers.

A. Producers:

- They are mainly the green plants, which can synthesize their food themselves by making use of carbon dioxide present in the air and water in the presence of sunlight by involving chlorophyll, the green pigment present in the leaves, through the process of Photosynthesis.
- They are also known as **photo autotrophs.**

B. Consumers: All organisms which get their organic food by feeding upon other organisms are called consumers, which are of the following types:

- **Herbivores:** They feed directly on producers and hence also known as primary consumers. E.g. Insect, rabbit
- **Carnivores:** They feed on other consumers. If they feed on herbivores called as secondary consumers. E.g. frog, and if they feed on other carnivores (snake, big fish etc.) called as tertiary carnivores/consumers.
- **Omnivores:** They feed on both plants and animals. e.g. Humans, rat, fox and many birds.
- **Detritivores:** They feed on the parts of dead organisms, wastes of living organisms. E.g. beetles, termites, ants, crabs and earthworms.

C. Decomposers: They derive their nutrition by breaking down the complex organic molecules to simpler organic compounds and ultimately into inorganic nutrients. Various bacteria and fungi are decomposers.

2. **Abiotic Structure:** The physical and chemical constitute its abiotic structure.

- **Physical Factors:** The sunlight and shade, intensity of solar flux, duration of sun hours, average temperature, annual rain fall, wind, latitude and altitude, soil type, water availability are some important physical features which have a strong influence on the ecosystem.
- **Chemical factors:** Availability of major essential nutrients like carbon, nitrogen, phosphorus, potassium, sulphur, hydrogen and oxygen, level of toxic substances present in the soil or water largely influence the functioning of the ecosystem.

Functional Attributes of an Ecosystem

- The major functional attributes of an ecosystem are as follows:

1. Trophic structure, food chain, food webs
2. Energy flow
3. Cycling of nutrients (Biogeochemical cycles)
4. Primary and secondary production
5. Ecosystem development and regulation

Trophic Structure: The structure and function of ecosystem are very closely related and influence each other so intimately that they need to be studied together.

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

Food Chains: The sequence of eating and being eaten in an ecosystem is known as food chain.

- All organisms, living or dead, are potential food for some other organism and thus, there is essentially no waste in the functioning of a natural ecosystem.
- **Grass →→→ grasshopper →→→ frog →→→ snake →→→ hawk (grassland ecosystem)**
- **Phytoplanktons →→→ water fleas →→→ small fish →→→ tuna (pond ecosystem)**
- **Lichens →→→ reindeer →→→ man (arctic tundra**)
- **Types of food chains:**
- **Grazing food chain:** it starts with green plants and culminates in carnivores.
- Grass →→→ rabbit →→→ fox

Detritus food chain: it starts with dead organic matter which the detritivores and decomposers consume.

Partially decomposed dead organic matter and even the decomposers are consumed by detritivores and their predators. e.g. Mangroves

- Here, a large quantity of leaf material falls in the form of litter into the water.
- The leaf fragments are eaten by saprotrophs. These fallen leaves are colonized by small algae, which are also consumed by the saprotrophs or detritivores consisting of crabs, mollusks, shrimps, insect larvae and fishes.

Phytoplanktons → Zooplanktons → Fish

Grass → Rabbit → Fox

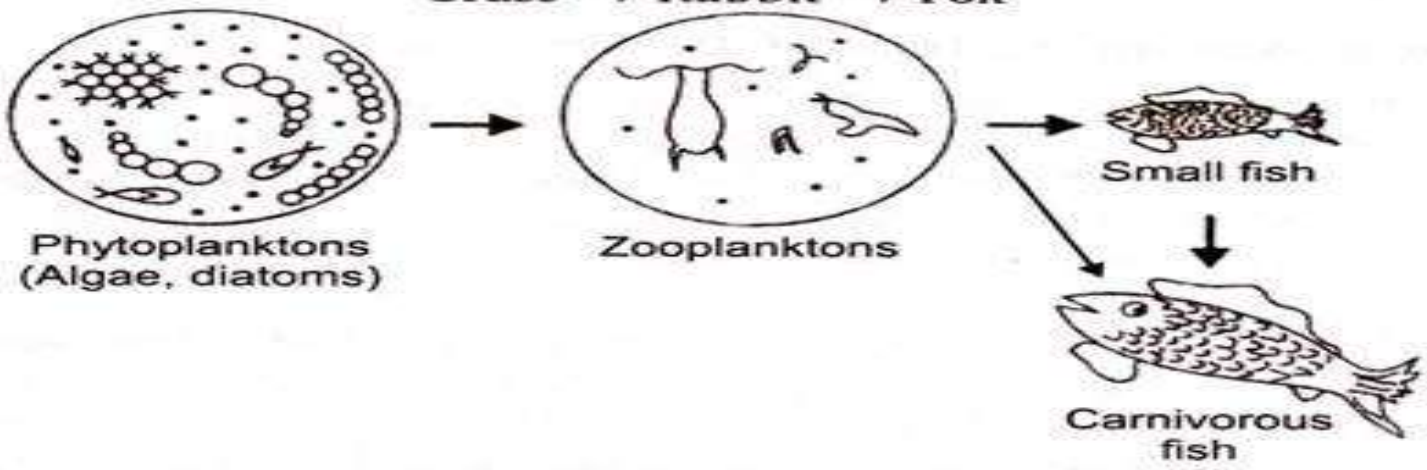


Fig. 2. A grazing food chain in a pond ecosystem.

