

# ENVIRONMENTAL SCIENCE

Quality Study Material  
Class 11th  
Prepared By  
DSEK In Collaboration  
With SIE, Srinagar

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# Preface

The present plight of the world as a victim to a plethora of environmental setbacks ranging from global warming, ozone layer depletion to an alarming increase in world pollution levels and present pandemics (COVID-19) is threatening the existence of the most intelligent species on earth. This has been enough for both environmentalists and laymen to wake up to the indisputable importance of environmental education. Almost every sphere that man has forged into has undergone a major demarcation from what it was before to suit the needs and greed of man better.

In this regard this study material will help students to understand the basic concepts of Environmental science in a simple and narrative language. We hope this material shall provide a solid foundation for students to understand environmental problems and their possible solutions. It integrates information from a wide range of disciplines such as Biology, Chemistry, Agriculture, Forestry, Ecology and Soil science. This is a concise and affordable study material that will fill the need of both science and non-science students.

The study material prepared is in compliance with the revised syllabus as prescribed by the J&K Board of school education. The material is divided into ten chapters in a logical sequence which strikes a reasonable balance between environmental science and human social systems. The more concise presentation of the content focuses on key topics on scientific methods and ideas and lifelong learning skills of students. The study material is a modest attempt by the contributing team to meet the challenging and requirements of students studying environmental science at 10+2 level.

All the chapters of this study material offer an insight into the fundamentals of environmental science. The first chapter of this book describes the introduction of environmental Science and its understanding, second chapter depicts the characteristic features Ecology and the third one embodies the description of Ecological interactions and Adaptations. Fourth one describes population Ecology and fifth one describes different Energy Resources. Sixth and seventh chapters of the book evaluate the Earth's environment and Natural Disasters and Environmental Education respectively. Environment Health and Natural Resources are described under eighth and ninth chapters and agriculture management is summarized in the last chapter of the book.

Any suggestions for the improvement of this study material is highly appreciated and thankfully acknowledged.

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# Unitization

(07 marks each )

## Unit 1: Understanding Environment

- Concept of Environment and its types; Physical, Biological Environment
- Scope and importance of Environmental Science
- Components Of Environment
  - a. Lithosphere
  - b. Hydrosphere
  - c. Atmosphere
  - d. Biosphere
- Origin of Earth
- Human and Environment relationship

## Unit 2: Ecology

- Ecology definition and types
- Concept and structure of ecosystem
- Trophic relationships (Food chain, food web, ecological pyramids)
- Functions of ecosystem (Energy flow in an ecosystem, Productivity)
- Ecological Succession (types and stages)

## Unit 3: Ecological Interactions and Adaptations

- Ecological Interactions and its types
- Inter-specific interaction: Positive interactions (Mutualism, Commensalism, proto-cooperation, Symbiosis and scavenging)
- Negative interactions ( parasitism, predation, competition and Ammensalism)
- Intra-specific interactions: Cooperative and competitive
- Adaptations: concept and need
- Types of adaptations with special reference to wind, light and temperature

## Unit 4: Population Ecology

- Concept of species, population and community
- Population dynamics (Population size, Natality, mortality, density, dispersion and Age structure)
- Population growth ( exponential and logistic)
- Factors regulating population growth (competition, weather, climate, territory, predation, natural disasters and diseases)
- Human population, Demographic transition
- Malthus theory and neo-Malthus theory

## Unit 5: Energy resources

- Concept of Energy resources
- Renewable energy resources (Solar, Wind and Hydropower)
- Non- renewable energy resources (Coal, Petroleum Natural gas)
- Nuclear energy- use and limitations
- Biofuels

#### **Unit 6: Earth's Environment and Natural disasters**

- Atmosphere: structure and composition
- Hydrosphere: Distribution, Hydrological cycle
- Lithosphere: structure
- Biogeochemical cycles ( Carbon, Nitrogen and Phosphorus)
- Natural disasters (Earthquakes, Floods and Volcanoes)

#### **Unit 7: Environmental Education and Awareness**

- Concept and need of Environmental Education
- Formal and Non-formal means of environmental education
- Modes of Environmental Awareness
- Role of NGOs
- Environmental Movements (Chipko movement, Narmada Bachao Andolan)

#### **Unit 8: Environmental Health**

- Concept of health and diseases
- Water borne diseases (Cholera, Hepatitis, typhoid)
- Air borne diseases (Influenza, TB)
- Soil borne diseases (Tetanus, Botulism)
- Occupation Diseases (Silicosis, Asbestosis)

#### **Unit 9: Natural resources**

- Forest Resources ( types and uses)
- Animal Resources ( Fish and Livestock)
- Water resources ( fresh and marine)
- Mineral Resources (types and uses)
- Medicinal Plant resources with special reference to (J & K)

#### **Unit 10: Managing Agriculture**

- Concept of traditional and modern agriculture
- Green Revolution and White revolution
- Pesticides and fertilizers (types, advantages and disadvantages)
- Integrated Pest management (IPM)
- Food Security

# Unit 1- Understanding Environment.

## ❖ Learning Outcomes

After going through this Lesson the learner's will be able to understand:

- The definition of Environment.
- What is Environmental science?
- Why do we study Environmental science?
- Need to understand about various components of Environment.
- How is Environment important for human?
- How did earth originate?

### 1.1. Environment.

To define environment is as difficult as defining life. In general terms, it refers to all the external conditions in which an organisms lives. Literally, the very word 'Environment' comes from a French word 'Environner' which means 'to surround 'or 'to encircle'. Thus the word environment is used to describe everything that surrounds the organism, air, soil, water, climate, food supply and a myriad of their external conditions including the things created by man. Etymologists frequently conclude that in English usage at least, environment is the total of the things or circumstances around or organism - including humans though environs is limited to the "surrounding neighborhood of a specific place, the neighborhood or vicinity." In simple word, Environment is the 'Surroundings of the Self.' It is the totality of the biotic and a-biotic factors. According to the Encyclopaedia Britannica (1994) "Environment is the complex of physical, chemical and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival." So in reference to man, the environment has two broad components viz. physical or natural environment and social environment of human race which is a by-product of economic, social, and political interactions.

According to the International Encyclopaedia of the Social and Behavioural Science (2001) "Environment is the total external conditions and influences affecting the life and fortunes of organisms, affecting the parameters of life."

The environment is thus the aggregate of all the conditions that support living things. In turn, living things, including humans, are all interactive parts of the environment. The environment consists of both natural and human-made systems. The natural environment includes the biosystem that supports all living things. The built environment is the human-made system, which is supported by the natural environment. The state of the natural environment ultimately determines the quality and survival of life on Earth.

In the medical sense, the environment includes the surroundings, conditions or influences that affect an organism (Davis, 1989). Along these lines, Last (2001) defined the environment for the International Epidemiological Association as: ‘All that which is external to the human host can be divided into physical, biological, social, cultural, etc., any or all of which can influence health status of populations..’. According to this definition, the environment would include anything that is not genetic, although it could be argued that even genes are influenced by the environment in the short or long-term. Figure 1 shows one way to represent the environment, from the most inclusive to the most restrictive definition (Smith, Corvaten and Kjellstrom, 1999).

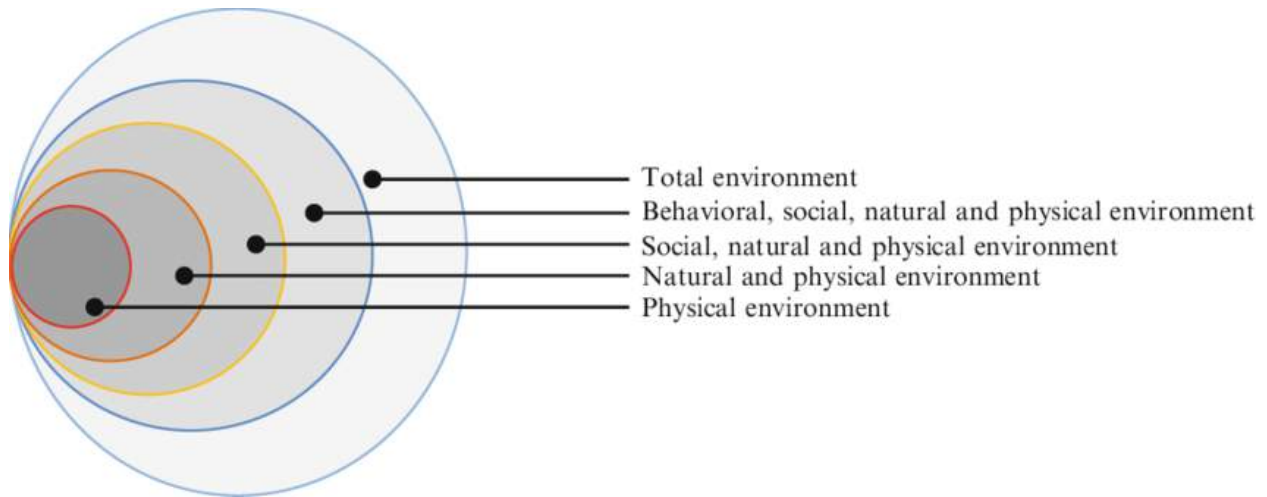


**Fig 1.1:** Definition of Environment ((Adapted from Smith, Corvaten and Kjellstorm, 1999)

For the purposes of environmental health, however, a more practical definition of the environment is needed, because environmental health action generally tries to change only the natural and physical environments and related behaviours (e.g. hand washing). Such interventions can rarely modify the social and cultural aspects of a community, which are usually independent of the environment (e.g. cultural pressures on lifestyle, unemployment).

As a result, a more practical definition of the environment might be ‘The environment is all the physical, chemical and biological factors external to a person, and all the related behaviours.’

### Classification and Components of Environment

The classification of the environment can be described from the following figure:

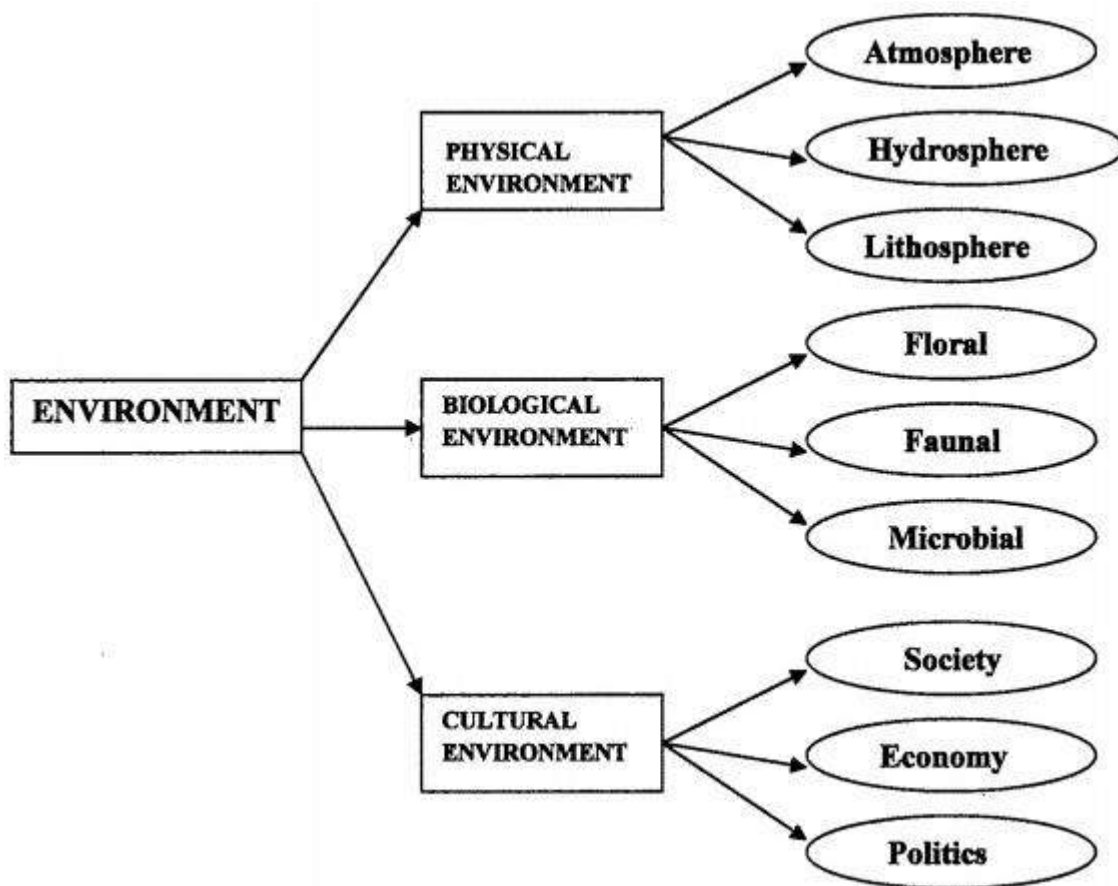


**Fig 1.2:** Classification of the Environment (Source: [www\\_seribd.com/doc/.../11](http://www_seribd.com/doc/.../11) - components of environment)

Environment has three distinct dimensions namely: Physical environment, Biological environment and Cultural environment. All the same, the study of the cultural environment has been allocated to sociologists, economists and managers. The physical and biological environment is taken care of by the environmentalists including biologists and doctors. The components of the environment are broadly classified into two major categories: 1. Biological components or Biotic components 2. Physical components or Abiotic components (Shrivastava, 2007).

## 1.2. Physical and Biological Environment;

- **PhysicalComponents/Abiotic components:** According to odum, abiotic components are carbon, nitrogen, hydrogen and temperature, light (duration and intensity).

According to modern classification Abiotic or physical components of environment include:

- Temperature
- Light
- Wind
- Water
- Humidity
- Soil
- Soil pH
- Topography.

2. **Biological components:** The biological components of the environment includes all living organisms (Biotic),Plants(Flora),Animals(Fauna), micro-Organisms and the most importantly human beings.

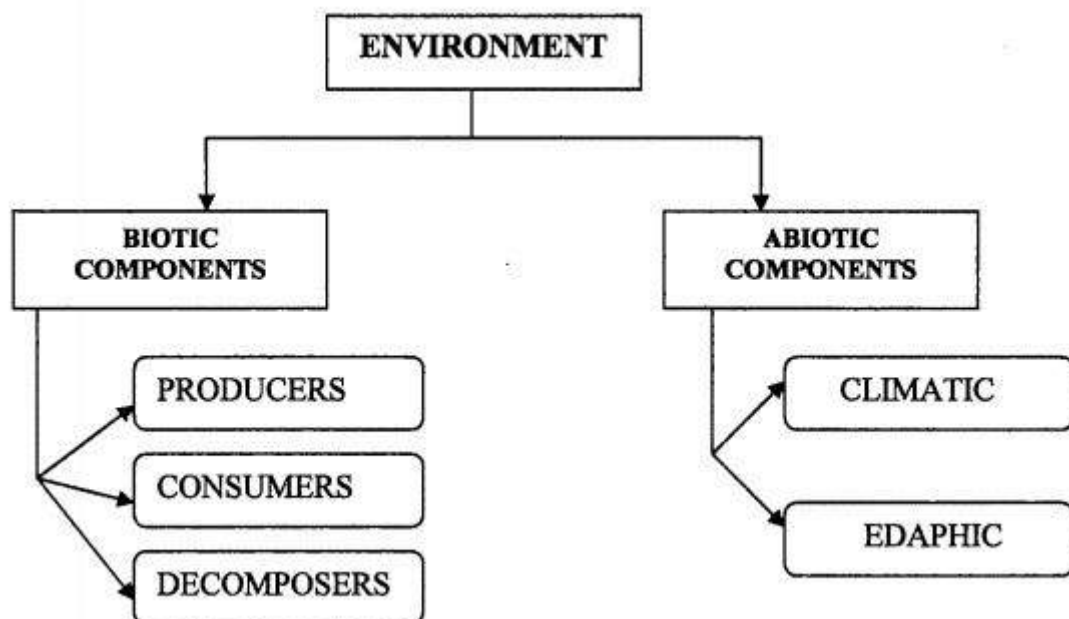


**Fig 1.3:** Classification of the Environmental components

Here the components are classified in terms of life. The biotic components are further listed as producers, consumers and decomposers and the abiotic components are classified as

climatic (water, air) and edaphic (land /soil). On the other hand, if ecospheres are taken into consideration then the components of Environment are as follows:

- Hydrosphere (Water)
- Atmosphere (Air)
- Lithosphere (Soil)
- Biosphere (Flora / Fauna / Microbes)

### 1.3: Scope and Importance:-

#### 1.3.1. Scope of Environmental Science:

Environmental studies deal with working of earth, it's life supporting systems, it's interactions, influences, it's problems and solutions. keeping in view the complex nature of environment, knowledge and information from various disciplines of science, social science, law and engineering have to be included in the Environmental studies to understand it completely.