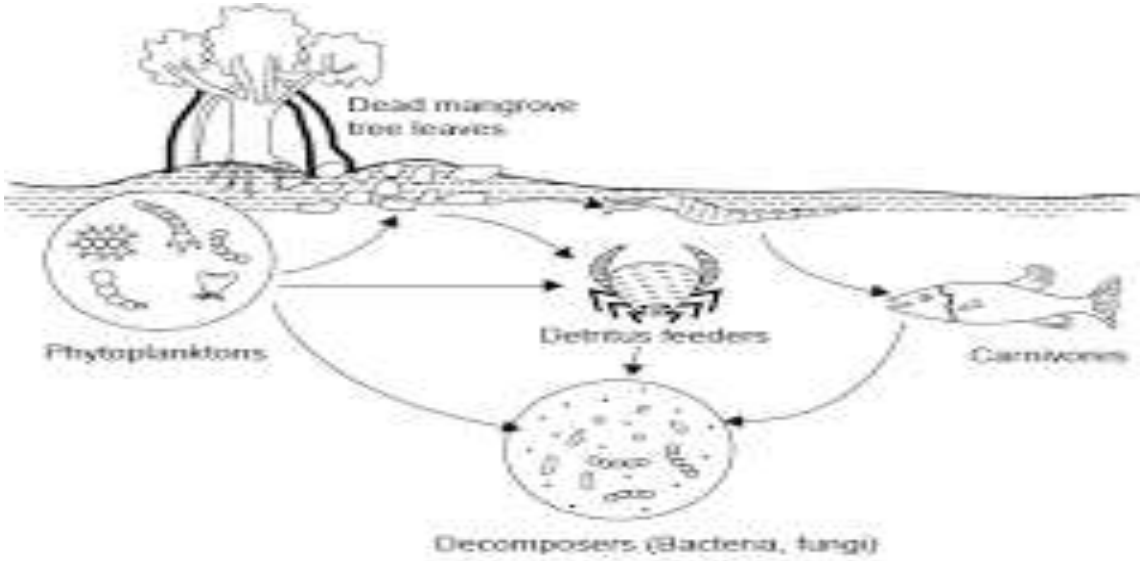
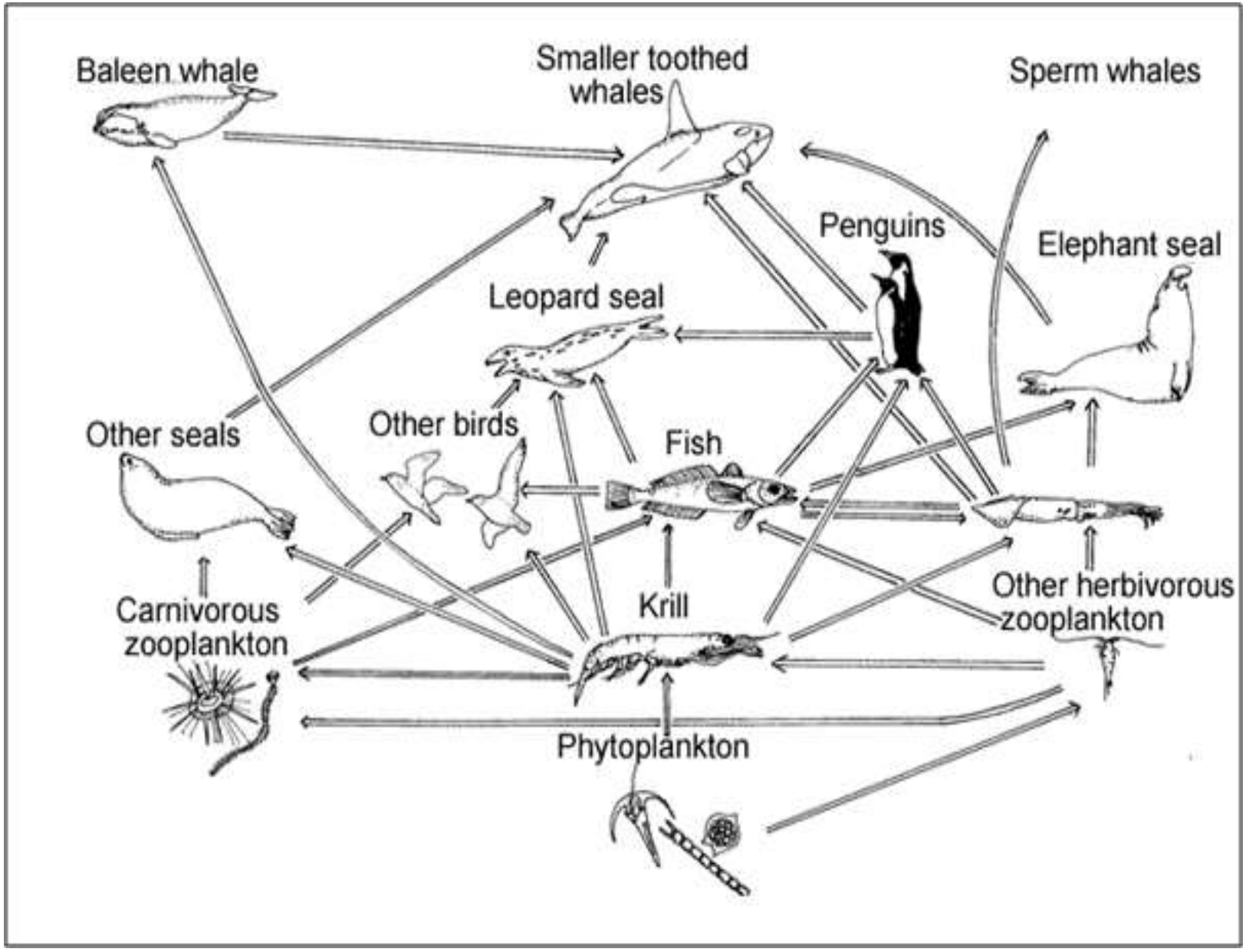


Fig. 3.3. A detritus food chain in an estuary based on dead leaves of mangrove trees.

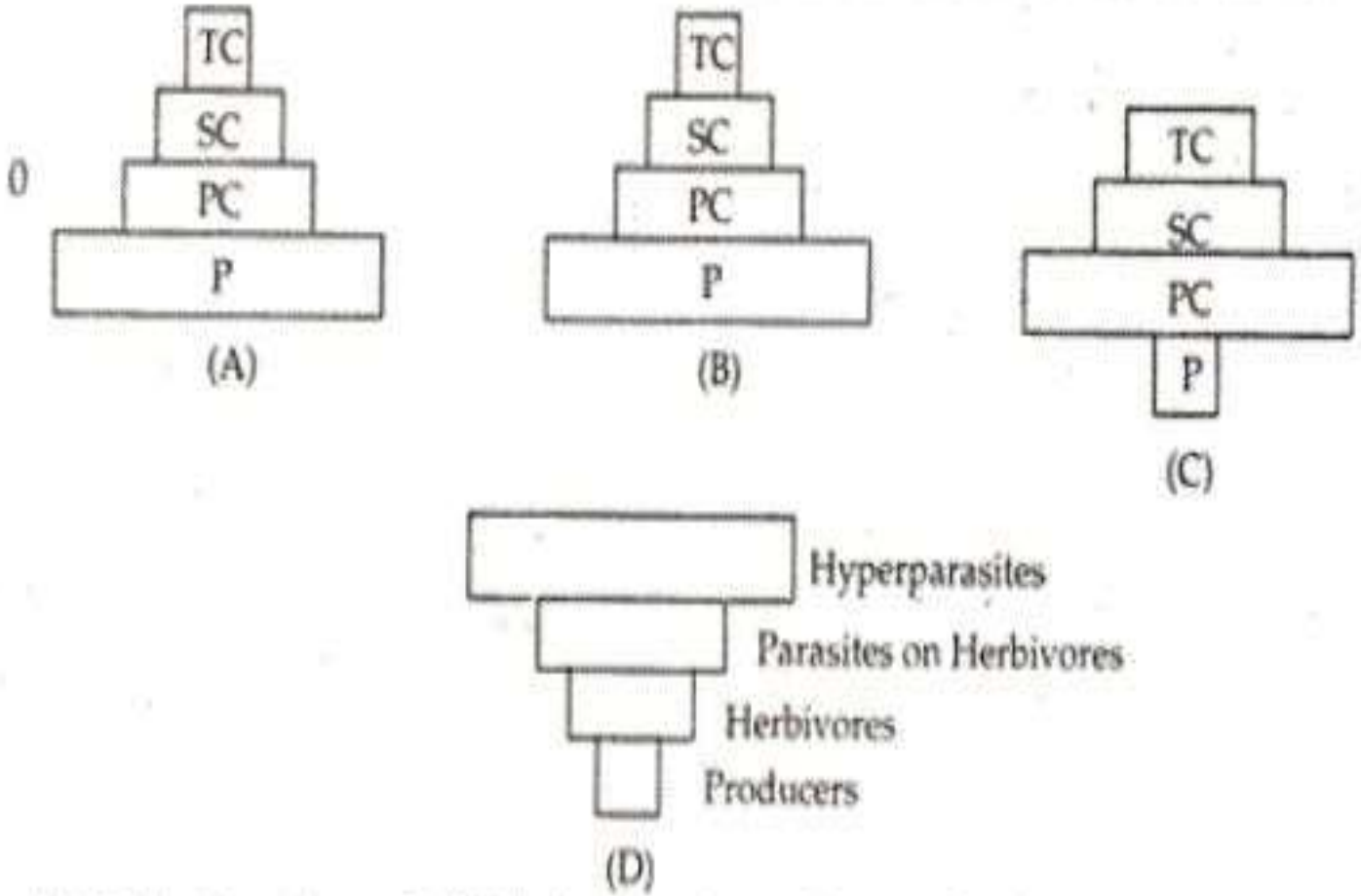
- The detritivores are eaten by small carnivorous fishes, which in turn are eaten by large carnivorous fishes.
- Leaf litter →→→ algae→→→ crabs →→→ small carnivorous fishes →→→ large carnivorous fishes (mangrove ecosystem)
- Dead organic matter →→→ fungi →→→ bacteria (Forest ecosystem)
- **Food Web:**
- Food chains in ecosystem are rarely found to operate as isolated linear sequences. Rather, they are found to be interconnected and usually form a complex network with several linkages and are known as food webs.
- Food web is a network of food chains where different types of organisms are connected at different trophic levels, so that there are number of options of eating and being eaten at each trophic level.
- Simple food chains of Arctic Tundra ecosystem
- Cladoina →→→ Reindeer →→→ Man
- Grass →→→ Caribou →→→ Wolf


Baleen whale
Smaller toothed whales
Sperm whales
Penguins
Elephant seal
Leopard seal
Other seals
Other birds
Fish
Carnivorous zooplankton
Krill
Other herbivorous zooplankton
Phytoplankton

ECOLOGICAL PYRAMIDS

- Graphic structure of trophic structure and function of an ecosystem, starting with producers at the base and successive trophic levels forming the apex is known as an ecological pyramid.
- Ecological pyramids are of three types:
- **Pyramid of numbers:** It represents the number of individual organisms at each trophic level.
- We may have upright or inverted pyramid of numbers, depending upon the type of ecosystem and food chain.
- A **grassland ecosystem** and a **pond ecosystem** show an upright pyramid of numbers.
- The producers in the grasslands are grasses and that in a pond are phytoplanktons, which are very small in size and very large in number.
- So the producers form broad base.
- The herbivores in a grassland ecosystem are insects while tertiary carnivores are hawks or other birds which are gradually less and less in number and hence the pyramid apes becomes gradually narrower forming an **upright pyramid**.
- Similar is the case with the herbivores, carnivores and top carnivores in pond which decrease in number at higher trophic levels.

- In **forest ecosystem**, big trees are the producers, which are less in number and hence form a narrow base.
- A large number of herbivores including birds, insects and several species of animals feed upon the trees (on leaves, fruits, flowers, bark etc.) and form a much broader middle level.
- The secondary consumers like fox, snakes, lizards etc. are less in number than herbivores while top carnivores like lion, tiger etc. are still smaller in number.
- So the pyramid is narrow on both sides and broader in the middle.
- **Parasitic food chain** shows an inverted pyramid of number.
- The producers like a few big trees harbour fruit eating birds acting like herbivores which are larger in number.
- A much higher number of lice, bugs etc. grow as parasites on these birds while a still greater number of hyperparasites like bugs, fleas and microbes feed upon them, thus making an inverted pyramid.



Pyramids of numbers : (individuals per unit area) A—grassland ecosystem. B—pond ecosystem, C—Forest ecosystem, D-parasitic food chain. P= producers; PC = primary consumers (herbivores), SC = Secondary consumers (carnivores); TC=Tertiary consumers (carnivores).

- **Pyramid of Biomass:**
- It is based upon the total biomass (dry matter) at each trophic level in a food chain.
- The pyramid of biomass can also be upright or inverted.
- The pyramid of biomass in a forest is upright in contrast to its pyramid of numbers.
- This is because the producers (trees) accumulate a huge biomass while the consumers total biomass feeding on them declines at higher trophic levels, resulting in broad base and narrowing top.
- The pond ecosystem shows an inverted pyramid of biomass.
- The total biomass of producers (phytoplanktons) is much less as compared to herbivores (zooplanktons, insects), carnivores (small fish) and tertiary carnivores (big fish).
- Thus the pyramid takes an inverted shape with narrow base and broad apex.

Pyramid of Biomass

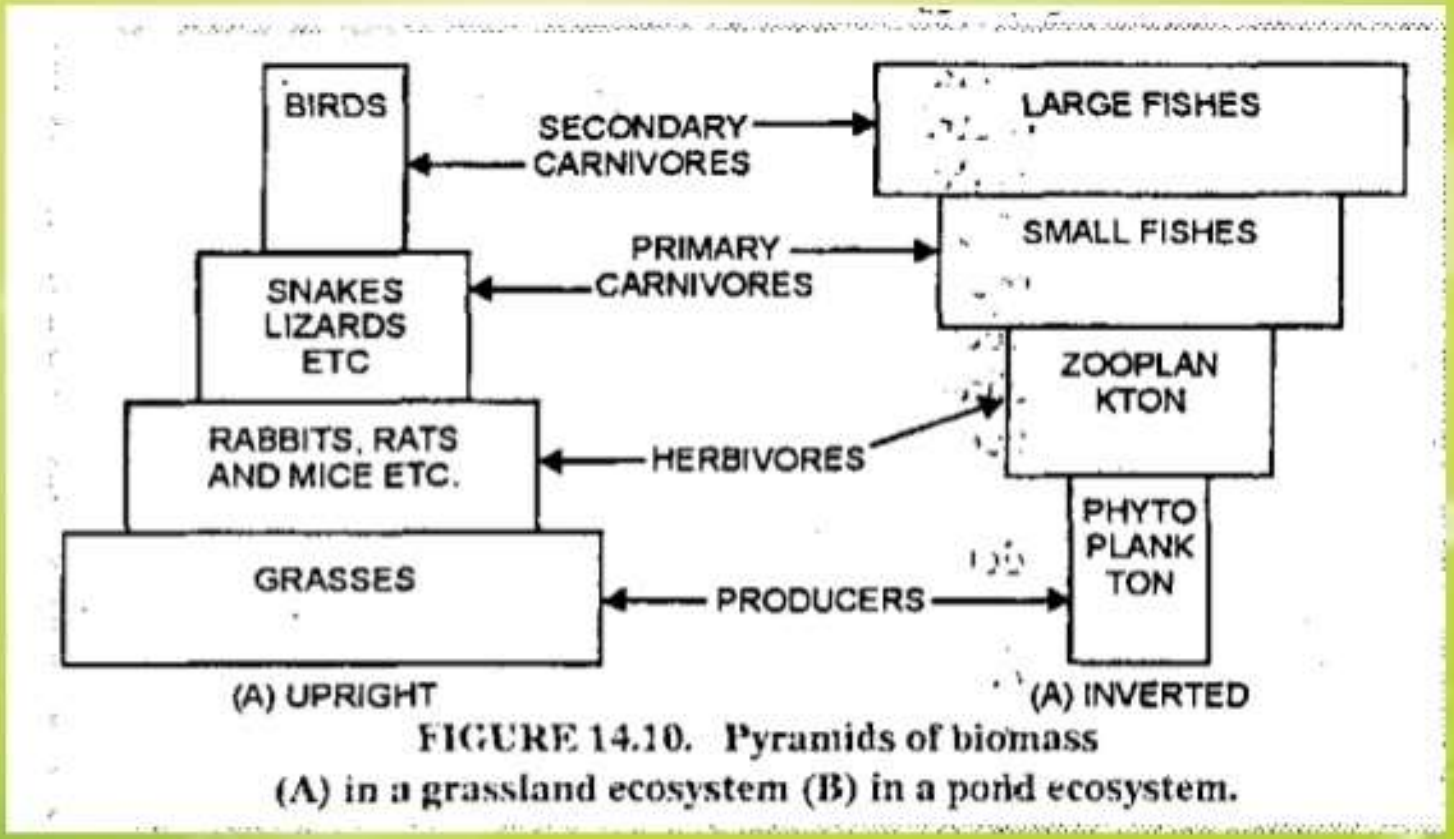
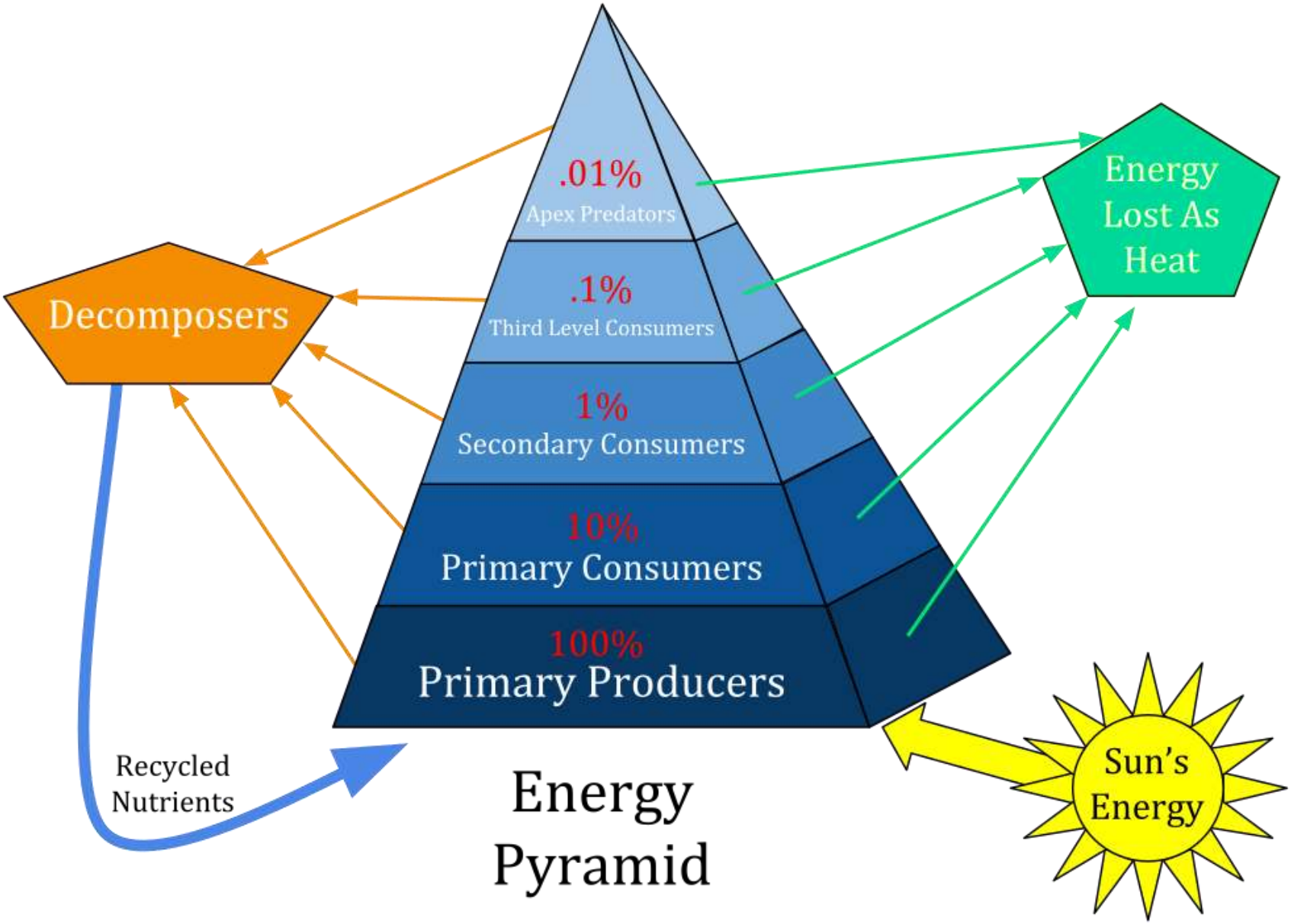