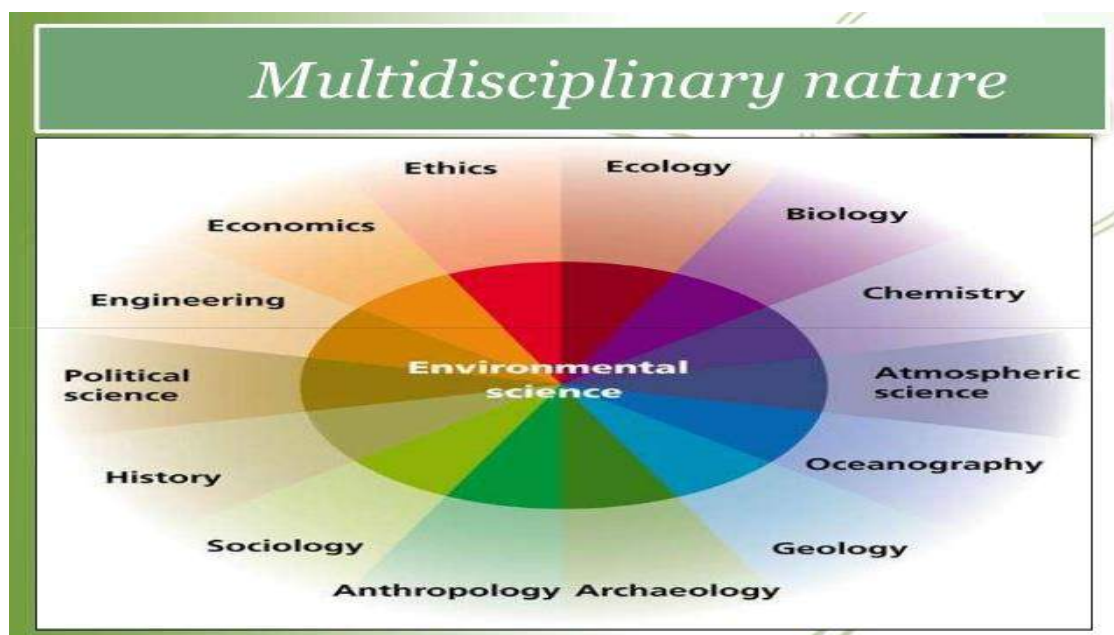


**Fig 1.4:** Multidisciplinary nature of Environmental Science

Due to its complex and multi-disciplinary nature Environmental studies as a subject has a wide scope. It encompasses a large number of areas and aspects, which are as

- Natural resources their conservation and management.
- Biodiversity and its conservation.
- Human population and its control.
- Sustainable development.

- Disaster and its management.
- Environmental pollution and control.
- Social issues in relation to development and environment.
- Human population and environment.

In recent years, the scope of Environmental studies has expanded dramatically in the world. Several career options have emerged in this field which is as

- Research and development in environment to examine various environmental problems in a scientific manner and carry out research and development for developing cleaner technologies and promoting sustainable development.
- Green Advocacy to implement Environmental laws and Acts.
- Green Marketing to implement all environmental standards and ISO mark.
- Green media to spread awareness regarding environmental aspects among common masses.
- Environmental consultancy for studying and tackling environment related problems.

### **1.3.2. Importance of Environmental Science:**

Environment belongs to all, influences all and is important to all. Whatever be the occupation or age of a person, he/She will affect the environment by his/her deeds. That is why it becomes necessary to make every one aware and conscious about the importance of Environment. There is an internationally observed environment calendar to mark some important aspects of issues of environment, so that people think, discuss, carry out campaigns and for the cause of Environmental issues. The importance of Environmental Science may be summarized as

- It helps us to study the design of Environment, functions of nature and it's coordination with living world.
- It develops an understanding that human beings, plants, animals are part of nature and dependent on each other.
- It high lights the effect of anthropogenic activities on natural processes.
- It develops the understanding that local environments can contribute in the protection and safety of global environment.

- It develops the responsibility among the people and concerned authorities to maintain ecological balance for a sustainable life.
- It makes a way for the participation of public in decision making and contribution in redressal of local and global environmental issues.

#### 1.4. Components of environment

The chief components of environment comprises are-

- 1.4.1. Biosphere:-**The Biosphere (from Greek bios= life, Sphaira = sphere or zone). The biosphere is unique as there has been no existence of life elsewhere in the universe and earth is the only planet known to possess life because of the living conditions such as Air, water, soil, food etc., provided by it to the different living organisms. Our earth along with its living organisms and physical environment (air, water, land) that sustains life is known as biosphere or ecosphere. The term biosphere (bio- sphere) was first used by a Geologist Edward Suers (1875) which according to him is a place on earth where life dwells.

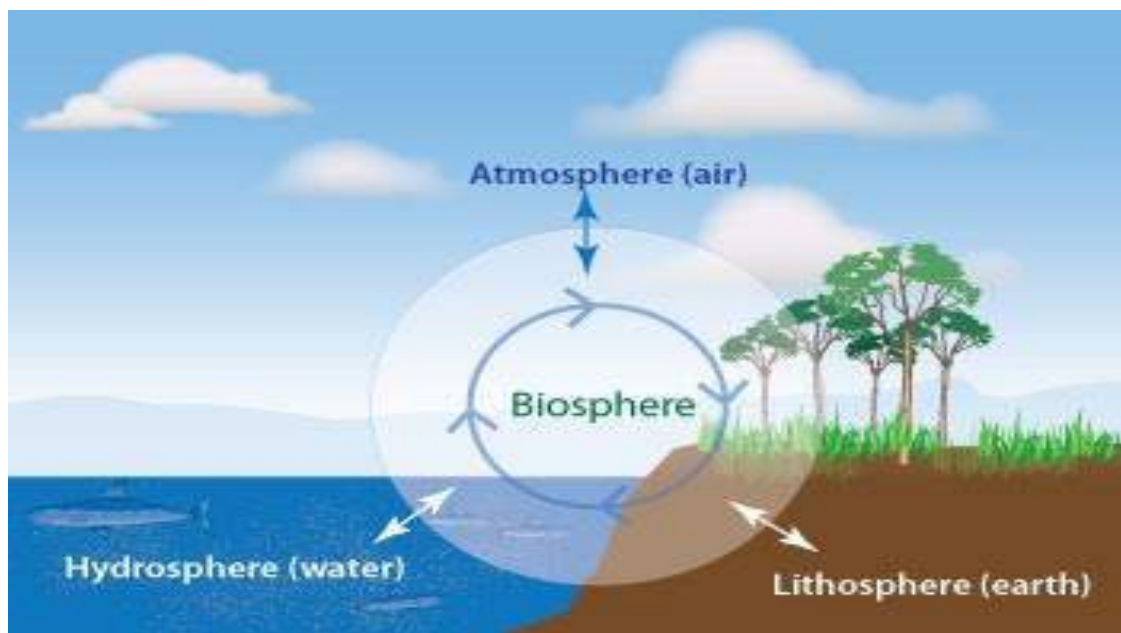


**Fig 1.5:** Concept of Biosphere

#### 1.4.2. Hydrosphere:-

Hydrosphere (Hydro = Water ) includes the water resources in the form of oceans, seas, rivers, lakes, reservoirs, streams, ice caps, ground water (aquifers, soil moisture), water locked up deep inside the earth crust and water present in atmosphere and cells of living organisms. Water is a marvellous substance essential for life. It flows, swells, seeps, constantly moves from sea to land and

back again by hydrological cycle. It is important medium for life processes as it dissolves nutrients regulates temp of body, removes wastes, supports structures and it has been estimated that there are 370 billion gallons of water on earth which includes water in all the three forms. However its distribution is extremely uneven. 97% occurs in oceans as salt water and only 3% is fresh water out of which 69% resides in glaciers, 30% underground and less than 1% resides in lakes, rivers, streams, ponds etc. which indicates that only 1% of total water is usable for humans.

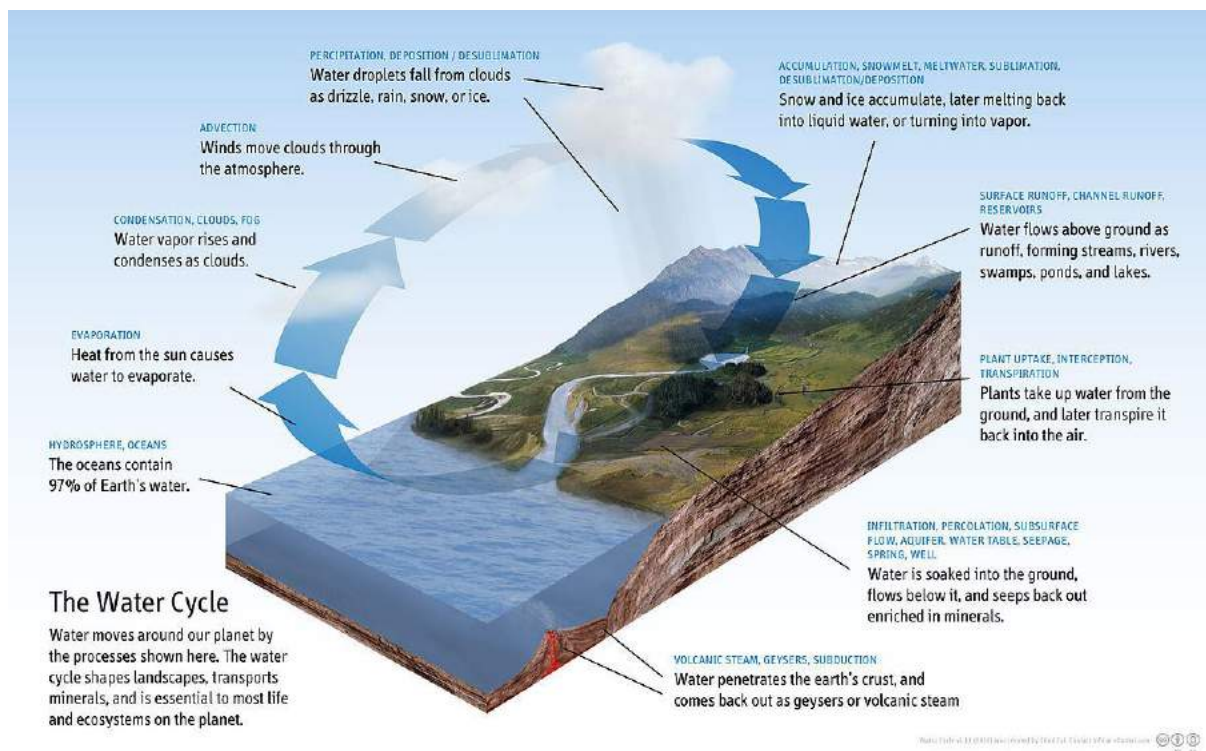


**Fig 1.6: Hydrological Cycle**

The total mass of earth hydrosphere is about  $1.4 \times 10^{18}$  tones which cycles endlessly through the environment by hydrological cycle.

#### 1.4.3. Lithosphere:-

(Lithos = rocky) the concept of lithosphere was given by E.H Love (1911). It includes the outer mantle of solid earth and the crust consisting of minerals and soil. Although we think that earth under our feet is solid and stable, but it has a dynamic structure where forces inside the earth cause continents to move apart, spilt crash into each other but slowly. It has a layered structure with core at the interior made up of hot mass of metal (Fe) which is surrounded by a hot pliable layer of rock called mantel (made up of  $O_2$ , Si, Mg) and the outer

most layer of earth – the crust which is cool, lightweight, brittle layer with variable thickness. The lithosphere includes the crust and the upper most mantle which forms the hard and rigid outer layer of earth . The lithosphere is subdivided into tectonic plates and the upper most peel of crust that constantly reacts with atmosphere, hydrosphere and biosphere through the formation of soil. Below the lithosphere lies aesthenosphere which is a weaker and hotter part of the upper mantle. The lithosphere may be either oceanic or continual depending upon its location. Thus, the main components of Lithosphere are hard rocks and soil. The rocks are solid cohesive aggregates of one or more minerals which may be sedimentary, igneous or metamorphic in nature. Sedimentary rocks are formed when loose particles of other rocks are consolidated by temperature and pressure while as igneous rocks are formed by the solidification of molten magma or lava. However, others formed by melting, contorting and recrystallization of other rocks known as metamorphic rocks. Most crystalline rocks are extremely hard and durable, but due to exposure to atmosphere hydrosphere, changing temperature, these are broken down slowly into smaller and finer particles by weathering process leading ultimately to the soil formation.

#### **1.4.4. Atmosphere :-**

It is a layer of gases protective in nature surrounding the earth from all sides. The word atmosphere, (atmos= Greek word which means vapour) indicates a mixture of gases surrounding the earth by gases which sustains life and saves it from the hostile environment of outer space. The atmosphere of earth is composed of N<sub>2</sub> (78.084%), O<sub>2</sub> (20.94%), Argon (0.93%) with CO<sub>2</sub> (0.04%) other trace gases like argon, Krypton, xenon, helium, methane, iodine etc., is about 0.01%. In addition water vapour is variable form 0-4 % and liquid droplets and minute particles known as aerosols also remain suspended in air.

The atmosphere has been classified into four main concentric layers on the basis of density, temperature, Composition and properties:

- Troposphere(upto16km)
- Stratosphere(16 to 50km)
- Mesosphere(50 to 85km)
- Ionosphere(85 km upwards).

#### **•Importance of Atmosphere:**

The atmosphere plays a key role in maintaining the life forms on earth by following means:

- Atmosphere provides oxygen for respiration, carbon dioxide for photosynthesis, nitrogen for plant and animal proteins, and nitrates in soil.
- Ozone blanket stops the harmful ultraviolet radiations from the sun.
- It provides a medium for birds, bats, and insects to fly.
- It helps in pollination and dispersal of spores, cysts, seeds and fruits.
- It maintains temperature on Earth.
- It maintains water cycle and regulates Climatic changes.
- It makes flights possible and acts as medium for sound wave transfer.
- It makes burning of fire possible.

### **1.5. Origin of earth:**

The scientists explained the origin of universe through Big Bang theory or expanding universe hypothesis. As per the evidences provided by Hubble 1920, universe is expanding and as the time passes, galaxies move apart farther and farther. The following developmental stages took place in the formation of universe.

Initially, all the matter existed in the form of a tiny ball with infinite small temperature, infinite small density and unimaginably small volume. The tiny ball exploded suddenly with a big bang that took place about 13.7 billion years ago. Such a bang led to huge expansion within fractions of a second that even continues till today although it has slowed down. Later, the temperature dropped to 4500K giving rise to atomic matter within a period of 300000 years from the big bang and universe became transparent.

As the universe expanded, matter collected into clouds that became to condense and rotate forming the galaxies. Within these galaxies, changes in pressure caused dust and gas to form distinct clouds and some of these clouds collapsed due to sufficient mass, force and gravitational attraction. Due to sufficient compression of mass of material, nuclear reactions started and a star was born. In the middle of the flattened spinning disc, some proportions of the stars were formed including the sun. The gas and the dust within the disc collided and aggregated into small grains, and these small grains piled up into larger bodies known as planetesimals or small planets. In successive stages such small planets coalesced into the present day planets including earth and other numerous galaxies. The rocky planets were near the sun and the gaseous planets in more distant orbits. Due to high temperature of the inner solar nebula, the small planets like mercury, earth, venus were too hot to hold the dominant volatile gases present in solar nebula and only high melting point substances like iron and silicates were stable. The temperature was cool enough in the outer nebula which helped the

abundant gases to accumulate and to be held. Thus planets like Jupiter, Uranus and Neptune are gas giants formed from Helium, hydrogen and other hydrogen compounds like methane.

The materials that accumulated into early earth were not added into any order and being molten due to gravitational compression and radioactive decay, the materials inside started getting separated as per their densities and the denser metallic liquids sank to the centre of earth and the lighter ones rose to the top. With the passage of time due to further cooling it solidified and condensed into small size which led to the development of the outer surface in the form crust. Thus due to differentiation earth forming materials got separated into different layers like the crust, mantle, outer core and inner core.