FIGURE 14.10. Pyramids of biomass
(A) in a grassland ecosystem (B) in a pond ecosystem.

- **Pyramid of Energy:**
- The amount of energy present at each trophic level is considered for this type of pyramid.
- Pyramid of energy gives the best representation of the trophic relationships and it is always upright.
- At every successive trophic level, there is a huge loss of energy (about 90%) in the form of heat, respiration etc.
- Thus, at each next higher level only 10% of the energy passes on. Hence, there is a sharp decline in energy level of each successive trophic level as we move from producers to top carnivores.
- Therefore the pyramid of energy is always upright.


.01%
Apex Predators
.1%
Third Level Consumers
1%
Secondary Consumers
10%
Primary Consumers
100%
Primary Producers
Decomposers
Energy Lost As Heat
Sun's Energy
Recycled Nutrients
Energy Pyramid

ECOLOGICAL SUCCESSION

• An ecosystem is not static in nature. It is dynamic and changes its structure as well as function with time and quite interestingly, these changes are very orderly can be predicted.

• It is observed that one type of community is totally replaced by another type of community over a period of time and simultaneously several changes also occur. This process is known as **ecological succession**.

• The whole sequence of communities which are transitory are known as **Seral stages** or **seres.**

• Whereas the community establishing first of all in the area is called a **Pioneer community.**

• Ecological successions starting on different types of areas are named differently as follows:

1. **Hydrarch or Hydreosere:** starting in watery area like pond, swamp, bog
2. **Mesarch:** starting in an area of adequate moisture.

- **Xerarch or Xerosere:** strating in a dry area with little moisture.
- They can be of the following types:
- Lithosere: starting on a bare rock
- Psammosere: starting on sand
- Halosere: starting on saline soil

Process of succession: the process of succession takes place in a systematic order of sequential steps as follows:

1) Nudation: it is the development of bare area without any life form.

- The bare area may be caused due to landslides, volcanic eruption etc. (topographic factor), or due to drought, glaciers, frost etc. (climatic factor), or due to overgrazing, disease outbreak, agricultural/ industrial activities (biotic factors)

2) **Invasion:** it is the successful establishment of one or more species on a bare area through dispersal or migration, followed by ecesis or establishment.

- Dispersal of the seeds, spores etc. is brought about by wind, water, insects or birds.
- Then the seeds germinate and grow on the land. As growth and reproduction starts, these pioneer species increase in number and form groups or aggregation

3) Competition and coaction:

- As the number of individuals grows there is competition, both inter-specific and intra-specific, for space, water and food.
- They influence each other in a number of ways as coaction.

4) Reaction: the living organisms grow, use water and nutrients from the substratum, and in turn, they have a strong influence on the environment which is modified to a large extent and this is known as reaction.

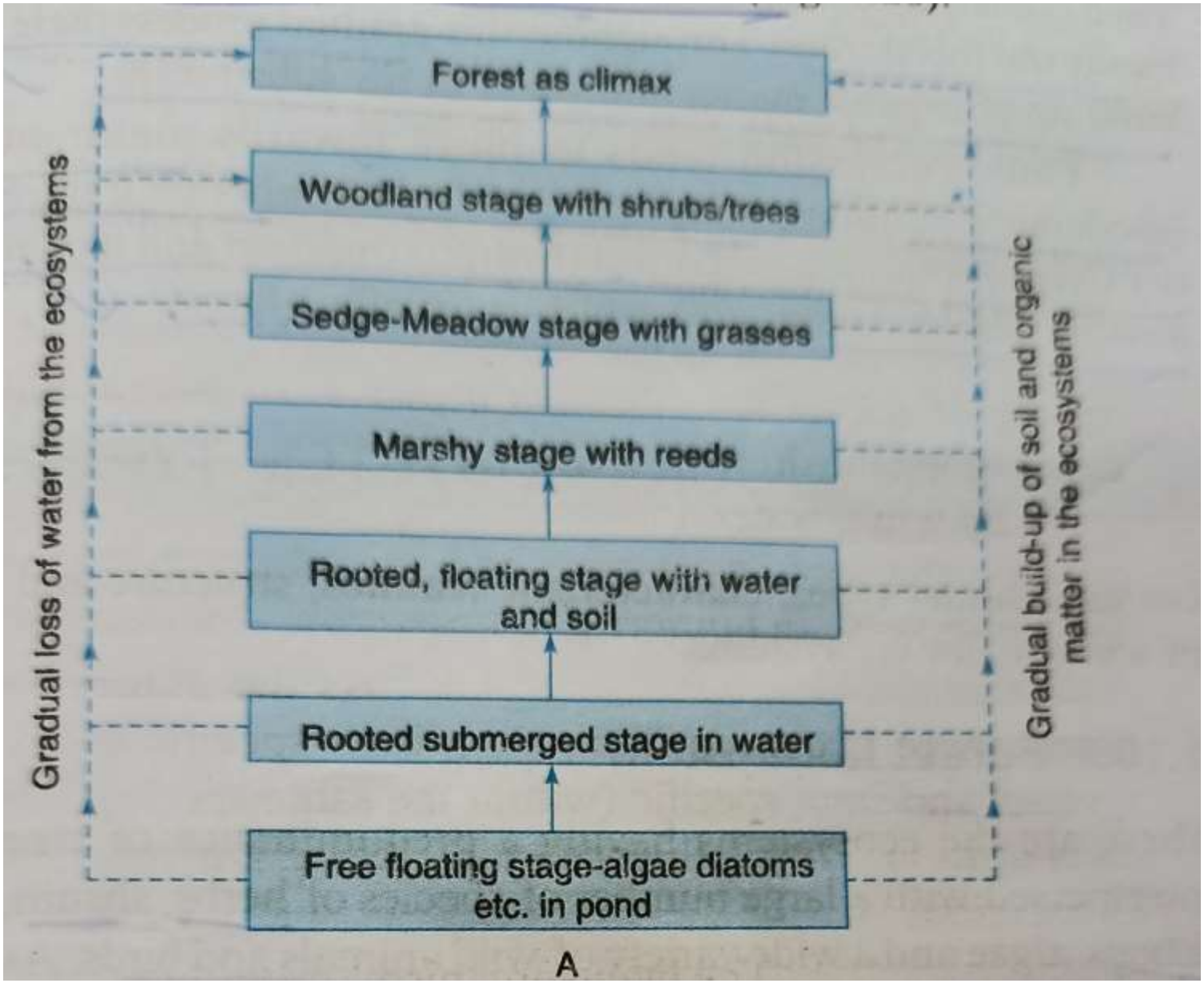
- Thus, reaction leads to several **Seral communities.**

5) Stabilization: The succession ultimately culminates in a more or less stable community called climax which is in equilibrium with the environment.

The climax community is characterized by maximum biomass and symbiotic linkages between organisms and are maintained quite efficiently per unit of available energy.

Let us consider very briefly succession of Hydrosere.

- **Hydrosere or Hydrarch:**
- This type of succession starts in a water body like pond.
- A number of intermediate stages come and ultimately it culminates in a climax community which is a forest.
- The pioneer community consists of phytoplanktons, which are free floating algae, diatoms etc.
- Gradually these are replaced by rooted submerged plants followed by rooted-floating plants.
- Growth of these plants keep on adding organic matter to the substratum by death and decay and thus a layer of soil builds up and shallowing of water takes place.
- Then Reed swamp (marshy) stage follows in which the plants are partly in water and partly on land.
- This is followed by a sedge-meadow stage of grasses then by a woodland consisting of shrubs and trees and finally by a forest acting as a climax.


Forest as climax
Woodland stage with shrubs/trees
Sedge-Meadow stage with grasses
Marshy stage with reeds
Rooted, floating stage with water and soil
Rooted submerged stage in water
Free floating stage-algae diatoms etc. in pond
Gradual loss of water from the ecosystems
Gradual build-up of soil and organic matter in the ecosystems

A

DESERT ECOSYSTEM

✓The ecosystem occur in regions where evaporation exceeds precipitation.

✓The precipitation is less than 25cm per year.

✓About 1/3rd of our world's land area is covered by deserts.

✓Deserts have little species diversity and consist of drought resistant or drought avoiding plants.

✓The atmosphere is very dry and hence it is a poor insulator. That is why in deserts the soil gets cooled up quickly, making the nights cool.

✓Deserts are of three major types, based on climatic conditions:

A. **Tropical Deserts** like Sahara and Namibia in Africa and Thar desert in Rajasthan, India are the driest of all with only a few species.

   Wind blown sand dunes are vey common.

B. **Temperate Deserts** like Mojave in Southern California where day time temperatures are very hot in summer but cool in winters.

C. **Cold Deserts** like the Gobi desert in china has cold winters and warm summers.

- **How are desert and semi-arid ecosystems used?**
- Areas of scanty vegetation with semi-arid scrubland have been used for camel, cattle and goat grazing in Rajasthan and Gujarat, and for sheep grazing in the Deccan Plateau.
- Areas that have a little moisture, for example along the watercourses, have been used for growing crops such as Sorghum, Millets.
- The natural grasses and local varieties of crops have adapted to growing at very low moisture levels.
- These can be used for genetic engineering and developing semi-arid land crops for the future.
- **Threats to Desert Ecosystem:**
- Several types of development strategies as well as human population growth.
- The conversion of these lands through extensive irrigation systems has changed several of the natural characteristics of this region.
- Canal water evaporates rapidly bringing the salts to the surface.
- The over extraction of groundwater from tube wells lowers the water table, creating an even drier environment.

- Human activities are destroying the authenticity of this unique ecosystem.
- **Conservation strategies:**
- There is a pressing need to protect residual patches of this ecosystem within national parks and wildlife sanctuaries in desert and semi-arid areas.
- The Indira Gandhi canal in Rajasthan is destroying this important natural arid ecosystems, as it will convert the region into intensive agriculture.
- In Kutch, areas of the little Rann, which is the only home of the wild ass, will be destroyed by the spread of salt works.
- Development projects alter the desert and arid landscape. There is a sharp reduction in the habitat available for its noteworthy species, bringing them to the verge of extinction.
- We need a sustainable form of development that takes the special needs of the desert into account.

GRASSLAND ECOSYSTEM

- Grasslands are dominated by grass species but sometimes also allow the growth of a few trees and shrubs.
- Rainfall is average but erratic .
- Limited grazing helps to improve the net primary production of the grasslands but overgrazing leads to degradation of these grasslands resulting in desertification.
- These type of grasslands are found to occur in different climatic regions:

Tropical grasslands:

- They occur near the boarders of tropical rain forests in regions of high average temperature and low to moderate rainfall.
- In Africa, these are typically known as **savannas**, which have tall grasses, shrubs and stunted trees.
- The savannas have a wide diversity of animals including zebras, giraffes, gazelle, antelopes etc.
- During dry season fires are quite common. Termite mounds are very common here.

- Tropical savannas have a highly efficient system of photosynthesis.
- Most of the carbon assimilated by them in the form of carbohydrates is in the bulbs, rhizomes, runners etc. which are present underground.
- Deliberate burning of these grasslands can release huge quantities of carbon dioxide, a green house gas, responsible for global warming.

Temperate grasslands:

- They are usually found on flat, gentle, sloped hills.
- Winters are very cold but summers are hot and dry.
- In USA and Canada these grasslands are known as **Prairies,** in South America as **Pampas**, in Africa as **Velds** and in central Europe and Asia they are known as **Steppes**.
- Winds keep blowing and evaporation rate is very high. It also favours rapid fires in summer.
- The soils are quite fertile and therefore, very often these grasslands are cleared for agriculture.

Polar grasslands:

- They are Arctic polar region where severe cold and strong, frigid winds along with ice and snow create too harsh a climate for trees to grow.
- In summers the sunshine almost round the clock and hence several small annual plants grow in the summer.
- The animals include arctic wolf, weasel, fox, reindeer etc.
- A thick layer of ice remains frozen under the soil surface throughout the year and is known as permafrost.


South African Veld


Tundra- Polar Grasslands

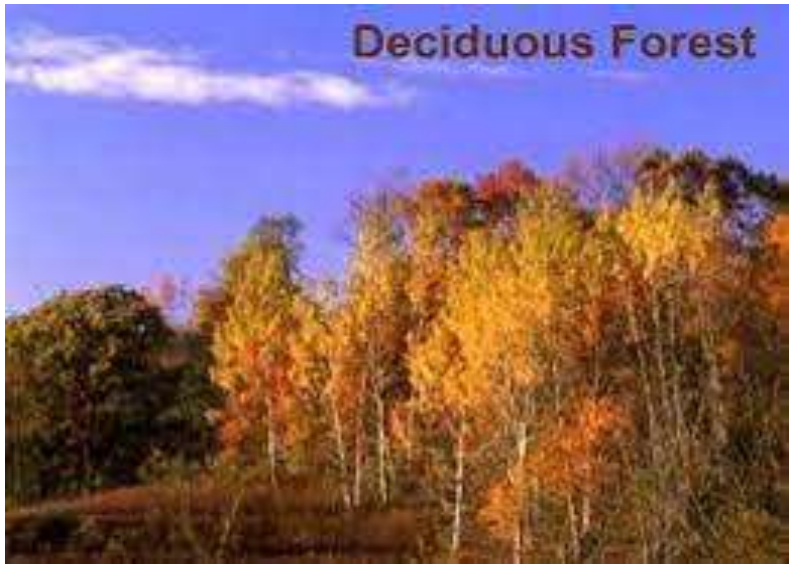
FOREST ECOSYSTEM

- These are the ecosystems having a predominance of trees that are interspersed with a large number of species .
- Forests are found in undisturbed areas receiving moderate to high rainfall and usually occur as stable climax communities.
- Depending upon the prevailing climatic conditions forests can be of various types:
- **A. Tropical rain forests:** They are evergreen broadleaf forests found near the equator.
- They are characterized by high temperature, high humidity and high rainfall, all of which favour the growth of trees.
- All through the year the climate remains more or less uniform.
- Different forms of life occupy specialized areas within different layers and spaces of the ecosystem depending upon their needs for food, sunlight, water and nutrients.
- Interestingly, the flowers of forest trees are very large, colourful, fragrant and attractive which helps in pollination by insects, birds, bats etc.