### **1.6. Human and Environment relationship:-**

Human beings need to interact with their environment to get necessities of life like food, water, shelter, fuel, medicines, raw materials and many other things. These interactions are there since the people first walked on earth. Human environment relationship is a phenomenon to understand how human beings interact with the environment to meet the demands from it and how the environment in turn responds to this interaction. In addition it indicates how humans have to adapt to ensure their survival. Humans have to adapt to those conditions of the environment which they cannot modify, to ensure fulfillment of their needs. Examples include building houses on higher grounds in flood prone areas, using slope of the land to transport water for irrigation and wearing warm clothes in winters etc. Similarly, humans can modify the environment and make it easy to extract their resources in a much better way. Such modifications include cutting down of forests to clear land for cultivation, drilling holes in ground for oil extraction, building dams for water storage etc. There are many ways in which humans influence their environment and in turn humans are being affected both positively as well as negatively. Major environmental events like earth quakes, floods, volcanoes and droughts also affect us to a larger extent by their disastrous effect on our homes, property and agriculture. Our relationships with the environment changed with the advent of industrialization that started from 18<sup>th</sup> century. Prior to industrialization, the impacts of human activities were insignificant because of the fact that the technologies used were not modifying the environment as people used simple technologies and less resource. People used to live in agricultural societies and used hand tools and traditional technologies that

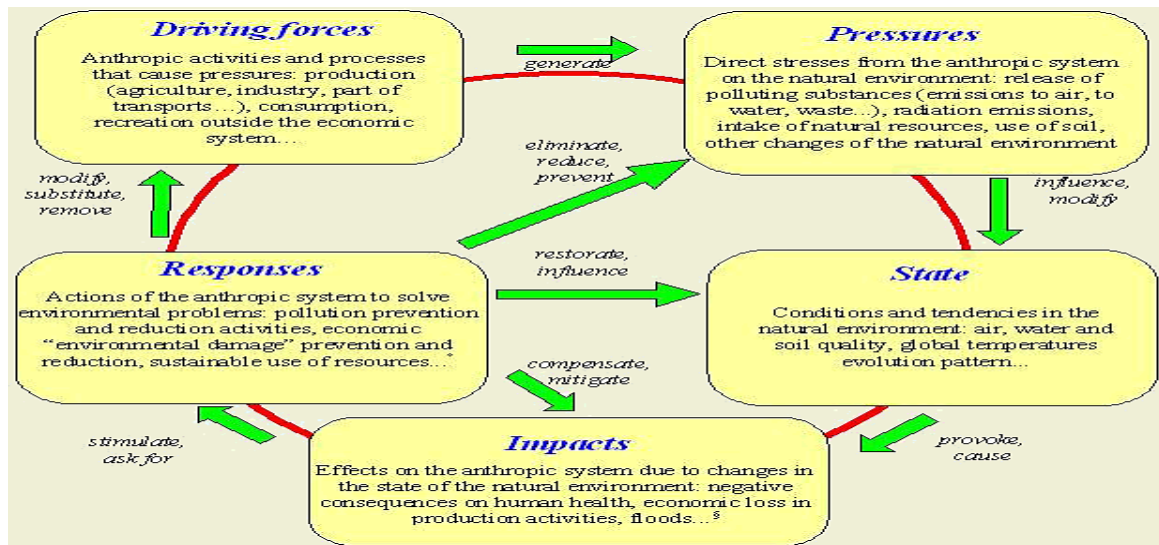


**Fig 1.7:** Human-environment interactions and its impact

limited the environmental damage. Much slowly humans settled down, became civilised and learnt how to manipulate the surroundings and as the time passed the advent of science and technology made the life more and more comfortable and man became more ambitious of consuming more resources and the effect of his activities on environment became more prominent. Industrialization has allowed a rapid exploitation of natural resources such as wood, minerals and fossil fuels which has increased the human impact on the environment in terms of environmental pollution, climate change and loss of biodiversity which has endangered many species of plants and animals putting entire ecosystem under threat.

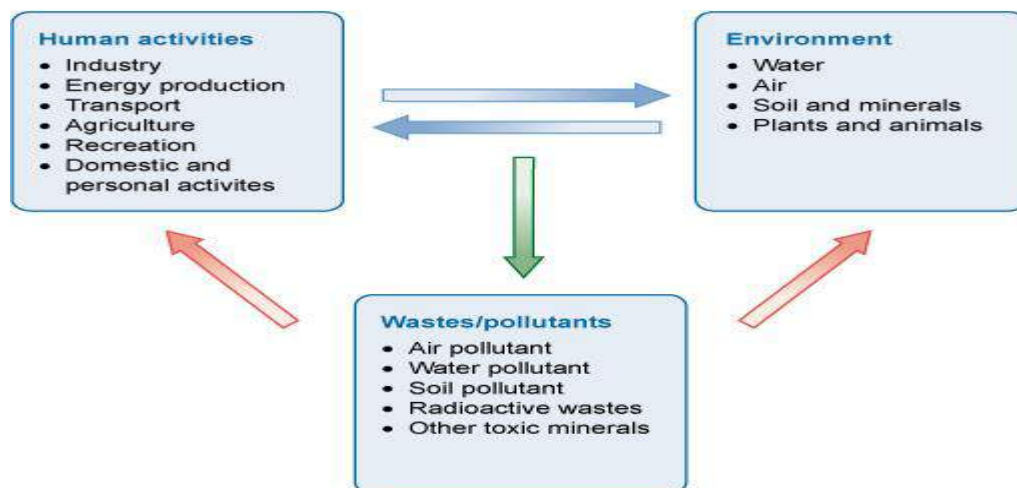


**Fig 1.8:** Model representing human-environment interactions

## Evaluation

### Short Answer Type Questions

- Q.1: Define Environment.
- Q.2: What are the various components of Environment?
- Q.3: How does man affect its environment?
- Q.4: How is atmosphere important to us?
- Q.5: Write down the composition of Atmosphere.

### Very Short Answer Type Questions

- Q.1: Define Hydrosphere.
- Q.2: What is Biological Environment?
- Q.3: Define Biosphere.

### • References:

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2. Ecology and environment 2018 edition by P.D Sharma
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## Unit 2 Ecology

### ❖ Learning outcomes;

- Develop the understanding in students about ecology and its types
- To acquaint with the concept of ecosystem and its trophic structure
- Conceptual understanding of Energy flow, food chain and food web
- To have the knowledge of Succession and its steps

### 2.1. Definition

Ernest Haeckel, (1867) is considered to have proposed the term ecology (Oekologie) meant the study of the animal's relationship to its organic as well as inorganic environment. Literally ecology is the study of organisms at home. (The interaction of Physical environment and other organisms living there). Thus ecology is the branch of biology that studies interrelationships between organisms and their environment. Although Haeckel used the term environment in his definition but better definition of ecology may be the scientific study of the distribution and abundance of organisms and their interactions.

**2.2. Types of Ecology:-** Ecology deals with three levels of organization the individual organisms, the population and the community level. At the level of organisms, it deals with how organisms are affected by (and how they affect) their surroundings. At the level of populations, ecology deals with the presence or absence of a particular species, their abundance or rarity and the dynamic trends in fluctuations of their numbers. Thus, ecology inspects the interaction and distribution of an individual organism as well of a population. Therefore ecology could be discussed under following two headings.

**a. Autecology:-** the study of interactions of an individual organism and its environment can be considered as autecology. It gives an idea of distribution, adaptation, speciation etc. of a particular species. Various species in nature live in various habitats. Some are confined to limited area due to limited character of adaptation while others grown in different habitats due to wide range of adaptation. Different species differ from each other in terms of their resource demands from their environment and also in respect of the tolerance of fluctuations in environment. Thus, all aspects of a species like its distribution, tolerance, adaptation, reproduction, growth, nutritional requirement etc. are studied under autecology. Hence, it deals with the study of interaction of an organism or a species with the environment.

**b. Synecology:-** Organisms group like population and communities and synecology brings with this concept that refers to the study of interaction between species of communities on many spatial and temporal scales including the distribution structure, dynamics abundance, demography with primary focus on interaction between groups of individuals and their environment. thus synecology deals with the study of interactions of groups of organism with their environment.

**2.2.1 Concept of Ecosystem:** - life on earth is sustained by interaction of individuals, species and populations with each other and with their physical environment that surrounds them. This interacting unit of environment is known to be ecosystem (term given by A .G Tansley 1935). So when individuals of organisms functioning and interacting together with their physical and chemical environment form a self-sufficient and stable unit- it is known as ecosystem. Ecosystems are nearly self-sustained where there is exchange of nutrients within the system than with other systems. Thus, a complete description of an ecosystem is a biotic community and its physical environment and interaction among them. The term ecosystem most preferably includes all organisms in a given area which interact with the physical environment in a way that there occurs of flow of energy and nutrient cycling with a clearly defined tropic structure with the system. Thus, earth could be considered and ecosystem where living and non-living components constantly exchange materials and are constantly acting and reacting with each other bringing forth changes in both structure and functions in it.

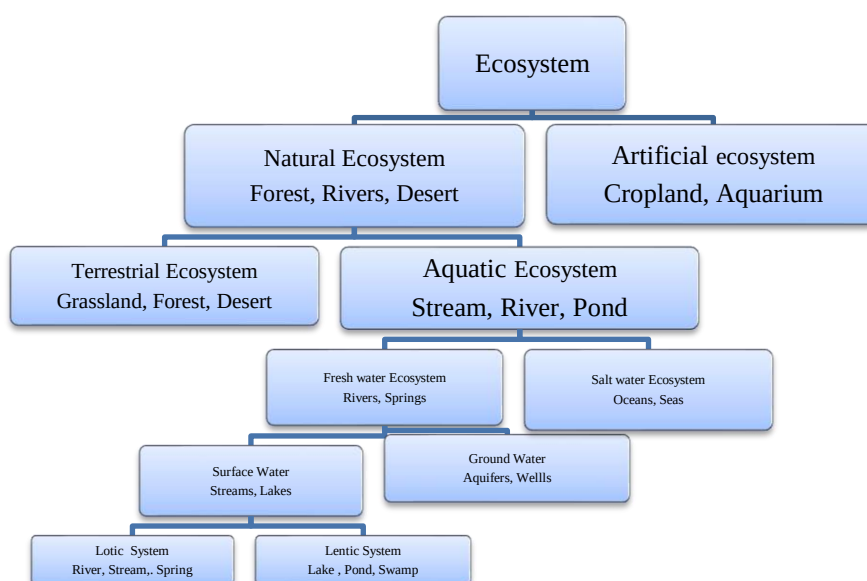


**Fig 2.1 Showing classification of Ecosystem**

**2.2.2 Structure of an ecosystem:** - One of the important feature of an ecosystem is its structure which is evident from the unique combinations of living organisms with their non-living component in any particular ecosystem. By structure we mean the composition of an ecosystem i.e. the components and their arrangement of which an ecosystem is composed or made up of. Hence in the structure of an ecosystem there are mainly two components to be studied which are discussed as under;

**a) Abiotic component:** - It represents the non-living or physical environment of an ecosystem which has a strong influence on the life of living organisms (their distribution, behaviour etc.) present over there. The abiotic component further includes;

- (i) The climatic factors and the (ii) edaphic factors

The climatic factors include (temperature, light, rain, wind, humidity etc.) and the edaphic factors include soil and chemical factors such as pH, and nutrients both inorganic as well as organic. It includes the amount of inorganic substances including C, P, S, N and S which are continuously cycling through regular paths between living organism and their non-living environment. The amount of these inorganic substances present in an ecosystem at any given time is known as standing state. The amount and distribution of organic materials like proteins, lipids, carbohydrates present in soil and atmosphere that regularly move to and fro between living and non-living components are also characteristic of abiotic component of an ecosystem.

**b) Biotic Component:-**

Various species of plant, animals and microbes which are interdependent upon each other in the ecosystem represents its biotic component. Thus living part called the ecological community is the set of species that are interacting within an ecosystem. Depending upon the role these living organisms play in an ecosystem they are further divided into:

- **Producers:-** The green plants, algae and photosynthesis bacteria which have the capacity to fix solar energy through photosynthesis and chemosynthesis for building up complex organic substances or energy rich carbon compounds.
- **Consumers:-** the nutritional needs of some organisms are met by feeding on producers or their products are called as consumers. These are also called as

heterotrophs as they depend on autotrophs. A primary consumer or more commonly a herbivore is a heterotroph that derives its nutrition directly from plants. A carnivore or secondary consumer is a heterotroph deriving its energy directly from primary consumers but indirectly from producers. While as a tertiary consumer is a carnivore feeding on secondary consumers. Omnivores are the consumers that derive their energy i.e. they feed on both producers and herbivores.

- **Decomposers:-** there is another major group of heterotrophs present in an ecosystem called as decomposers or reducers e.g. bacteria and fungi. Like herbivores and carnivores, decomposers mostly do not consume food by ingestive manner but by absorption as their bodies secrete chemicals called enzymes which breakdown the dead organic matter of producers and consumers into simple inorganic constituents and are thereby made available for reuse by producers and other organisms.

## 2.3 Trophic Relationships

One interaction among organisms is by feeding in one another and this relationship that exists between organisms in terms of food is known as trophic relationship. (The word trophic derived from Greek tropein = to feed). Such relationship transfer energy and chemical element from creation to creature and give rise to a specific arrangement of organism with – linkages suggesting who feeds on whom-the food chain. Each organism occupies a particular place in a food chain which is known as trophic level e.g. Producers, primary consumers, secondary consumers and tertiary consumers etc.

### a) Food chain

The flow of energy (food) in an ecosystem takes place from producers through a series of organisms (producer→ consumer→ decomposer) with repeated eating and being eaten i.e. producer is eaten by primary consumer, secondary consumer eats primary consumer and so on. This interconnectedness or linkage of organisms in terms of food for their very existence where each organism feeds on the preceding ones is called as a food chain. Thus a food chain is an energy sequence of links or trophic levels that start with a species that eats no other species and ends with species that is eaten by no other species.

The position of a living organisms in a food chain is expressed as trophic levels i.e in the above shown food chain, grasses form the 1<sup>st</sup> trophic level, grasshopper form the second,

frog forms the 3<sup>rd</sup> and so on. But this position may vary as an organism may occupy different trophic levels depending upon the number of steps required for obtaining food from producers. The number of trophic levels in different food chains may also vary. There are basically two-types of food chains that operate in nature viz;

i) **Grazing food chain**:-Such of food chain operates in those ecosystems where the producer level is formed by green plants, goes to grazing herbivores and then to carnivores e.g. grasslands, forests, lakes etc. hence, such ecosystems need a continuous supply of solar radiation which is converted by the autotrophs making the whole ecosystem functional.

ii) **Detritus food chain**:-Such food chain start from dead organic matter goes to detritivores (bacteria worms) and on to their predators. This food chain is less dependent on solar energy but exclusively dependent on continuous supply of dead organic matter e.g.

Dead organic matter → Detritivores (Bacteria worms) → Predators (insects)

Litter accumulated in a forest → Soil mites → Insects → Fish

Under natural conditions, both these food chains are interlinked in order to ensure efficient functioning of an ecosystem.

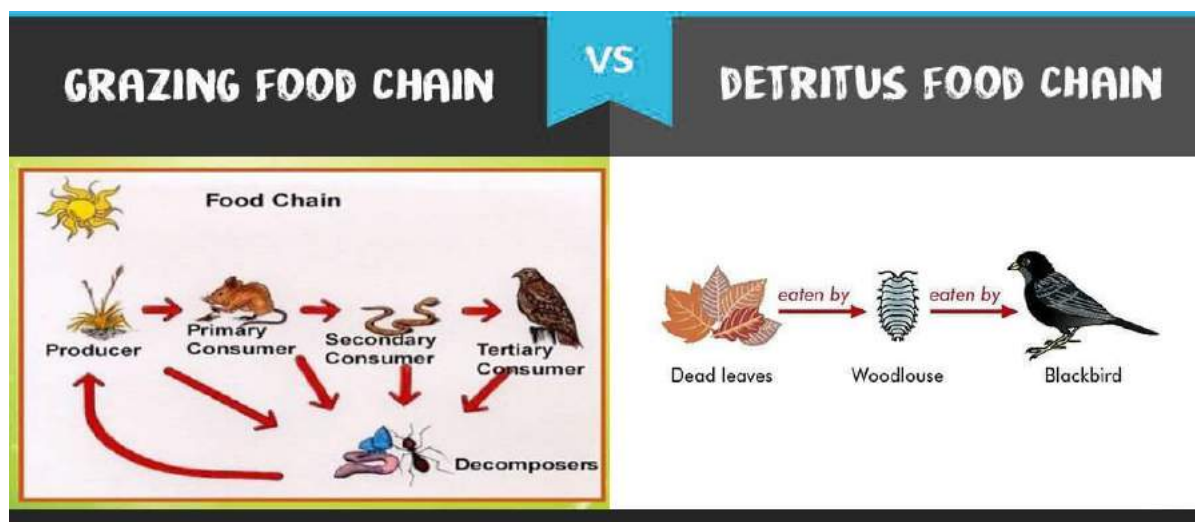


Fig.2.2: Comparison of different food chains.

### b) Food Web

Food chains are never isolated from each other. Food chains are the pathways of food or energy transfer, and there are often multiple and inter connected pathways resembling a web rather than a simple chain referred to a food web. In fact, under natural conditions food

chains never operate in an isolated manner but these are interconnected with each other through different types of organisms at different trophic levels. Such interlocking pattern of food chains with each other is called as food web. Food webs are important in maintaining the stability of an ecosystem because the individual consumers have alternate and multiple options of deriving their food. However, the complexity of a food web directly depends upon the length of food chains and the diversity of organisms which provide more alternatives at different levels. Thus, more complex a food web, more stable is the ecosystem.



**Fig. 2.3: Comparison between food chain and food web**

### 2.4.1 Functions of an Ecosystem

So many elements are required by at least some form of life, and each chemical element required needs to be available to every organism in right amount at the right time. These elements ought to be recycled, converted to usable form, taken up by organisms, and converted into wastes which need to convert into food once again thus keeping the cycling going on indefinitely to keep the ecosystem viable. Several species must interact to complete recycling of the elements to take place. Plants trap the solar energy and absorb nutrients from soil and surroundings for building up organic compounds (food) which is then used by consumers. But no photosynthetic organism can decompose the already built organic matter back to its original inorganic form. The decomposers primarily bacteria and fungi are able to decompose the organic matter but are unable to produce their own food instead; they obtain food from dead tissues on which they feed. Thus an ecosystem at least needs one species that produces its own food from inorganic compounds and another species that decomposes the wastes of the first species. Thus energy flow accompanies nutrient cycling and nutrient cycling accompanies energy flow leading to the basic design of the ecosystem.

### a) Productivity of an Ecosystem

Biomass is increased by biological production or growth. Change in biomass over a specific period of time is called as production. The capture of usable energy from the environment is called as biological production. Productivity means the amount of organic matter accumulated in unit time when solar energy is fixed by autotrophs, there is production of organic matter and how much matter is produced & assimilated at different trophic levels gives rise to the concept of productivity. Productivity may be primary or secondary in nature.