- Ex. Rafflesia arnoldi, the biggest flower (7 kg weight) is known to smell like rotten meat and attracts flies and beetles which help in its pollination.
- The Silent Valley in kerala is the only tropical rain forest lying in India which is the natural habitat for a wide variety of species.
- **B. Tropical deciduous forests:** They are found a little away from the equator and are characterized by a warm climate the year round.
- Rain occurs only during monsoon.
- A large part of the year remains dry and therefore different types of deciduous trees are found here, which lose their leaves during dry season.
- **C. Tropical scrub forests:** they are found in areas where the dry season is even longer. Hence there are small deciduous trees and shrubs.

- **D. Temperate rain forests:** they are found in temperate areas with adequate rainfall.
- These are dominated by coniferous trees like pines, firs, red woods etc.
- They also consist of some evergreen broad leaf trees.
- **E. Temperate deciduous forests:** They are found in areas with moderate temperatures.
- There is a marked seasonality with long summers, cold but not too severe winter and abundant rainfall throughout the year.
- the major trees include broad leaf deciduous trees like oak, hickory, poplar etc.
- **F. Evergreen coniferous forests (Boreal Forests):**
- They are found just south of arctic tundra. Here winters are long, cold. Sunlight is available for a few hours only.
- The major trees include fir, pines, spruce, cedar etc. which have tiny, needle shaped leaves having a waxy containing so that they can withstand severe cold and drought.

Tropical rain forests


Deciduous Forest


Temperate rain forests


Tropical Thorn Forests


Evergreen coniferous forests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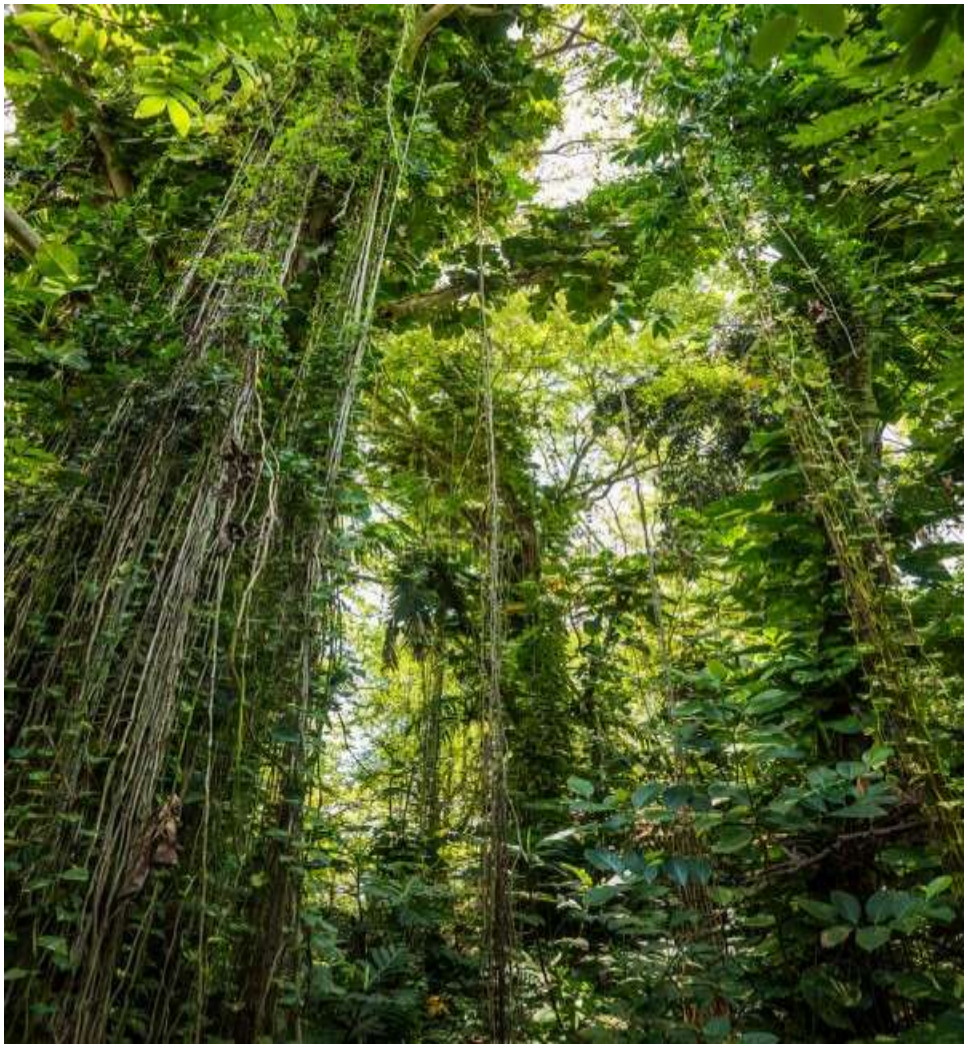
emergent layer

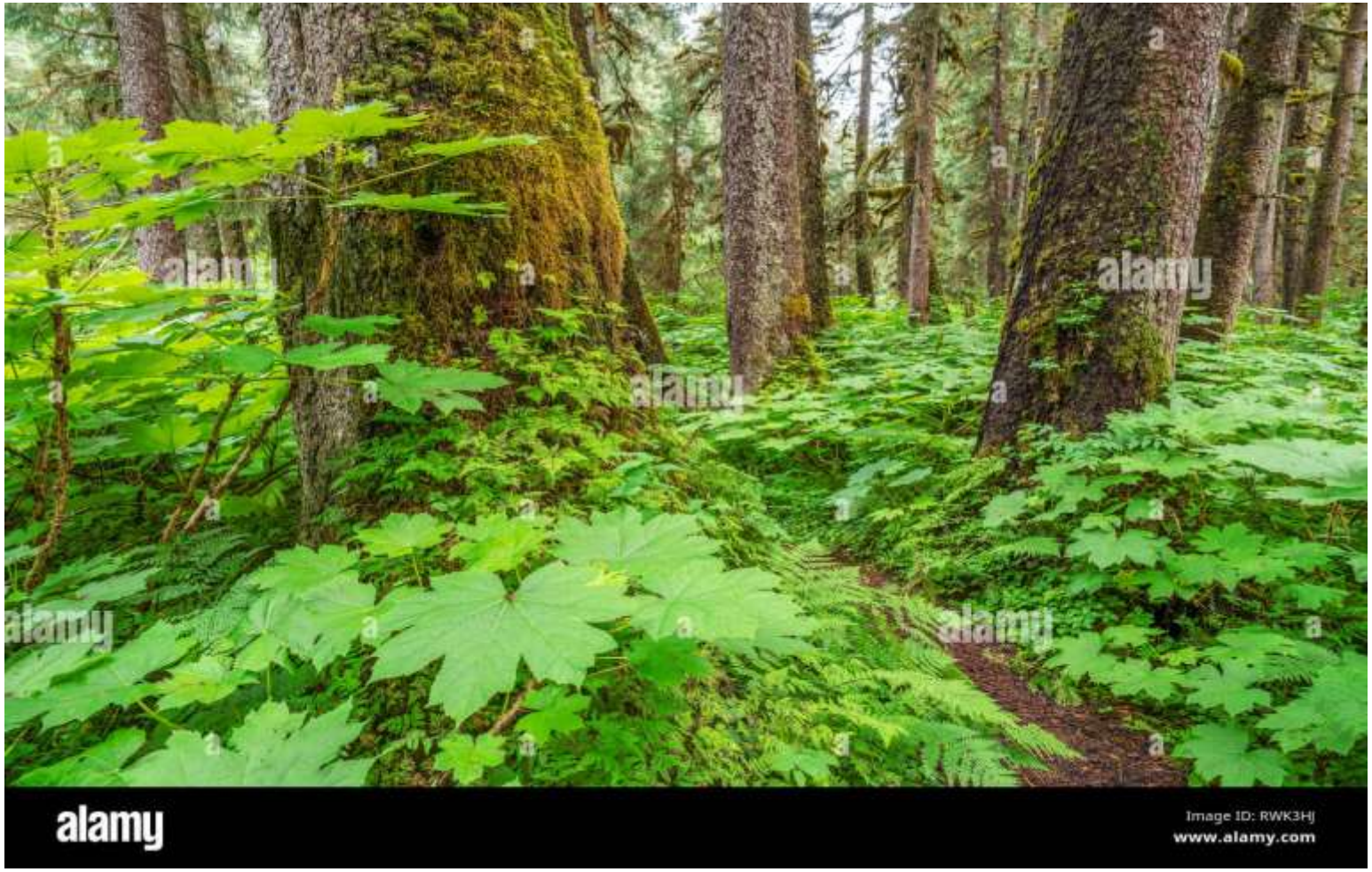
LIANAS



EPIPHYTES

CANOPY

UNDERSTORY TREES



- The symbiotic relationship between fungi and plant roots is called a mycorrhiza.
- Plant roots and fungi form symbiotic relationships. The fungi help trees or shrubs, and in return, the roots give the fungi carbon, carbohydrates, and other nutrients.

AQUATIC ECOSYSTEM

- Aquatic ecosystems dealing with water bodies and the biotic communities present in them are either freshwater or marine.
- Freshwater ecosystems are further of standing type (**lentic**) like ponds and lakes or free-flowing type (**lotic**), like rivers.

Some important ecosystems:

(a) Pond ecosystem: it is a small freshwater aquatic ecosystem where water is stagnant.

- Ponds may be seasonal in nature i.e. receiving enough water during rainy season.
- Ponds are usually shallow water bodies which play a very important role in the villages where most of the activities center around ponds.
- They contain several types of algae, aquatic plants, insects, fishes and birds.
- The ponds are, however, very often exposed to tremendous anthropogenic pressures,
- They are used for washing clothes, bathing, swimming, cattle bathing and drinking etc. and therefore get polluted.

(b) Lake ecosystem: Lakes are usually big freshwater bodies with standing water.

- They have a shallow water zone called **Littoral zone**, an open-water zone effective penetration of solar light takes place, called **Limnetic zone** and a deep bottom area where light penetration is negligible, known as **profundal zone.**
- The Dal Lake in Srinagar (J&K), Naini Lake in Nainital (Uttarakhand) and Loktak Lake in Manipur are some of the famous lakes in our country.
- **Organisms:** the lakes have several types of organisms.
- **Planktons:** that float on the surface of waters. E.g., phytoplanktons like algae and zooplanktons like rotifers.
- **Nektons:** that swim e.g. fishes
- **Neustons:** that rest or swim on the surface. E.g. Beetles, spiders, worms, insect larvae
- **Benthos:** That are attached to bottom sediments. E.g., snails
- **Periphytons:** that are attached or clinging to other plants or any other surface. E.g., crustaceans

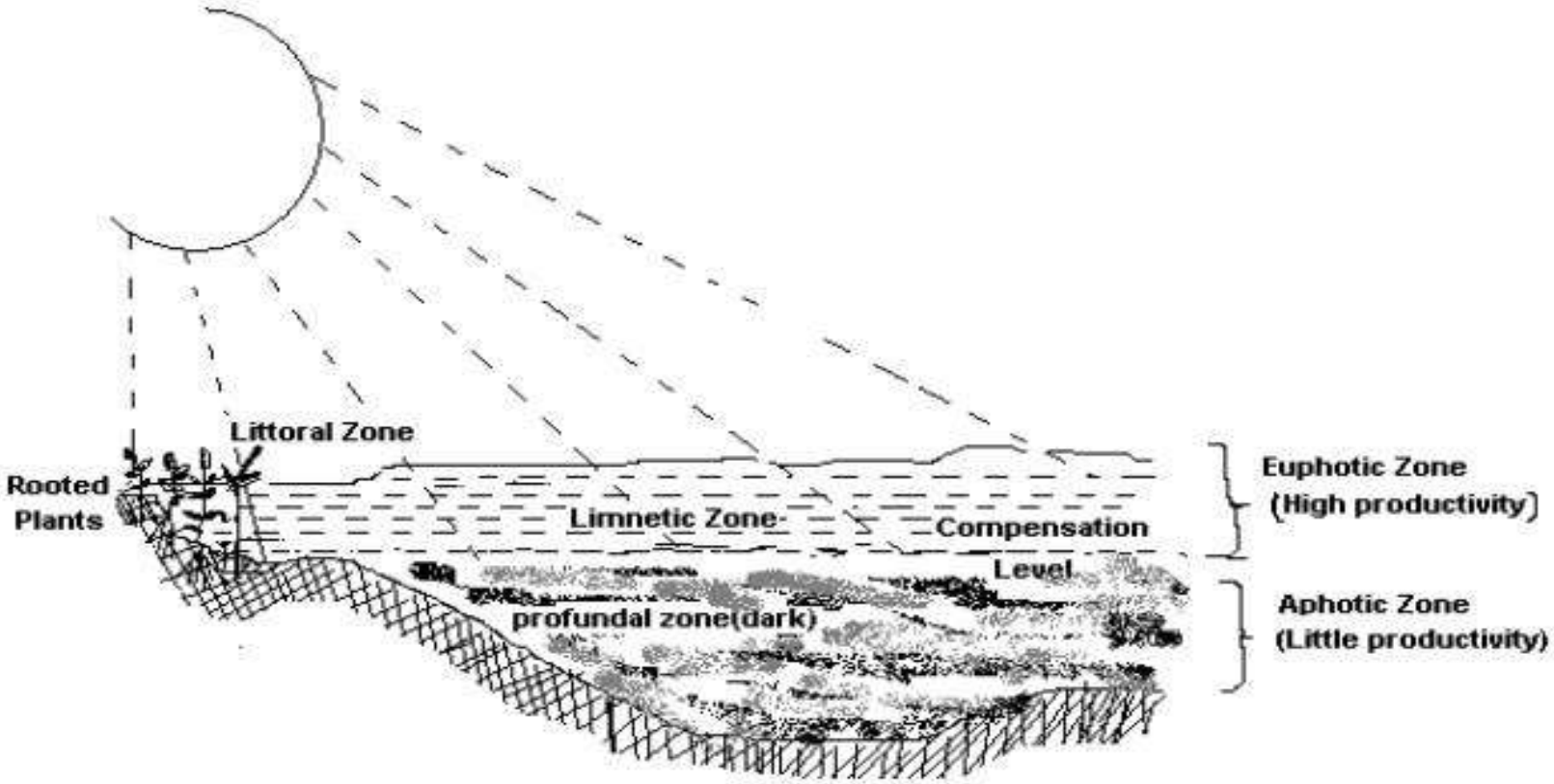
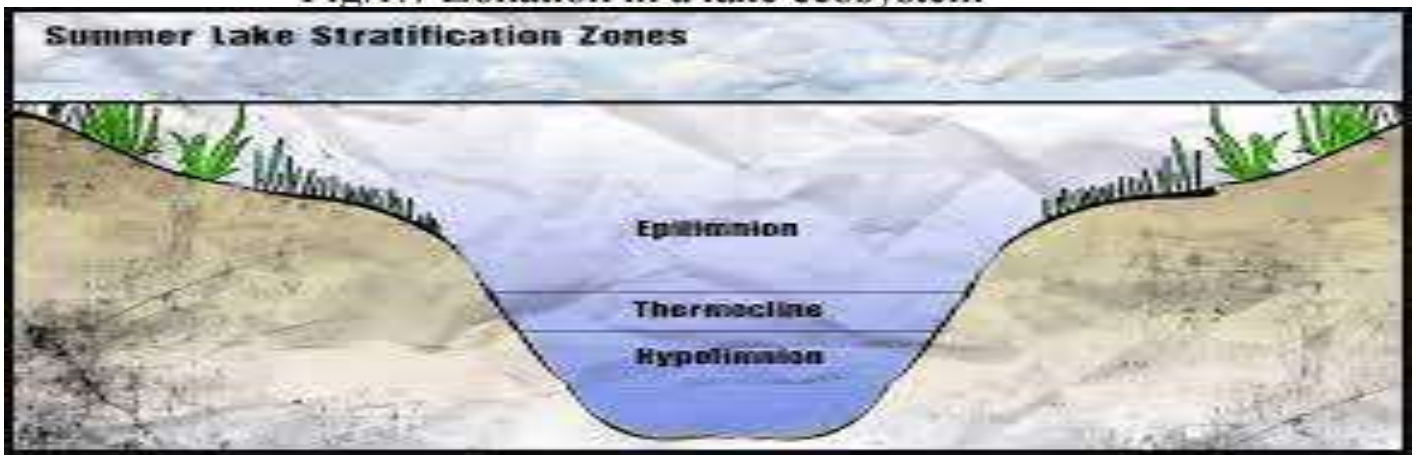