**(1) Primary productivity:** - it is associated with producers (autotrophs and chemotrophs). The production carried out by producers is called as primary production. It is the rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producers. It is further distinguished as;

- **Gross primary productivity:** - this is the measure of the total amount of the dry matter made by the plant in photosynthesis. It is measured in units of dry weight/ unit area/ unit time. Once the organism has obtained new organic matter, the energy in that can be used to grow or reproduce or it can be stored for future uses.
- **Net primary productivity:** - Living organisms including autotrophs respire and some of the matter from gross primary production is converted back into carbon dioxide and water and dry weight is therefore lost. Thus overall gain of dry weight or increase in biomass by the plant after respiration is called net primary productivity.

Hence: **Net primary Production = (Gross primary productivity – Respiration)**

**(2) Secondary productivity:-** The sort of production carried out by heterotrophs is called as secondary production. It is the rate of energy storage at consumer level or rate of formation of new organic matter by heterotrophs i.e. the amount of organic compounds matter taken up by consumers from autotrophs and converted to animal tissue.

**(3) Net productivity:-** It is the rate of storage of organic matter by consumers not used in respiration. Thus the organic matter stored by consumers is net productivity.

Hence, Net productivity = (Secondary productivity – Respiration)

### b) Energy flow

Essentially most of the organisms depend on sun for the energy needed to carry out life processes and to create structures by means of photosynthesis in green plants. Photosynthesis converts radiant energy into useful chemical energy in the bonds that hold together organic molecules. Energy captured by this mechanism nearly supports all life on earth. The chemical energy then gets transferred to other organisms by means of food chain through different trophic levels. When the trophic levels are connected with each other to show the inputs and losses of energy at each trophic level, an energy flow model is constructed. Following are some energy models;

*Single channel energy flow model by Lindeman:*

Where  $\Lambda$  = Standing crop energy of any trophic level.

$\Lambda_1$  = for producers  $\Lambda_2$  = Consumers (herbivores) and so on

$\lambda_1$  = Total energy loss (Energy loss to a trophic level as respiration ( $\lambda_2 + R_1$ ) plus the energy transferred to higher trophic level  $\lambda_2$  i.e. from  $\Lambda_1$  to  $\Lambda_2$

out of that energy ( $\lambda_1$ ) absorbed by first trophic level ( $\Lambda_1$ ), some amount ( $\lambda_2$ ) is passed to next trophic level ( $\Lambda_2$ ) and some amount is lost as respiration ( $R_1$ ). Therefore total loss of energy at first trophic level  $\lambda_1' = \text{amount passed} + \text{amount lost in respiration}$ :

i.e.,  $\lambda_1' = \lambda_2 + R_1$

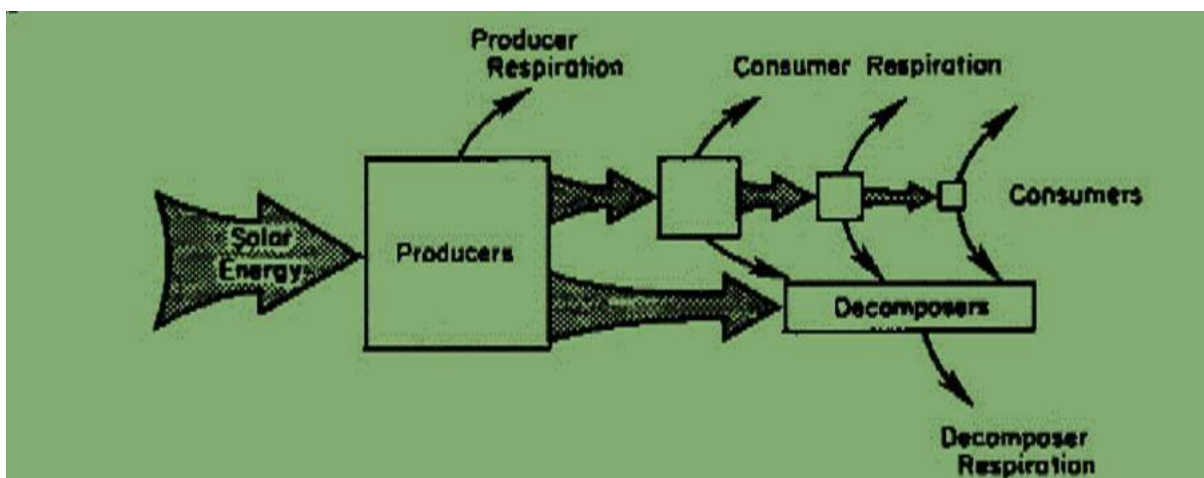


**Fig.2.4. Single channel energy flow model**

Another model is given by Odum where grazing and detritus food chains are shown together where he pointed out that in nature two food chains operate in any system- the grazing food chain beginning with plants going to herbivores then to carnivores and the detritus food chain beginning with dead organic matter going to microbes and then passing to detritivores and their other organisms which feed on them.

Here each arm represents a food chain (grazing and detritus food Chains) and indicate that these two chains are not completely separate but parts of the grazing food chain after death become incorporated in the detritus food chain. This model seems to be more specific as compared to other models.

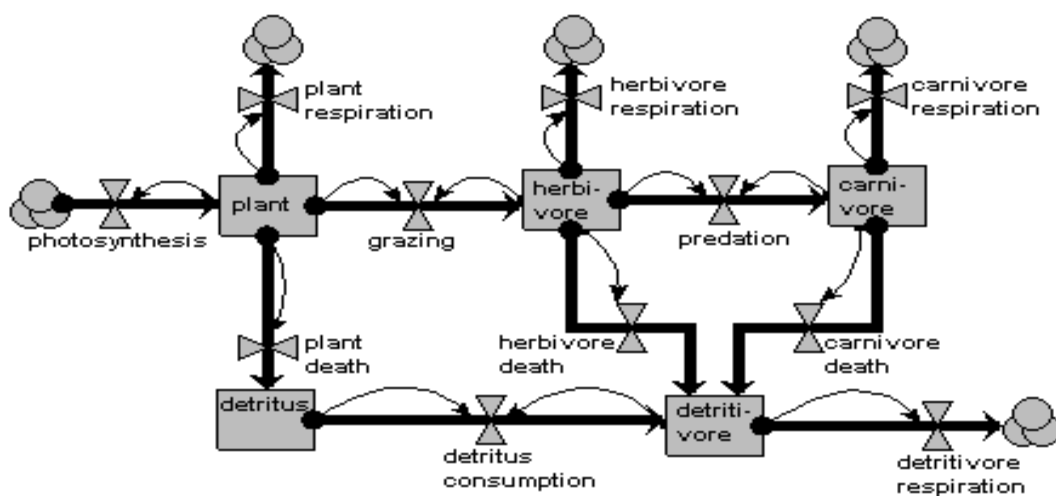


**Fig.2.5. Y-shaped energy flow model**

## 2.5 Succession:-

The term was first used by Hult in 1885. The change in the species composition of the community over time is known as ecological succession or succession may be defined as continuous sequential change in the species structure of natural communities. Succession is usually set in motion by some factors whether internal or external which bring marked changes in the dominant organisms of existing community which is replaced sooner or later by some other community. The process continues and successive communities develop one after another over the same area until a final community again becomes more or less stable for a period of time i.e. the community achieves some degree of equilibrium or steady state with the environment. Finally the mature, self maintaining stage with the environment is called as climax community or climax. The sequence of communities from one to that of

terminal relatively stable community is called a *sere* and each of the change is a seral stage having its characteristics species composition as it is considered as a distinct and separate community.

a) **Types of succession:-** Different types of succession based on different complex processes involved in recovery of disturbed ecosystems when the damage is not too great, one can classify the succession as follows;

- **Primary Succession:** - Establishment and development of ecosystem where one does not exist previously. i.e, there was previously no living matter, is known as primary succession and such areas have never supported life. Organisms that colonize such areas are known as pioneer organisms or primary colonisers. Primary succession usually starts on sand dunes, rocks, cliffs ponds etc. These types of successions are generally slow in nature. Forests that develop on new lava flows are examples of primary succession.
- **Secondary Succession:-** It is the establishment of an ecosystem after a disturbance has occurred or when the succession that proceeds on areas where other organisms were present previously or substratum previously build with living matting is known as secondary succession. Secondary succession arises on the areas where the vegetation cover has been disturbed by humans, other animals or natural forces like fires, storms or floods and area becomes devoid of living matter but the substratum is build up already instead of primitive one. Forests that develop on abandoned pastures after floods and hurricanes are the examples of secondary succession. These successions are much faster than primary successions.
- **Autogenic Succession:** - when the changes in the environment are brought about by the organism themselves as a result of their actions with the environment causing the modification of their own environmental conditions and hence cause its own replacement by some other community giving rise to change in species structure.
- **Allogenic Succession:-** when the changes in the environment of an area are caused by some external factors unaffected by the organisms, the succession is termed as allogenic succession. Such environmentally induced succession, often long term may involve climate change or successive changes in the soil over a long period of time.



**Fig. 2.6 Types of ecological succession**

**b) Process of succession:** - Succession is a process involving several sequential phases which follow one another and these steps were given specific names by ecologists like Clements as follows;

- **Nudation:** when there occurs a disturbance in terms of a landslide or erosion, it results in the formation of a bare area known as nudation. The causes of nudation i.e. bare area formation may be climatic catastrophes, human activities or topographic disturbances like soil erosion, deposition, landslides volcanic eruptions etc. Such areas are fit to serve as sites for establishment of a new community.
- **Invasion:-** Invasion involves the establishment of a species that comes from other area to this bare area through Migration i.e. arrival of seeds, spores etc to the bare area by means of wind or water etc. Migration is followed by the establishment and initial growth of the vegetation. The seeds germinate, giving rise to new seedling and finally to adults which start reproducing, increasing their number and come close to each other (aggregation) and the individual species establishes with the prevailing environmental conditions.
- **Competition:-** when the vegetation becomes well established, it grows more and spreads more and species start to compete for resources like space, light, and nutrients, i.e. competition starts. This phase is called as competition. Hence, these interactions of species affect each other's life in so many ways which is called as co-action. During the course, the fittest species will persist while those unable to compete will get perished.
- **Reaction:-** Next step is reaction which involves the modification of the prevailing environmental conditions by the living organisms like changes in soil, water, light,

temperature, etc to give rise to modified environment which ultimately becomes unfavourable for the existing community but favourable for another community to come, hence causes the replacement of the existing community.

- **Stabilization:-** After the replacement of one plant community by another resulting in the persistence of one community or stabilization. Finally, the a community becomes more or less stable or maintains itself in equilibrium with the conditions of the area and this terminal community is not replaced by any other community-is known as climax community and the stage is known as climax stage. The climax is an assemblage of vegetation that belonged to the highest type of vegetation community possible under the prevailing climate conditions. Each serial stage so modifies the environment that plants of stage eventually can no longer exist there instead they prepare the site for the replacement plants of the next stage. The process continues until vegetation arrives at the self reproducing climax. This is the end of the succession process.

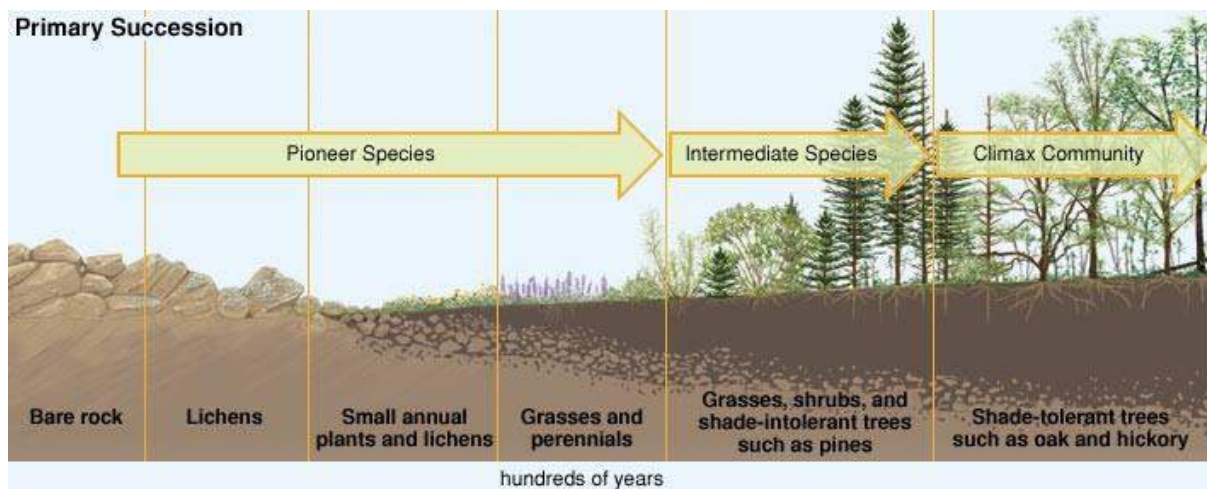


**Fig.2.7: Stages of succession**

## Evaluation

### Short Answer Type Questions

.Q.1: Explain succession and its different types.

Q.2: Write a short note on ecology.

Q.3: What are different types of ecosystems?

Q.4: Describe food web in detail.

Q.5: Define trophic relationships.

### Very Short Answer Type Questions

Q.1: What is an ecological pyramid?

Q.2: Define food chain.

Q.3: Define ecosystem.

Q.4: What do you mean by Autecology?

Q.5: What does climax mean?

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## Unit 3- Ecological interactions and Adaptations

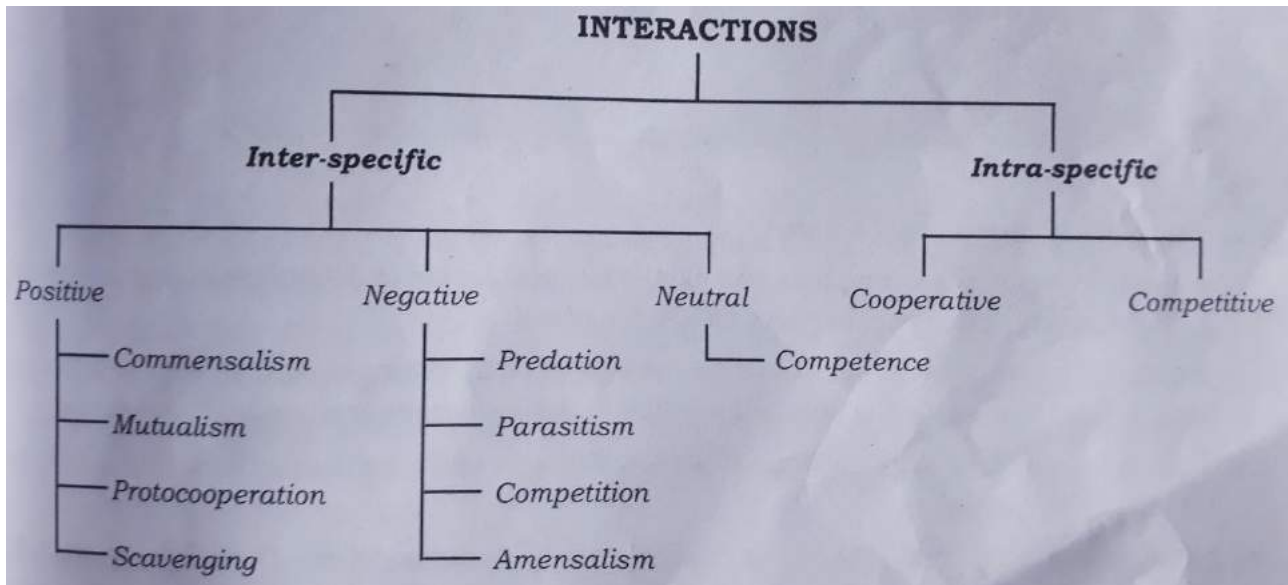
### ❖ Learning Outcome

- Develop the understanding in students about Ecological interactions and its types.
- Develop the understanding in students the concept of intra-specific and inter-specific interactions
- Develop the understanding in students about positive, negative and neutral interactions.
- Develop the understanding in students about the concept of Adaptations and how various organisms are adjusted to various ecosystems by these adaptations.

### 3.1 Ecological interactions and its types

An ecosystem has diverse living organisms. In natural world, no organism can remain in complete isolation i.e. an organism in a community can't remain unaffected by other co-occurring organisms. They interact with each other i.e. they affect each other's life in one way or other. Organisms cooperate, tolerate or compete with the members of their own or different species in order to survive or reproduce. The organisms also affect the environment in which they live by either changing the conditions or by adding or removing resources from the environment. All these activities of organisms that affect their life are known as interactions. These interactions are fundamental to the survival of an organism as well as for the functioning of the ecosystem. e.g., a plant depends upon insects for pollination, birds for seed dispersal and mycorrhizal fungi association to absorb nutrients from soils.

In ecology, biological interactions can involve individuals of the same species (intraspecific Interaction) or individuals of different species (Inter specific interactions). These can further be classified either by the mechanism of the interaction or strength, duration and direction of the effects. Some interactions may be short lived or lifelong which others may direct or indirect in nature.