Fig.1.7 Zonation in a lake ecosystem



- **Stratification:** The lakes show stratification or zonation based on temperature differences.
- During summer, the top water become warmer than the bottom water.
- Therefore, only the warm top layer circulates without mixing with the colder layer, thus forming a distinct zonation.
- **Epilimnion:** Warm, lighter, circulating surface layer.
- **Hypolimnion:** Cold, Viscous, non-circulating bottom layer.
- In between the two layers is **thermocline**, the region of sharp drop in temperature.
- **Types of Lakes:**
- **Oligotrophic Lakes:** which have low nutrient concentrations. Ex. Michigon
- **Eutrophic Lakes:** which are overnourished by nutrients like nitrogen and phosphorus, usually as result of agricultural run-off or municipal sewage discharge. E.g., Dal Lake
- **Dystrophic Lakes:** that have low pH, High humic acid content and brown waters. E.g., Bog lakes
- **Endemic Lakes:** that are very ancient, deep and have endemic fauna which are restricted only to that lake. E.g., Baikal
- **Desert Salt Lakes:** that occur in arid regions and have developed high salt concentrations as a result of high evaporation. Sambar Lake in Rajasthan

- **Volcanic Lakes:** that receive water from magma after volcanic eruptions. e.g., many lakes in Japan
- **Meromictic Lakes:** that are rich in salts and are permanently stratified e.g., Lake Nevada
- **Artificial Lakes:** that are created due to construction of dams e.g. Govindsagar Lake at Bhakra-Nangal.

Streams: These are freshwater aquatic ecosystems where water current is a major controlling factor, oxygen and nutrient in the water is more uniform and land-water exchange is more extensive.

River Ecosystem: Rivers are large streams that flow downward from mountain highlands and flowing through the plains fall into the sea.

Oceans: these are gigantic reservoirs of water covering more than 70% of our earth's surface and play a key role in the survival of about 2,50,000 marine species, serving as the food for humans and other organisms, give a huge variety of sea-products and drugs.

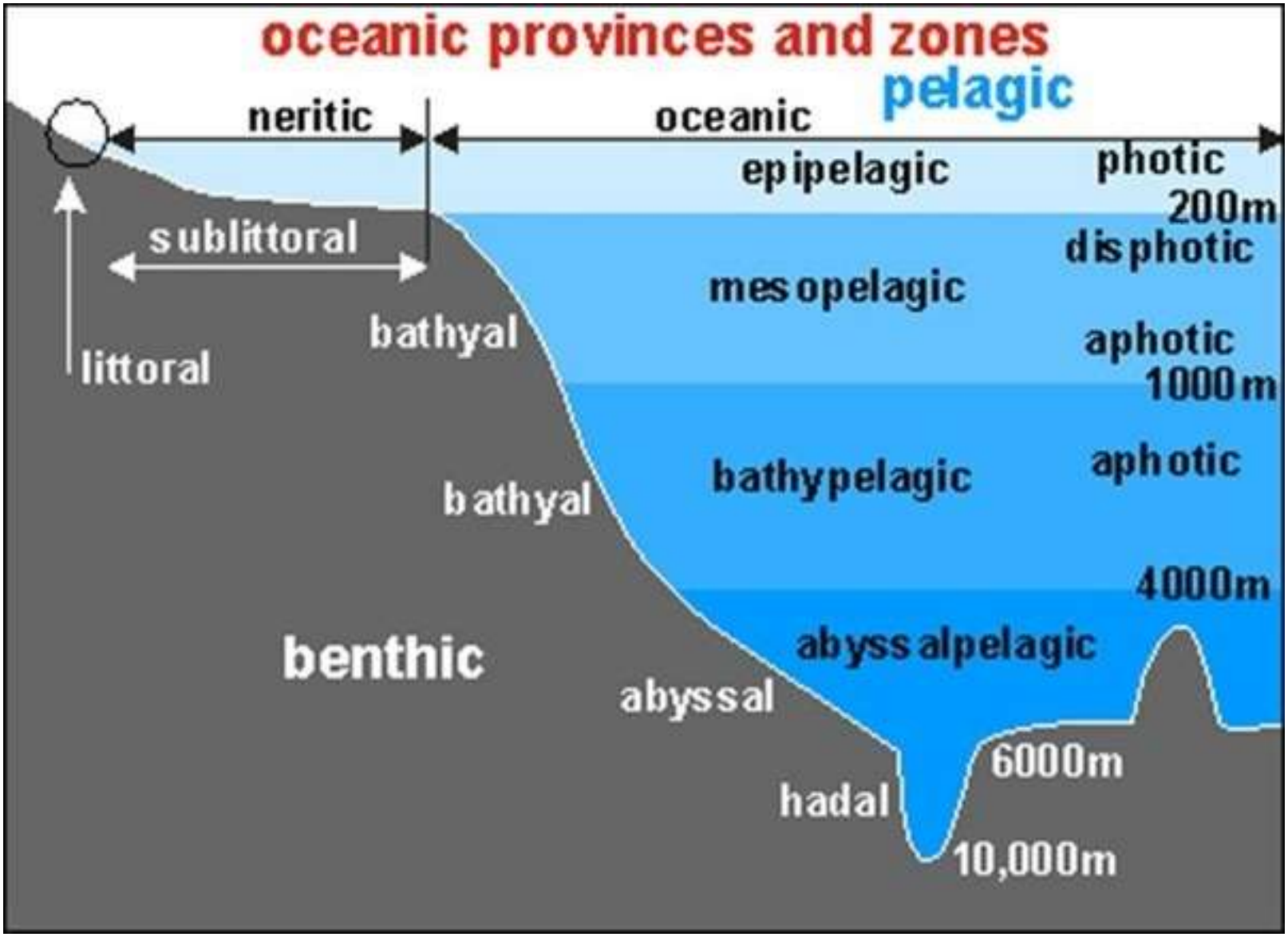
- Oceans provide us iron, phosphorus, magnesium, oil, natural gas, sand and gravel.
- Oceans are the major sinks of carbon dioxide and play an important role in regulating many biogeochemical cycles and hydrological cycle, there by regulating the earth's climate.

- The oceans have two major life zones:
- **Coastal zone** with relatively warm, nutrient rich shallow water.
- Due to high nutrients and ample sunlight this is the zone of high primary productivity.
- **Open Sea:** it is the deeper part of the ocean, away from the continental shelf (The submerged part of the continent). It is vertically divided into three regions:

1. **Euphotic zone:** which receives abundant light and shows high photosynthetic activity.
2. **Bathyal zone:** receives dim light and is usually geologically active.
3. **Abyssal zone:** is the dark zone, 2000 to 5000 meters deep. The abyssal zone has no primary source of energy. i.e solar energy. It is the world's largest ecological unit but it is an incomplete ecosystem.

- **Estuary:** an estuary is a partially enclosed coastal area at the mouth of a river where fresh water and salty sea water meet.
- These are the transition zones which are strongly affected by tidal action.
- Constant mixing of water stirs up the silt which makes the nutrients available for the primary producers.
- Coastal bays and tidal marshes are examples of estuaries.

- Estuaries have a rich biodiversity and many of the species are endemic.
- They are many migratory species of fishes like eels and salmons in which half of the life is spent in fresh water and half in salty water.
- Estuaries are highly productive ecosystems.
- The river flow and tidal action provide energy subsides for the estuary thereby enhancing its productivity.
- Estuaries are of much use to human beings due to their high food potential.


oceanic provinces and zones
pelagic
neritic
oceanic
epipelagic
photic
200m
sublittoral
dysphotic
mesopelagic
bathyal
littoral
aphotic
1000m
bathypelagic
aphotic
bathyal
4000m
benthic
abyssalpelagic
abyssal
6000m
hadal
10,000m