### 3.2 Inter-Specific Interactions

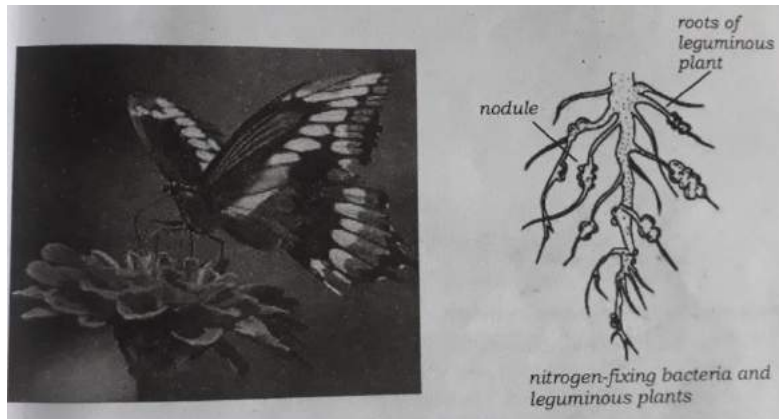
The essence of inter specific interaction is that populations of two species are involved in the relationship with respect to positive or negative effect on the interacting species. Not all the interactions are competitive but sometimes organisms depend on each other to help acquire resources.

**A) Positive Interactions:-** A cooperative relationship between individuals of different species where both or one of the interacting individuals gets benefited is known as positive interaction. It can act to promote species co- existence under harsh physical and biological stresses and can improve the growth and survival of the species in natural environments. Theoretically following are the interspecific interactions which are positive in nature:

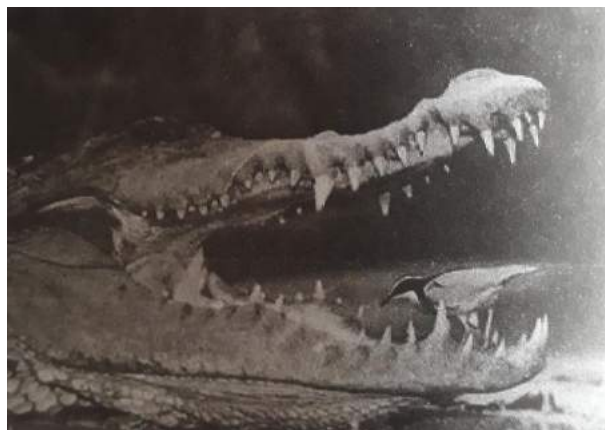
**(a) Symbiosis:-** An interaction where both the interacting species get benefited by the association e.g. The nodule bacterium of legume plants is most important as bacteria fixes  $N_2$  for the plant and inturn, the bacteria gets nutrition from the plant. The symbiosis may be an obligation type i.e. the two organisms have a complete dependence upon each other and they can't survive without each other or a facultative one in which neither of the organisms is absolutely dependent on its partner. Each can survive without its associate.

**i) Mutualism:-** It is an obligate symbiotic relationship in which the organisms benefit from the association and they can't live without their partner. Often mutualism involves organisms with different requirements such as autotrophy and heterotrophy, higher plants and  $N_2$  fixing bacteria etc.

**ii) Facultative symbioses:-** Majority of mutuality associations are non- obligatory and opportunistic where the partners may co- exists without reliance each other, e.g. pollination and seed dispersal by animals.



**i) Proto-cooperation:-** It is a positive interaction in which both the organism gain by the relationship. However, in this relationship none of the organisms absolutely depends on its partner and each can survive without this association as well. e.g. Crocodile bird (*Pluvianusaegyptius*) enters the mouth of Crocodile to feed on the parasitic leeches. The bird gets food and the crocodile gets rid of blood sucking parasites.



**c) Commensalism:-** It represents the first step towards the benefit of interacting species. It is a type of relationship in which one member clearly benefits and the other apparently is neither benefited nor harmed. In simple words we can say that it is the relationship between two living individuals of different species in which one is benefited while the other is neither harmed nor benefitted.e.g., The pilot fish always accompanies shark without getting attached to the same. It feeds on fallen pieces of food when the shark is eating the prey.



**d) Scavenging:-** When the organisms that are eaten are already dead, the interaction is called as scavenging. It is a direct food relationship in which an organisms feeds on dead organisms or their parts. It is a beneficial relationship for the environment as it prevents wastage of food and clears the space for other organism. So it is also called as detritivory and is represented by (+ 0) where detritivores get benefited and the dead organisms remain unaffected.



## **B) NEGATIVE INTERACTIONS**

The interactions which are detrimental or harmful to either of the interacting organisms are known as negative interactions e.g. Competition, Predation, Parasitism, Parasitoidism or Ammenalism. All represent an inharmonious relationship where at least one participating organism gets harmed.

### **a) Competition:-**

In its broadest sense, it refers to the interaction of two competing for the same resource like light food, space, mate etc. The essence of interspecific competition is that individual of one specie suffer a reduction in fecundity, growth or survival as a result of exploitation by another species. It simply refers to the interaction in which one organism consumes a resource that would have been available to and might have been consumed by another. When one organism deprives the other (from a resource), the other grows slowly leaves, fewer progeny or is at great risk of death. Competition may be for a single resource or for multiple ones; however, the more closely related the species are, the more severe the competition is. If the similarity of the resource requirement is extremely high, it may lead to competitive exclusion of one individual by another. However, if the interaction is weak, the species

are able to coexist which is favoured by resource sharing and partitioning (in which no two species use the resource the same way). The competition may be either result in direct physical fighting or in other kind the two organisms may not be present at same place at same time but if one of them uses a particular resource that may not be available for other in future. The former case is known as interference competition while as the later one is known as exploitation competition. However in all the situations under competition, the organisms will be affected in a negative way.

### **b) Parasitism:**

It is a well known example of negative interaction which results in negative effect on growth and survival of one population and a positive effect on other. The organism that feeds on another and derives nutrition from it is called as parasite (gets benefited) and the organism from which benefit is derived is called as host. The common feature of all the parasites is that they steal the resources from the organism that they are parasitizing. The parasites may be endo- or Ectoparasites depending whether they reside on or inside the host's body. Examples of ectoparasite is lice in humans, vascular parasite plants etc. When parasites are being parasitized by others, it is referred to as hyper parasitism. Parasites can also affect the population of the host not by killing but by affecting the rate of their reproduction. The parasite seduce the efficiency of hosts than they otherwise would have. In other words, the evolutionary fitness of an organism gets reduced by the parasite.

### **c) Predation:**

When the organism eats the food organism which is still alive, it is called predation. Here one species (predator) captures, kills, and consumes the other organism (prey). Most predations are animals of higher tropic levels but infact not all predators are animals as they may be plant species as well. In this interaction predation gets benefited and the prey gets harmed. The predator acts as a consumer of its prey and it affects the distribution and abundance of both the populations. (Carnivore predators consume animals, herbivore predations consume plants and omnivore consumes both). Sometimes the predator immediately kills its prey after attacking, it is known as true predator e.g. Leopard, Tiger, Lion etc. while as some others like grazers attack their prey (grass) but they remove only a part of each individual, so their effect on the prey although typically harmful, is rarely lethal. Thus, predation may be discussed under herbivory and carnivory as:

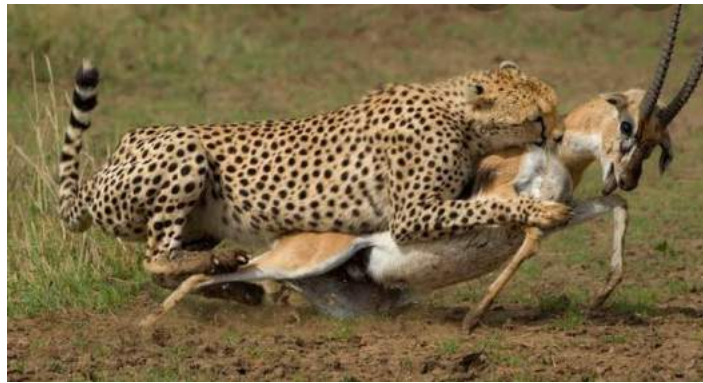
#### **i) Herbivory**

The interaction when the predation is a herbivore and the prey is a plant or a producer is known as herbivory. The two types of herbivores which have a substantial effect on plant communities are herbivore predators and grazers or browsers. The herbivore predator consumes whole plant or seeds while as browsers and grazers consume only a small portion of plant matter leaving rest to regenerate. The effect of herbivory on a

plant depends upon type of herbivore, plant parts affected, and the time relative to plant development and in return plants may also show tolerance to herbivore damage or resistance to attack.

## ii) **Carnivore**

True predators kill the prey soon after attacking. They range in size from microscopic to larger animals. The carnivore predators may be sit and wait predators or active predators which actively seek out their prey. These predators must expend energy finding their prey and should possess efficient characters of finding and catching their prey so that their attempts are successful. The predator always keeps a natural check on the prey population which as prey population also regulates the predator population in return.



## d) **Ammensalism:-**

A typical interaction where one species is inhibited by the direct effect of a toxic substance produced by other which remains stable. The mechanism is also called as allelopathy where the toxic produced by one causes the injury to the other. e.g. Shrubs in California produce volatile terpenes through their leaves which inhibit growth of herbs. Some plants produce phenols and alkaloids which kill other organisms. Here the producer organism does not gain any benefit but causes a harm to the other organisms nearby.

## 3.3 INTRASPECIFIC INTERACTIONS

The interactions that occur between the members of the same species are known as intraspecific interactions. These may be cooperative where the species cooperate and tolerate other members for benefit or competitive where the members get a harm out of the interaction.

### A) Cooperative Interactions

In biological world some organism depend on each other in a cooperative manner in order to survive and reproduce in a better way is known as cooperative interaction . Here members of the species work towards a common end. These interactions include the following:

**a) Mating:-**When the male and female individuals of a species pair together or come together in a particular season to reproduce and to give birth, it is known as Mating. Different animals have got different reproduction methods and they come together for mating by making communications in terms of singing, dancing, production of sex hormone, producing mating calls when both the sexes are receptive and ready to mate

.

**b) Leadership:-** It is a cooperative intraspecific interaction where individuals of a species follow a particular member called the leader for ensuring safe and secure survival of the entire group. The leader is generally an adult who keeps the members of the group together when on move. All the members have to follow the leader in various aspects such as when the group will move from one location to another, when they will and where from they will search out resources etc. Being interdependence between the members of the group, the leader does not enjoy any special privilege. When the group leader is a male, it is known as a patriarchal herd while as for female leaders, the herd is known as matriarchal herd.

**c) Territorial Behaviour:-** Every organism in its natural environment searches for food, water, mates in an area where the organism has to roam to meet out these requirements, such an area is known as home range. The area within which an organism performs its daily activities is its home range and actively defended area within this area is its territory. So in a territory the individuals of a breeding group live especially for shelter and mating, the territories of organisms are marked by secretions, urination, defecation etc. to indicate that the area is being occupied by the respective occupant. Home ranges of different breeding groups may overlap, but the territories do not. The territorial behaviour ensures security of family, food supply and mate for reproduction. It also provides privacy of complex reproductive cycles and ensures populations to be restricted within specific area.

**d) Altruism:-** The term was coined by French philosopher Auguste Comte which in biology means an act which is done with an intention of helping another. An altruist is one whose behaviour or act increases the fitness of other organism at the cost of its own. It is a cooperative interaction in which an individual organism increases the chances of survival of other or works for the welfare of other of same species due to its sacrificial behaviour e.g.

when a group of deer is attacked by a predator the old and weak members are surrounded by the adults with best antlers to guard them against the predators attack such behaviour is also observed in bees and wild turkeys.

**e) Parental Care:-** After laying eggs or giving birth to young ones, the parents take care of them either by making nest, hatching or feeding. This is known as parental care. Many birds prepare (construct) a special nest, lay eggs in it, hatch them and guard them after the young ones (atrecial –naked) come out and feed them. In case of plants, the young embryos are nourished by stored food. The seeds sometimes are with special devices to reach suitable places with protection. The maximum degree of parental care is witnessed in case of humans where the mothers nourishes the foetus in the womb by blood through placental connection and after birth feeds the young ones with milk, although such parental care is a lifelong affair compared to others.

**f) Group formation:-**It can be discussed under three headings:

**i) Family formation:-** A family is a social organization consisting of parents and their offspring to varied degrees as different grades of families are seen in case of animals. Some animals do not form permanent families such as tigers but they only live together at the time of mating and the young ones are being looked after by the female partner only. Animals may not have only one life partner throughout life but some animals (like deer, lion) are polygamous where a single male lives in the company of several females. Family formation is not beneficial to offspring only but it proves to be beneficial for parents as well in many aspects.

**ii) Aggregation Behaviour:-** The individuals of different populations usually occur in large groups and such large group formation may be either temporary or permanent. Such a habitual behaviour of occurring of individuals of a species in large groups especially for specific purposes is known as aggregation behaviour e.g. Birds aggregate during migration, mosquitoes and frogs for breeding etc. The aggregation behaviour proves to be fruitful as it provides protection, promotes successful chances of breeding, helps individuals in obtaining food, helping the young ones to learn the skills of life, transfer of knowledge from parents to offspring about obtaining food and defence against predators which proves to be an essential learning element for survival.

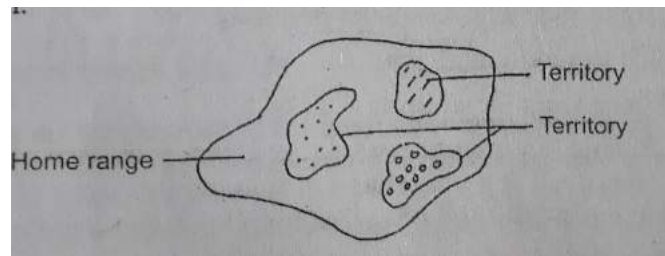
**g) Dominance and submissive behaviour:-** In societies, a hierarchical order seems to be quite obvious. The organisms in a group are ranked, where males are dominant to the females and young ones are subordinate to adults. These ranks are established through traditional battles, as per ages and sex. The dominant individuals usually act as leaders and displace the low rank animals to get the first choice for food, space and partner. An individual determines its dominance by aggressive postures or even actual fights while as the subordinate assumes an appeasement posture to avoid further conflict. This is known as ritualized submission. Although the dominance once established cannot be a permanent one because a low rank individual can move to high rank and become dominant by defeating the one with senior rank. Ecologists consider this behaviour to maintain social order and discipline in the social groups.

**h) Society formation:-** A well organized or highly integrated societies are seen in case of wasps, bees etc. where a large population of individuals lives, together in a hive or a nest. Each member of a society works for the welfare of the group and there is a clear division of labour seen within members each having a special task to perform. e.g. in bees, there are three groups viz Queen, drones and worker bees. The drones and the queen are reproductive individuals from which whole progeny of bees is derived while as the workers perform the duty of hive making, food collection and protection to the hive against the intruders.

**i) Communication:-** Several animals are seen to send meaningful signals at the time of reproduction, hunger, threat from enemy etc. which are received and interpreted by other members. The sending and receiving of signal by any audio-visual or electrical means is known as communication. The signals are usually sent and indicate the direction and distance of food, to indicate period of mating and mating desire, to evoke a certain behaviour in the receiving individuals, to attract the individuals etc.

**j) Home range:** A home range is a general natural wide region for flock or herd to seek food and shelter.

**k) Territorial behavior:** Marking off a particular area by an individual or a group of breeding individuals for breeding and defending it against trespassing, especially by members of the same species (except mates) is called territorial behavior. The marked off area is called a territory. The boundary is marked with urine, faeces or odorous secretions.



**1) Cannibalism:-** It refers to an interaction between members of same species where they practice the eating of their own members. The larger members may consume the smaller ones as in case of fish or in case of extreme hunger stranger members may eat the old and weak ones like in case of wolves. The individual that eats the members of its own species or any of its body part is known as Cannibal and the one that is being eaten is known as prey. The practice of cannibalism is considered to keep the population of species under control e.g. cobra, ants, spiders.

**B) Competitive intraspecific Interactions:-** The contest between individuals of the same species for common resources gives rise to competitive intraspecific interactions. The competition between the individuals of same species occurs when they are exploiting a common resource base. As the population grows, the resource base will inevitably run up in short supply, and the main effect of competition will be the control of total number of individuals of a population. Individuals of the same species have very similar requirements for growth, survival and reproduction, but their combined demand may deplete the resource very quickly and not surprisingly at least some of them become deprived leading to reduction of their survivorship, growth or reproduction. The more the intraspecific competition the less is the likely contribution of individual to the next generation. The competition once again may be exploitative, on interference type, however, as the density of individual increases the death rate increases and birth rate decreases i.e. the population is established by density dependent mortality and fecundity. e.g. when a large number of seeds are grown together in a plot most of them form seedlings after germination. But after some time only few seedlings will be observed to survive – the competition will be one-sided and the strong early seedling will be shading and stunting a late one. Hence competition for light, space, nutrients will lead to the reduction of fitness of both the species. The greatest impact of intraspecific competition is reduction in growth rate i.e. the population growth shows as the competition becomes more intense making it a negatively density dependent process.

### 3.4 Adaptations: Concept and Need

**3.4.1. Concept of Adaptations:-**James BaptesteLamarek was the first to put forth the theory of adaptation. The changes in the environmental factors such as changes in soil conditions, light, temperature, and nutrients can lead to change in physiology and behaviour of an organism leading to selection pressures on the populations. The appearance of the organism results from interaction of its genotype and the environment. The special characteristics of organism that enable them to be successful under prevailing set of conditions of environment are called as adaptations. These special features have evolved over a long period through natural selection. The overall aim of adaptation is to get food and space, the organism needs for its survival. Each organism possesses a range of tolerance to variations in different environmental factors to which they respond through growth, reproduction and distribution. Any of the components of environment that limits the growth of an organism either due to its excess or its lack is known as limiting factors e.g. Temperature regimes, moisture content in terrestrial organism and O<sub>2</sub> and light content in case of aquatic organisms. Besides all the environmental factors have their minimum as well as maximum within which an organism grows and reproduces maximally. The range between these two conditions represents limits of tolerance. Sometimes the morphological variation induced due to temporary change in natural environment are short lived and non- inheritable, such adaptations are known as short-term adaptations while as permanent biological changes in response to permanent environmental changes gives rise to long term adaptations which are inheritable in nature. Adaptations are called the heart and soul of evolution. Adaptations enhance the fitness and survival of individuals.

### 3.4.2. Types of Adaptations:-

Adaptations are of two basic types:

#### 1) Short term adaptations

- i. These are temporary, morphological or physiological changes, developed in living organisms in response to temporary environment changes.
- ii. These are non-inheritable.
- iii. Different members of the same species show different degrees of adaptations.
- iv. DNA is not changed; hence these adaptations play no role in evolution.

**Example:** our skin becomes tanned and dark when exposed to strong sunlight for a long period. The melanin pigment of our skin accumulates in the top layers of the skin, absorbs the excess radiation and thereby protects the underlying tissues of our body from hazardous effects (such as mutations) of UV rays, which are abundant in tropical, high intensity light. The suntan disappears after sometime.

## 2) Long term adaptations

- a) These are useful, permanent, chemical and biological changes, developed in living organisms in response to permanent environment changes.
- b) These are inheritable.
- c) All the members of the same species show the same adaptations.
- d) DNA is changed, hence these adaptations play important role in evolution.

**Example:** The structure of beaks and claws of some common birds have developed in order to suit their perching and feeding habits.

The adaptations may be structural, physiological or behavioural which are briefly described as under :

**A) Structural adaptations:-** The modifications which are included by the environment in the structure and design of an organism which are quite evident from its appearance are known as structural adaptations. E.g. Seals have flippers to navigate in water.

**B) Physiological adaptations:-** These are specialties in body chemistry and metabolic activities which are not seeable from outside they are internal adjustments made by the organism to fit to a given environmental setup. e.g., Presence of toxins in plant leaves to repel the herbivores or presence of efficient kidneys in desert animals like kangaroo rats.

**C) Behavioural adaptations:-** The adaptations that indicate how an organism acts or reacts by its activities towards a given set of environmental variables are known as behavioural adaptations e.g. Migration of birds towards warmer areas to escape cold winters.

### 3.4.3. Need of Adaptations

The environment does not remain constant and adaptations help an organism to adapt to its environment accordingly. It also enables him to increase the chances of survival and continuation of race. Adaptations are the basic cause of evolution.

Organisms that are adapted to their environment are able to:

- (i) Secure food, water and nutrients.
- (ii) Obtain air, warmth and spaces.

- (iii) Cope with physical conditions such as temperature, light and wind.
- (iv) Defend themselves from their natural calamities.
- (v) Reproduce and rear offspring.
- (vi) Respond to changes around them.

### 3.5 Types of adaptations (with special reference to wind, light and temperature)

**Adaptations to temperature:** - Both plants as well as animals adapt themselves according to the changing temperature regimes be it extreme cold or hot.

**Plants:-** In response to extremes of temperature plants can produce various proteins which protect them from damaging effects of ice formation (that reduces the efficiency of enzymes) or enzymes denaturation at high temperatures. At low temperatures there is production of antifreeze proteins in plants and as the temperature rises, the production of heat shock proteins increases. The antifreeze proteins prevent the formation of extracellular and intracellular ice crystals while as the heat shock proteins prevent aggregation of proteins into inactive complexes and also prevent their degradation. Plants can also minimize the effect of over heating by transpiration or could reduce the absorption of light by scales, leaf hairs or waxes, In some plants rolling of leaves occurs when there is mid day sun and scorching heat. Similarly plants of dry regions may adapt themselves by thick fleshy hairy leaves with sunken stomata etc.

**Animals:-** Like plants, animals also adapt themselves to different temperature variations to survive and flourish. Animals with constant body temperature have an insulating coat to check heat loss in terms of subcutaneous fat, body hair, feathers etc. Such organisms are known as warm blooded or Homeotherms in which shivering and perspiration warms up and cool down the body respectively.

Other animals like cold blooded or Poikilotherms are affected by temperature variations more than anyone else. They fight these temperature variations by behavioural changes such as:

**Hibernation:-** It involves spending winter in dormant condition by means of winter sleep. The organisms build up brown fat and slow down all their body functions during cold periods to remain inactive for a long. E.g. Bear.

**Aestivation:-** Means spending the dry hot period in an inactive state. The animals hide themselves in cool shady places. This is known as aestivation e.g. Some reptiles.

**Periodic activity:-** According to the temperature tolerance, animals show periodic activity. Some warm their body during the day such as crocodiles while others is active during early morning (aural), evening (vesperal organisms) or night (nocturnal).

**Migration:** - Refers to a long distance or short distance movement of animals from one region to another especially those which can swim or fly. This behaviour enables them to take advantage of resources in different regions in winter to use the new place as feeding and breeding ground. They move from native place where the environmental conditions change to new place where they feel that the conditions are favourable and ultimately return back to their native place when the conditions once again return to the normal.

**Adaptation to Wind:-** Both plants as well as animals are affected by wind in their distribution and abundance. Plants are pollinated by winds, seeds and fruits are dispersed to avoid overcrowding and to colonise newer areas. Animals are distributed by carrying their eggs, spores, cysts or even small animals are dislodged to long distances. Insects in windy areas are wingless so that they do not get carried away by wind and birds and apes have developed strong grasping mechanisms by their feet and hands so that strong winds can't dislodge them from branches. In strong Windy areas, the plants respond by dwarfing, round growth of stem and by strengthen their stems. Trees have a well developed capacity to reinforce their trunks upon exposing to winds.

**Adaptation to light:-** Plants apply multilevel adaptations to fluctuating light intensities during the course of their life from systematic to the molecular level . The amount and duration of light is important for different types of plants.

Most plants use light as a source of energy in photosynthesis for food production. The photoperiod determines the time of flowering, fruiting and growth of plants. Some plants need long photoperiods where the light needs to be available for 12 hrs (long day plants such as wheat) while in others a photoperiod of less than 12hrs is sufficient (short day plants like cereals). Plants also are affected by light intensity where moderate light produces bright green leaves and high light intensity produces dark green leaves. Plants growing in open areas are strong and produce more flowers than those growing in light deficient areas. There being plenty of light available in tropical and temperate areas which is responsible for vegetation in

these areas hence distribution of vegetation also more being effected by light. Besides plants also show phototropism i.e. movement of different parts either towards or away from light affecting their growth and development.

The breeding cycle, colour of skin and working periods of animals are also affected by light factor. Some animals mate and breed within short day (e.g. deer). These are known as short day animals. Others breed in spring when the days are long (e.g. Turkeys). These are known as long day animals. Bright light results in lighter skin colour while as dim light results in bright colour of skin (e.g. in frogs). Some animals work during different time periods such as night (nocturnal), dawn and dusk (crepuscular) and during day time (diurnal).

## Evaluation

### Long and Short Answer Type Questions

- Q.1 Define ecological interactions. What are its different types?
- Q.2: What are positive interactions? Explain different types of positive interactions.
- Q.3: What are negative ecological interactions? Briefly describe its types.
- Q.4: Write short notes on cooperative and competitive interactions. Give examples
- Q.5: Write short notes on:
- a) Predation b) Ammensalism c) Parasitism
- Q.6: What are ecological adaptations? Discuss adaptation to wind in detail.
- Q.7: Give a brief description of adaptation of animals to temperature.
- Q.8: Plants and animals adapt themselves to light. Explain.
- Q.9. Why do organisms need to adapt themselves to different environmental conditions?
- Q.10. what do you mean by scavenging?
- Q.11. Define the term Adaptations?

### Multiple Choice Questions (MCQ's)

- Q.12. An association between two individuals or populations where both are benefited and where neither can survive without the other is
- (a) Competition (b) Commensalism (c) Mutualism (d) Proto-cooperation
- Q.13..... means winter sleep. (Hibernation/ Aestivation)

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## UNIT 4: - Population Ecology

### ❖ Learning outcomes

- To acquaint with the concept of species, population. And communities
- Develop the understanding of population size density, dispersion, natality, mortality, and age structure
- Develop the concept of population growth under different condition
- Develop understanding of different factors that regulate population growth like competition, weather and climate.
- To have the knowledge and understanding of different population growth theories
- Understand the concept of demographic transition and its different stages.

### 4.0. Introduction:

Ecologists study many different aspects of ecosystems. One aspect that is of particular importance is population ecology. This field of study is concerned with populations and how they interact with their environment. The study of populations has been a major concern of biologists ever since Charles Darwin enunciated his theory of evolution based on natural selection. The study of populations is central to all the problems of ecology and no part of ecology has more important practical aspects than a knowledge of the causes and characteristics of the rise and fall of populations.

### 4.1. Concept Of Species, Population And Communities

A species is basic unit of classification. It is type of entity of which different individuals can interact and reproduce offsprings of a similar kind. They exhibit similar characteristics and are hence capable of interbreeding. Species are characterized by the fact that they are reproductively isolated from other groups, which means that the organisms in one species are incapable of reproducing with organisms in another species. However, this definition of species seems to be adequate, but when looked more closely, many problems arrive while defining many species. A species concept that works good for sexually reproducing organisms cannot be generalized for those which reproduce asexually. A group of organisms in which sexual reproduction does not occur such as bacteria or some plants, hence some

diagnostic traits are needed to distinguish closely related asexually lineages as the biological concept of species cannot be applied and there is no sharp boundary between these species.

An ecological community can be regarded as an assemblage of species populations that has the potential of interactions. More precisely, a community may be defined as an interactive assemblage of species occurring together within a particular geographical area, a set of species whose ecological function and dynamics are in some way interdependent (Putman, 1994). These interactions include overt and critically determining competitive interaction and feeding relationships as well as more subtle manifestations, such as reliance of plants on animals for pollination and seed dispersal or of animals on plants for meeting habitat requirements. Communities may be small, consisting of few species' populations in a small space, or large, comprising several species populations in a large area. Each biotic community exhibits a number of characteristics, such as diversity, density, dominance, composition and stratification.

A population is any group of individuals of the same species in a given area or region at a specific time. It is a self-regulating system that helps in maintaining stability in an ecosystem. It has characteristics that are a function of the whole group and not of the individual members; these are population density, birth rate, death rate, age distribution, rate of dispersal and growth forms. Although individuals are born and die, individuals do not have birth rates and death rates; these are characteristics of the population as a whole. Populations are not static but they are instead dynamic entities which are always in a state of flux. Populations must adjust to their environment like the individuals, although their environmental relations are far more complex.

The populations may be subdivided into demes, or local populations, which are groups of inter-breeding organisms, the smallest collective unit of a plant or animal population. Some ecologists, however, recognize two types of populations-

- i) the monospecific population which is the population of individuals of only one species, and
- ii) mixed or polyspecific population which is the population of individuals of more than one species. However, ecologists referred the polyspecific population as a community and the term population only for monospecific population

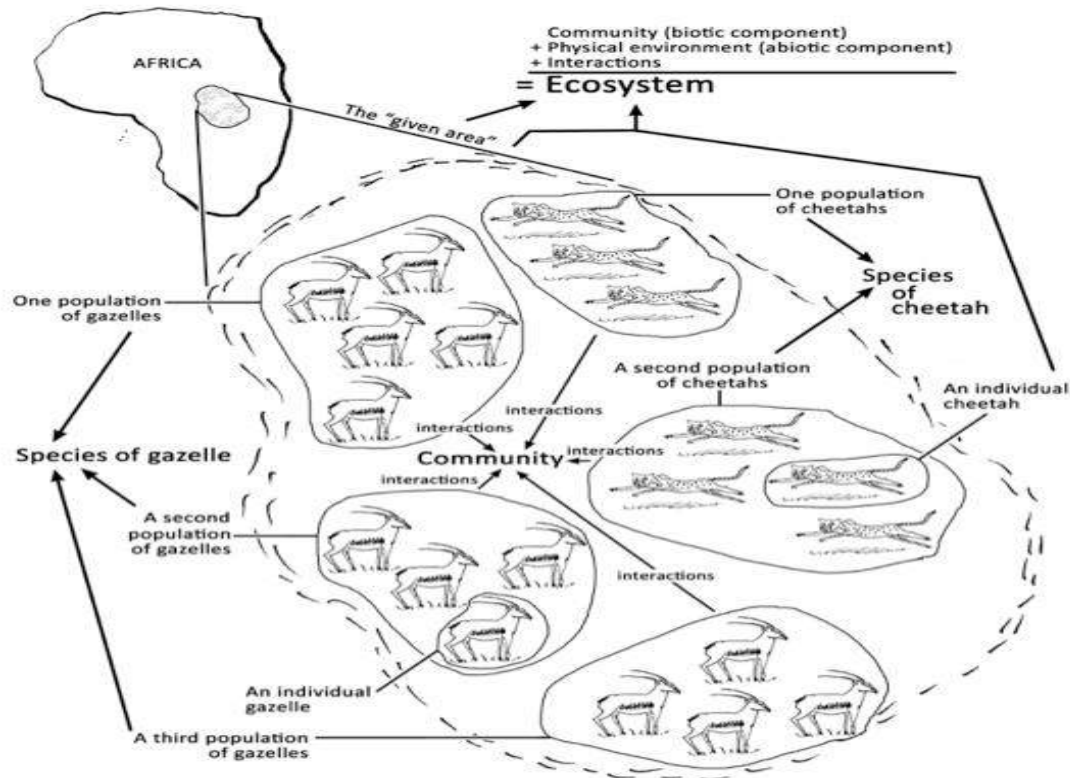


Fig 4.1: The diagram above will help you visualize how the different ecological levels are related to each other. Individuals make up a population; populations make up a species; multiple species and their interactions make up community; and multiple species and their interactions make up ecosystems when you include the abiotic factors. This is the hierarchy of ecology.

## 4.2. POPULATION DYNAMICS

Population dynamics shows the short-term and long-term changes in the size and age composition of populations, and the biological and environmental processes influencing those changes. Population dynamics deals with the way populations are affected by birth and death rates, and by immigration and emigration etc.

The characteristics exhibited by the population as whole and not by the individuals are known as populations characteristics. These group characteristics of populations could be measured as density, age distribution, natality and mortality.

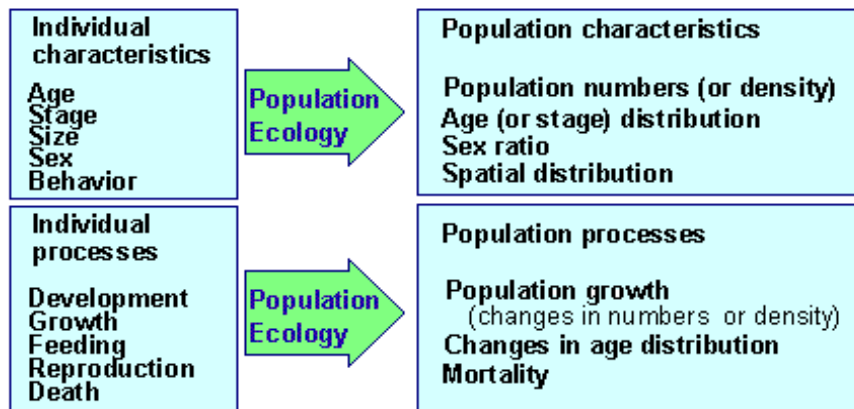


Fig. 4.2: Individual/Population characteristics

#### 4.2.1. Population Size and Density

Total size is generally expressed as the number of individuals in a population. Population density is defined as the numbers of individuals per unit area or per unit volume of environment. Larger organisms as trees may be expressed as 100 trees per hectare, whereas smaller ones like phyto-planktons (as algae) as 1 million cells per cubic meter of water. In terms of weight it may be 50 kilograms of fish per hectare of water surface. Density may be numerical density (number of individuals per unit area or volume) when the size of individuals in the population is relatively uniform, as mammals, birds or insects or biomass density (biomass per unit area or volume) when the size of individuals is variable such as trees. Since, the patterns of dispersion of organisms in nature are different population density is also differentiated into crude density and ecological density.

a. **Crude density:**

It is the density (number or biomass) per unit total space.

b. **Ecological density or specific or economic density:**

It is the density (number or biomass) per unit of habitat space i.e., available area or volume that can actually be colonized by the population. This distinction becomes important due to the fact that organisms in nature grow generally clumped into groups and rarely as uniformly distributed. For example, in plant species like *Cassia tora*, *Oplismenis burmanni*, etc, individuals are found more crowded in shady patches and few in other parts of some area. Thus, density calculated in total area (shady as well as exposed) would be crude density, whereas the density value for only shady area (where the plants actually grow) would be ecological density.

#### 4.2.2. Population dispersion or spatial distribution:

Dispersion is the spatial pattern of individuals in a population relative to one another. In nature, due to various biotic interactions and influence of abiotic factors, the following three basic population distributions can be observed:

**a. Regular dispersion:**

Here the individuals are more or less spaced at equal distance from one another. This is rare in nature but in common is cropland. Animals with territorial behavior tend towards this dispersion.

**b. Random dispersion:**

Here the position of one individual is unrelated to the positions of its neighbours. This is also relatively rare in nature.

**c. Clumped dispersion:**

Most populations exhibit this dispersion to some extent, with individuals aggregated into patches interspersed with no or few individuals. Such aggregations may result from social aggregations, such as family groups or may be due to certain patches of the environment being more favourable for the population concerned.

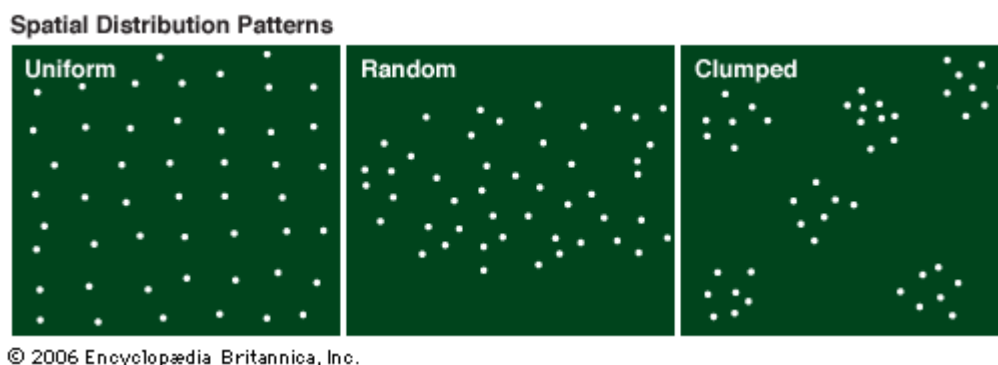


*Fig.4.3. Image showing the spatial distribution of individuals.*

#### 4.2.3. Age structure:

In most types of populations, individuals are of different age. The proportion of individuals in each age group is called age structure of that population. The ratio of the various age groups in a population determines the current reproductive status of the population, thus anticipating its future. From an ecological view point there are three major ecological ages in any population. These are, pre-reproductive, reproductive and post reproductive. The relative duration of these age groups in proportion to the life span varies greatly with different organisms.

### ❖ Age pyramid:

The model representing geometrically the proportions of different age groups in the population of any organism is called age pyramid. According to Bodenheimer (1938), there are following three basic types of age pyramids.

#### a. A pyramid with a broad base (or triangular structure):

It indicates a high percentage of young individuals. In rapidly growing young populations birth rate is high and population growth may be exponential as in yeasty house fly, Paramecium, etc. Under such conditions, each successive generation will be more numerous than the preceding one, and thus a pyramid with a broad base would result (Fig. 4.3A).

#### b. Bell-Shaped Polygon:

It indicates a stationary population having an equal number of young and middle aged individuals. As the growth rate becomes slow and stable, i.e., the pre-reproductive and reproductive age groups become more or less equal in size, post-reproductive group remaining as the smallest (Fig. 4.3B).

#### c. An urn-shaped structure:

It indicates a low percentage of young individuals and shows a declining population. Such an un-shaped figure is obtained when the birth rate is drastically reduced the pre-reproductive group dwindles in proportion to the other two age groups of the population. (Fig. 4.3.C.).

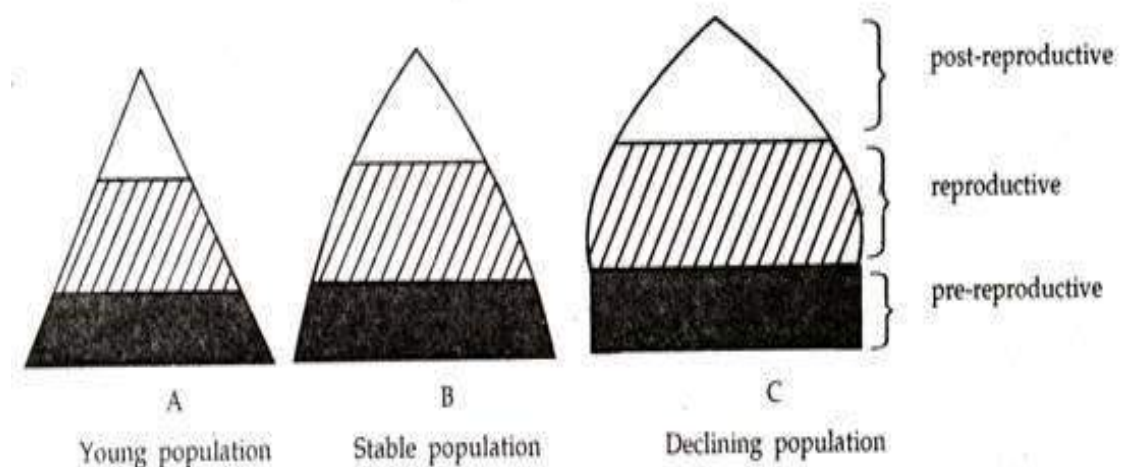


**Fig.4.4. different age pyramids**

#### 4.2.4. Natality (birth rate):

Population increase because of natality. It is simply a broader term covering the production of new individuals by birth, hatching, by fission, etc. The natality rate may be expressed as the number of organisms born per female per unit time. In human population, the natality rate is equivalent to the birth-rate. There are distinguished two types of natality.

##### a. Maximum natality:

Also called as absolute or potential or physiological natality, it is the theoretical maximum production of new individuals under ideal conditions which means that there are no ecological limiting factors and that reproduction is limited only by physiological factors. It is a constant for a given population. This is also called fecundity rate.

##### b. Ecological natality:

Also called realized natality or simply natality, it is the population increase under an actual, existing specific condition. Thus, it takes into account all possible existing environmental conditions. This is also designated as fertility rate.

#### Natality is expressed as

$$\Delta Nn / \Delta t = \text{Absolute Natality rate (B)}$$

$$\Delta Nn / N \Delta t = \text{Specific natality rate (b) (i.e., natality rate per unit of population).}$$

Where N = initial number of organisms.

n = new individuals in the population.

t = time.

Further, the rate at which females produce offsprings is determined by the following three population characteristics:

- a. Clutch size or the number of young produced on each occasion.
- b. The time between one reproductive event and the next and
- c. The age of first reproduction.

Thus, natality usually increase with the period of maturity and then falls again as the organism gets older.

#### 4.2.5. Mortality (death rate):

Mortality means the rate of death of individuals in the population. Like natality, mortality may be of following types:

a. **Minimum mortality:**

Also called specific or potential mortality, it represents the theoretical minimum loss under ideal or non-limiting conditions. It is a constant for a population.

b. **Ecological or realised mortality:**

It is the actual loss of individuals under a given environmental condition. Ecological mortality is not constant for a population and varies with population and environmental conditions, such as predation, disease and other ecological hazards.

**4.2.6. Vital index and survivorship curves:**

A birth-death ratio ( $100 \times \text{births/deaths}$ ) is called vital index. For a population, the surviving individuals are more significant for a population than the dead ones. The survival rates are generally expressed by survivorship curves.

**4.2.7. Biotic Potential:**

Each population has the inherent power to grow. When the environment is unlimited, the specific growth rate (i.e., the population growth rate per individual) becomes constant and maximum for the existing conditions. The value of the growth rate under these favourable conditions is maximal, is characteristics of a particular population age structure, and is a single index of the inherent power of a population to grow.

It may be designated by the symbol  $r$  which is the exponent in the differential equation for population growth in an unlimited environment under specific physical conditions. The index  $r$  is actually the difference between the instantaneous specific natality rate and the instantaneous specific death rate and may thus be expressed

$$r = b - d$$

The Overall population growth rate under unlimited environmental conditions ( $r$ ) depends on the age composition and the specific growth rates due to reproduction of component age groups. Thus, there may be several values of  $r$  for a species depending upon population structure. When a stationary and stable age distribution exists, the specific growth rate is called the intrinsic rate of natural increase or  $r_{\text{max}}$ . The maximum value of  $r$  is often called by the less specific but widely used expression biotic potential or reproductive potential.

Chapman (1928) coined the term biotic potential to designate maximum reproductive power. He defined it as “the inherent property of an organism to reproduce to survive, i.e., to increase in numbers. It is a sort of algebraic sum of the number of young produced at each reproduction, the number of reproduction in a given period of time, the sex ratio and their

general ability to survive under given physical conditions.” Thus with the term of biotic potential, one is able to put together natality, mortality and age distribution.

But under natural conditions, this is a rare phenomenon, since environmental conditions do not permit unlimited growth of any population. Its size is kept under natural check.

### 4.3. POPULATION GROWTH

Population is a changing entity; we are interested not only in its size and composition but also in nature of its change. As varying from place to place, population density also varies in time. Population may remain constant, they may fluctuate, or they may steadily increase or decrease. Such changes are the main focus of population ecology. They are brought about by the interplay between four factors. Natality (production of offsprings) and immigration (individuals entering a population from elsewhere) lead to an increase in density, while mortality (death of individuals) and emigration (moving out of population) lead to a decrease in density.

#### 4.3.1. Exponential growth.

The first and most basic model of population dynamics assumes that an environment has unlimited resources and can support an unlimited number of individuals. Although this assumption is clearly unrealistic in many circumstances, there are situations in which resources are in fact plentiful enough so that this model is applicable. Under these circumstances, the rate of growth of the population is constant and equal to the intrinsic rate of increase  $r$ . This is also known as exponential growth.

What happens to population size over time under exponential growth? If  $r$  is negative, the population declines quickly to extinction. However, if  $r$  is positive, the population increases in size, slowly at first and then ever more quickly. Exponential growth is also known as "J-shaped growth" because the shape of the curve of population size over time resembles the letter "J." Also, because the rate of growth of the population is constant, and does not depend on population density, exponential growth is also called "density-independent growth." Exponential growth is often seen in small populations, which are likely to experience abundant resources. J-shaped growth is not sustainable however, and a population crash is ultimately inevitable.

Some models represent population growth *without* environmental constraints in which the population size ( $N$ ) is undergoing **exponential growth**. In other words, this model shows the

growth of a population in an ideal environment with unlimited resources. This can be depicted as a *J-shaped curve* on a graph that models population growth.

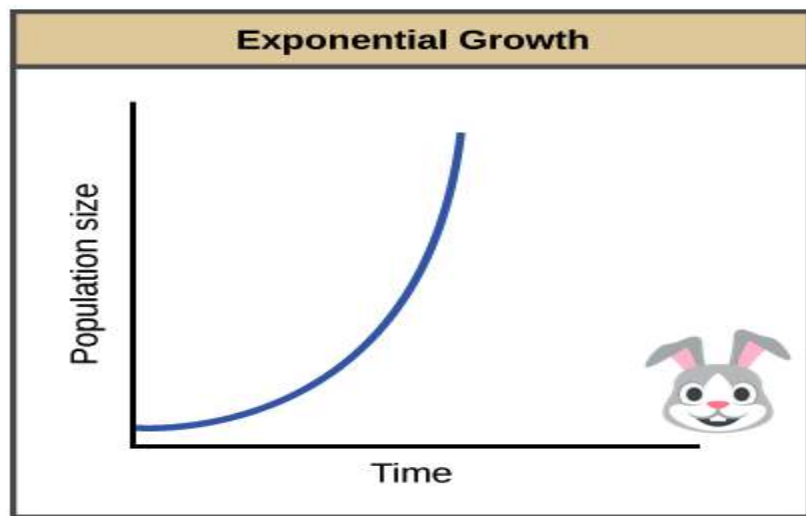


**Fig. 4.5. Graph of bunny population experiencing J-shaped exponential growth curve**

For example, if the bunnies on the island had unlimited resources (e.g. food, water, shelter, mates), their population size ( $N$ ) would continue to grow exponentially. In this "perfect" world of unlimited resources, there are no environmental constraints to reduce their population size ( $N$ ), and therefore, the island, given enough time, would be absolutely full of bunnies hopping around everywhere!

#### **4.3.2. Logistic growth.**

A different model of population increase is called logistic growth. Logistic growth is also called "S-shaped growth" because the curve describing population density over time is S-shaped. In S-shaped growth, the rate of growth of a population depends on the population's density. When the population size is small, the rate of growth is high. As population density increases, however, the rate of growth slows. Finally, when the population density reaches a certain point, the population stops growing and starts to decrease in size. Because the rate of growth of the population depends on the density of the population, logistic growth is also described as "density-dependent growth".

Under logistic growth, an examination of population size over time shows that, like J-shaped growth, population size increases slowly at first, then more quickly. Unlike exponential growth, however, this increase does not continue. Instead, growth slows and the

population comes to a stable equilibrium at a fixed, maximum population density. This fixed maximum is called the carrying capacity, and represents the maximum number of individuals that can be supported by the resources available in the given habitat. Carrying capacity is denoted by the variable  $K$ .

The fact that the carrying capacity represents a stable equilibrium for a population means that if individuals are added to a population above and beyond the carrying capacity, population size will decrease until it returns to  $K$ . On the other hand, if a population is smaller than the carrying capacity, it will increase in size until it reaches that carrying capacity. Note, however, that the carrying capacity may change over time.  $K$  depends on a wealth of factors, including both abiotic conditions and the impact of other biological organisms.

Logistic growth provides an accurate picture of the population dynamics of many species. It has been produced in laboratory situations in single-celled organisms and in fruit flies, often when populations are maintained in a limited space under constant environmental conditions.

Perhaps surprisingly, however, there are fewer examples of logistic growth in natural populations. This may be because the model assumes that the reaction of population growth to population density (that is, that population growth slows with greater and greater population densities, and that populations actually decrease in size when density is above the carrying capacity) is instantaneous. In actuality, there is almost always a time lag before the effects of high population density are felt. The time lag may also explain why it is easier to obtain logistic growth patterns in the laboratory, since most of the species used in laboratory experiments have fairly simple life cycles in which reproduction is comparatively rapid.

Biological species are sometimes placed on a continuum between  $r$ -selected and  $k$ -selected, depending on whether their population dynamics tend to correspond more to exponential or logistic growth. In  $r$ -selected species, there tend to be dramatic fluctuations, including periods of exponential growth followed by population crashes. These species are particularly suited to taking advantage of brief periods of great resource abundance, and are specialized for rapid growth and reproduction along with good capabilities for dispersing.

In  $k$ -selected species, population density is more stable, often because these species occupy fairly stable habitats. Because  $k$ -selected species exist at densities close to the carrying capacity of the environment, there is tremendous competition between individuals of the same species for limited resources. Consequently,  $k$ -selected individuals often have traits that maximize their competitive ability.

In reality, exponential growth is difficult to sustain over long periods of time for any population (including the bunnies) because resources are limited in nature. If this is the case, what would happen to the bunny population after it begins to face such limitations to growth? In order to answer this question, we can use a different growth model used by ecologists known as the logistic growth model.

In the logistic growth model, the population experiences a leveling off of exponential growth due to limiting resources. In turn, the shape of the graph, which was formerly a J-shaped curve, now shifts to an S-shaped curve on a graph that models population growth.

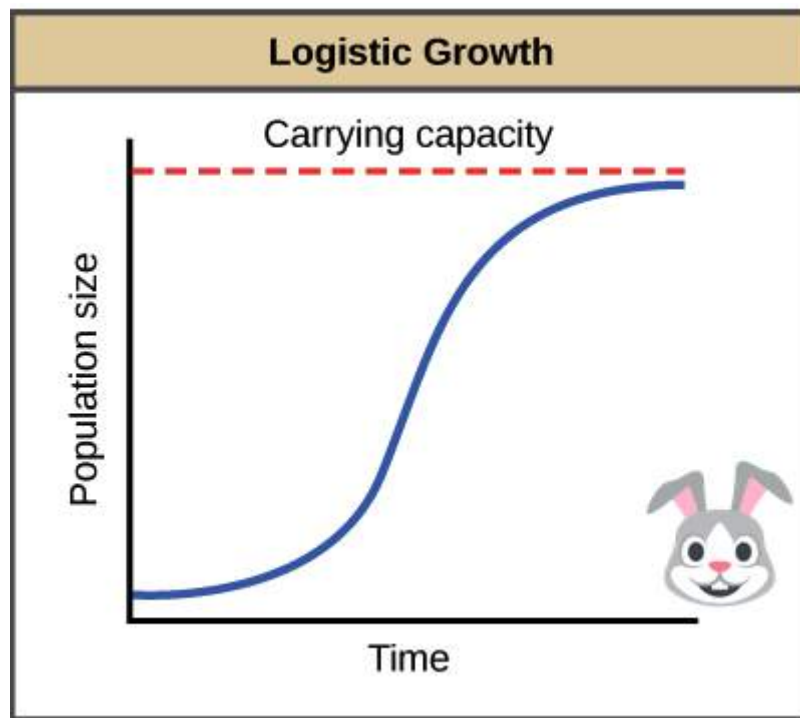


**Fig. 4.6. Graph of bunny population experiencing S-shaped logistic growth curve**

What exactly determines this "leveling off" of the population's growth? In population ecology, **carrying capacity**, symbolized as  $K$ , represents the maximum population size that can be supported by the available resources in an environment. Once carrying capacity ( $K$ ) has been reached, populations tend to fluctuate around ( $K$ ), periodically going slightly over and under this population size based on the available resources in the environment.

#### 4.4. POPULATION REGULATION

As you saw in the logistic growth model, the bunny population's growth, along with all other populations' growth, will always end up having to face some kind of resistance to growth, particularly when the population reaches carrying capacity ( $K$ ). As a population ecologist, it's

also worth trying to figure out what exactly are the factors that *regulate*, or influence, the size and growth of the bunny population?

The bunny population's growth is influenced by two main factors—**density-dependent factors**, in which the density of the bunny population at a given time affects its growth rate, and **density-independent factors**, which influence growth rate of the bunny population *regardless* of its population density.

In the table below, examples of density-dependent factors are shown. With these factors, an *increase* in population density causes each of these factors to exert an even *stronger* influence on the population size (N).

#### 4.4.1. Density-dependent factors

| Factor             | Explanation                                                                                                                                 | Island bunnies                                                      |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| <b>Competition</b> | In crowded populations, increasing population density intensifies competition for resources and may cause a decrease in population size (N) | Lots of bunnies = lots of competition for limited resources         |
| <b>Predation</b>   | As a prey population gets more and more dense, predators may have easier access to feed on that species                                     | Lots of bunnies = lots of easy targets for predatory cats on island |
| <b>Disease</b>     | In dense populations, diseases can spread more rapidly and may cause a decrease in population size (N)                                      | Lots of bunnies = lots of hosts for diseases                        |

#### 4.4.2. Density-independent factors

Density-independent factors are quite different. Many abiotic (non-living) factors influence the death rate of a population regardless of its density, including weather, natural disasters, and pollution. An individual bunny may be killed in a catastrophic earthquake on an island regardless of how many bunnies happen to be in that area. Its chances of survival are the same whether the population density is high or low, thus exemplifying a density-independent factor.

As you can see, population ecology is about a lot more than just counting bunnies on an island. Instead, with a deep understanding of all the different factors that affect the bunny

population, you, as the population ecologist, can now describe the dynamic changes occurring in the population and, importantly, even predict future changes based on what is already known about the bunnies' past and present population dynamics. Off to the next island!

### Common misconceptions

- Students might mistakenly think that once a population reaches its carrying capacity (K), it no longer changes in population size. This is definitely *not* true in population ecology! Populations do not permanently remain at carrying capacity (K). Remember that ecology is a dynamic study that *always* involves ever-changing factors influencing populations and their growth. Most stable population sizes fluctuate around K, as opposed to remaining exactly at that value.
- Students might mistakenly think population growth models can *only* be either exponential or logistic...this is *not* the case! Population growth rates aren't exclusively exponential or logistic in their growth pattern. Population growth models are on a spectrum that can *range* from exponential to logistic. Growth patterns often fluctuate anywhere between purely exponential and purely logistic growth.
- Students might mistakenly think that population sizes are always increasing. However, population sizes aren't always growing. Sometimes, a population might be experiencing serious enough issues that *decrease* the population size (N). A decrease in population size is caused by a *negative* growth rate, which can be due to a variety of factors like disease, famine, or natural disasters that lead to widespread deaths over a given time period.

### 4.4.3. FACTORS REGULATING POPULATION GROWTH

#### a) Density-dependent factors include:

- i. **Competition** for resources such as food, oxygen, water, etc. occurs when the population of a species reaches a large enough level where there aren't enough resources to go around. For example, some aquatic plants spread rapidly in ponds and use most of the oxygen needed by other plants and fish. If you have one guppy in your aquarium, food isn't going to be a problem, unless you forget to feed it. But if you have 50 guppies in a goldfish bowl, there is probably going to be competition for food, space, oxygen, etc. In nature, shortages of food will cause animals to die, or

move to areas with more food and/or less competition. Unfortunately for your guppies, they are stuck in their goldfish bowl.

- ii. **Predation** - if the jackrabbit population in the high desert of Nevada migrates to Arizona in search of food, the foxes left behind will have less food. The foxes will be unable to maintain their population density, and some will die. On the other hand, a surplus of predators, such as wolves, can cause a density limit on the elk herd in Yellowstone National Park. They're eating all the elk they want, so the elk will not be reproducing as they had been. Predation isn't an issue in the goldfish bowl, unless you introduce an Angelfish, who will eat the guppies. Predation affects populations that have reached a certain size.
- iii. **Parasitism** - this is where one species benefits while harming the other. Parasites work more slowly than predators. Some don't kill their hosts, but others do. Too many parasites on a single host can cause the death of the host. For example, ticks often swarm on young moose in spring, sucking their blood and introducing infections. This can cause the death of the moose.
- iv. **Disease** can wreck havoc on crowded populations. In fact, diseases need organisms to be in close proximity in order to spread from one organism to another. Think about cities like New York or Hong Kong. Millions of people live there and a new disease can spread rapidly. If you consider rural areas, such as Nevada or Wyoming, there aren't as many people living closely together, so diseases aren't able to spread as quickly, if at all.

b) **Density-independent factors:**

Density-independent factors affect all populations the same, regardless of how large or small they may be. Examples of these types of factors include:

- v. **Natural disasters**, such as droughts, floods, hurricanes, and fires, can all influence whatever populations are in the area at the time. Not only do these occurrences kill individuals in all populations, they also disrupt the availability of resources for survivors. For instance, your dog, Cujo, wags his tail and knocks over the goldfish bowl of guppies. Water and guppies go flying all over the room. Some guppies will be killed outright, while others may survive to be returned to their bowl.

- vi. **Weather and Climate-** Weather and climate are density independent factors that play a significant role in regulating the size of a population. The influence of weather and climate is irregular and unpredictable. It functions largely by influencing the availability of resources including food. A favourable weather pattern increases the availability of resources to a population and hence may increase the size of a population and conversely if the climatic conditions are harsh, it may accordingly reduce the size of the population by increasing the death rate.
- vii. **Territory-** The actively defended area by an organism is known as territory while as the area in which an organism lives and performs its activities is its home range. It exists external environmental resistance on a population by restricting the food supply and partners for mating e.g. birds, insects and mammals often defend their territory by aggressive postures, signals or fights while as for others the use of scent or pheromones is widespread for marking and defending their territories. In case of plants, secretion of toxic chemicals is also considered as a mean of territory spacing. As population of individual increases, it is difficult to maintain that population within a particular territory and thus it causes a decline of population.

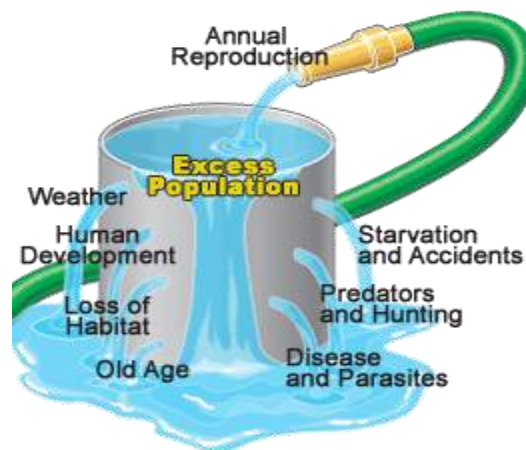


**Fig.4.7** This figure shows the different factors that regulate the size of a population.

#### 4.5. Human population growth

##### a) Malthusian Theory of Population (Explained with its Criticism)

The most well-known theory of population is the Malthusian theory. Thomas Robert Malthus wrote his essay on “Principle of Population” in 1798 and modified some of his conclusions in the next edition in 1803. The rapidly increasing population of England encouraged by a

misguided Poor Law distressed him very deeply. He feared that England was heading for a disaster, and he considered it his solemn duty to warn his country-men of impending disaster. He deplored “the strange contrast between over-care in breeding animals and carelessness in breeding men.”

His theory is very simple. To use his own words: “By nature human food increases in a slow arithmetical ratio; man himself increases in a quick geometrical ratio unless want and vice stop him. The increase in numbers is necessarily limited by the means of subsistence. Population invariably increases when the means of subsistence increase, unless prevented by powerful and obvious checks.”

The theory propounded by Malthus can be summed up in the following propositions:

1. Food is necessary to the life of man and, therefore, exercises a strong check on population. In other words, population is necessarily limited by the means of subsistence (i.e., food).
  2. Population increases faster than food production. Whereas population increases in geometric progression, food production increases in arithmetic progression.
  3. Population always increases when the means of subsistence increase, unless prevented by some powerful checks.
  4. There are two types of checks which can keep population on a level with the means of subsistence. They are the preventive and a positive check.
- The first proposition is that the population of a country is limited by the means of subsistence. In other words, the size of population is determined by the availability of food. The greater the food production, the greater the size of the population which can be sustained. The check of deaths caused by want of food and poverty would limit the maximum possible population.
  - The second proposition states that the growth of population will out-run the increase in food production. Malthus thought that man’s sexual urge to bear offspring knows no bounds. He seemed to think that there was no limit to the fertility of man. But the power of land to produce food is limited. Malthus thought that the law of diminishing

returns operated in the field of agriculture and that the operation of this law prevented food production from increasing in proportion to labour and capital invested in land.

In fact, Malthus observed that population would tend to increase at a geometric rate (2, 4, 8, 16, 32, 64, etc.), but food supply would tend to increase at an arithmetic rate (2, 4, 6, 8, 10, 12). Thus, at the end of two hundred years “population would be to the means of subsistence as 259 to 9; in three centuries as 4,096 to 13, and in two thousand years the difference would be incalculable.” Therefore, Malthus asserted that population would ultimately outstrip food supply.

- According to the third proposition, as the food supply in a country increases, the people will produce more children and would have larger families. This would increase the demand for food and food per person will again diminish. Therefore, according to Malthus, the standard of living of the people cannot rise permanently. As regards the fourth proposition, Malthus pointed out that there were two possible checks which could limit the growth of population: a) *Preventive checks*, and b) *Positive checks*.

**a. Preventive Checks:**

Preventive checks exercise their influence on the growth of population by bringing down the birth rate. Preventive checks are those checks which are applied by man. Preventive checks arise from man's fore-sight which enables him to see distant consequences. He sees the distress which frequently visits those who have large families. He thinks that with a large number of children, the standard of living of the family is bound to be lowered. He may think that if he has to support a large family, he will have to subject himself to greater hardships and more strenuous labour than that in his present state. He may not be able to give proper education to his children if they are more in number.

Further, he may not like exposing his children to poverty or charity by his inability to provide for them. These considerations may force man to limit his family. Late marriage and self-restraint during married life are the examples of preventive checks applied by man to limit the family.

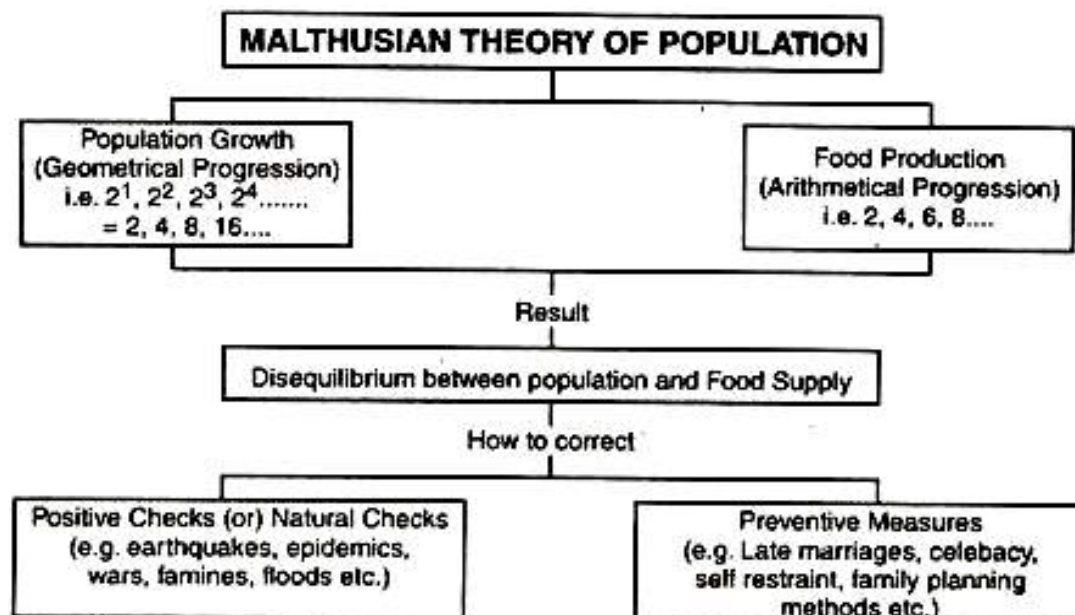
**b. Positive Checks:**

Positive checks exercise their influence on the growth of population by increasing the death rate. They are applied by nature. The positive checks to population are various

and include every cause, whether arising from vice or misery, which in any degree contributes to shorten the natural duration of human life.

The unwholesome occupations, hard labour, exposure to the seasons, extreme poverty, bad nursing of children, common diseases, wars, plagues and famines are some of the examples of positive checks. They all shorten human life and increase the death rate.

Malthus recommended the use of preventive checks if mankind was to escape from the impending misery. If preventive checks were not effectively used, positive checks like diseases, wars and famines would come into operation. As a result, the population would be reduced to the level which can be sustained by the available quantity of food supply.



### Criticism of Malthusian Theory:

The Malthusian theory of population has been a subject of keen controversy.

The following are some of the grounds on which it has been criticized:

- It is pointed out that Malthus's pessimistic conclusions have not been borne out by the history of Western European countries. Gloomy forecast made by Malthus about the economic conditions of future generations of mankind has been falsified in the Western world. Population has not increased as rapidly as predicted by Malthus; on

the other hand, production has increased tremendously because of the rapid advances in technology. As a result, living standards of the people have risen instead of falling as was predicted by Malthus.

- Malthus asserted that food production would not keep pace with population growth owing to the operation of the law of diminishing returns in agriculture. But by making rapid advances in technology and accumulating capital in larger quantity, advanced countries have been able to postpone the stage of diminishing returns. By making use of fertilizers, pesticide better seeds, tractors and other agricultural machinery, they have been able to increase their production greatly.

In fact, in most of the advanced countries the rate of increase of food production has been much greater than the rate of population growth. Even in India now, thanks to the Green Revolution, the increase in food production is greater than the increase in population. Thus, inventions and improvements in the methods of production have belied the gloomy forecast of Malthus by holding the law of diminishing returns in check almost indefinitely.

- Malthus compared the population growth with the increase in food production alone. Malthus held that because land was available in limited quantity, food production could not rise faster than population. But he should have considered all types of production in considering the question of optimum size of population. England did feel the shortage of land and food.

If England had been forced to support her population entirely from her own soil, there can be little doubt that England would have experienced a series of famines by which her growth of population would have been checked. But England did not experience such a disaster. It is because England industrialized itself by developing her natural resources other than land like coal and iron, and accumulating man-made capital equipment like factories, tools, machinery, mines, ships and railways, this enabled her to produce plenty of industrial and manufacturing goods which she then exported in exchange for food-stuffs from foreign countries.

There is no food problem in Great Britain. Therefore, Malthus made a mistake in taking agricultural land and food production alone into account when discussing the population question. As already said, he should have rather considered all types of production.

- Malthus held that the increase in the means of subsistence or food supplies would cause population to grow rapidly so that ultimately means of subsistence or food supply would be in level with population, and everyone would get only bare minimum subsistence. In other words, according to Malthus, living standards of the people cannot rise in the long run above the level of minimum subsistence. But, as already pointed out, living standards of the people in the Western world have risen greatly and stand much above the minimum subsistence level.

There is no evidence of birth-rate rising with the increases in the standard of living. Instead, there is evidence that birth-rates fall as the economy grows. In Western countries, attitude towards children changed as they developed economically. Parents began to feel that it was their duty to do as much as they could for each child.

Therefore, they preferred not to have more children than they could attend to properly. People now began to care more for maintaining a higher standard of living rather than for bearing more children. The wide use of contraceptives in the Western world brought down the birth rates. This change in the attitude towards children and the wide use of contraceptives in the Western world has falsified Malthusian doctrine.

- Malthus gave no proof of his assertion that population increased exactly in geometric progression and food production increased exactly in arithmetic progression. It has been rightly pointed out that population and food supply do not change in accordance with these mathematical series. Growth of population and food supply cannot be expected to show the precision or accuracy of such series.

However, Malthus, in later editions of his book, did not insist on these mathematical terms and only held that there was an inherent tendency in population to outrun the means of subsistence. We have seen above that even this is far from true.

#### ❖ NEO-MALTHUSIAN THEORY:

The term Neo-Malthusianism was first used in 1877 by Dr. Samuel Van Houten, one of the vice- presidents of the Malthusian League. Neo- Malthusianism was not just a campaign in favor of birth control; it was particular perspective on the effects of population on human conduct and behavior.

The Neo-Malthusian movement therefore was different from conventional Malthusian position on two counts: it stressed on birth control methods and also identified the working class with the problem of overpopulation. The overcrowded industrial slums were identified as sites of moral degeneration.

This diverted the debate on population from issues of poverty and unequal access to resources, to birth control per se. In fact, the assumption was that access to commons or availability of resources would give the poor little reason to abstain from having more children. Neo- Malthusianism thereby reinforced the ideology of private property, individualism and capitalism. The Neo-Malthusian position found favor with the elite sentiments on the issue of overpopulation. The elite, threatened by the growing numbers of commoners, considered birth control as an important means of checking future conflict over their property.

Neo-Malthusian believes that earth's resources can only support a finite population. Believes that limited resources keep population in check and reduce economic growth therefore growth should be controlled. Pressure on scarce resources leads to famine and war.

#### **4.6. Demographic Transition**

Over the course of human history, there have been many people who have been interested in the characteristics of the human population and the future of population growth. After analyzing how western populations have changed over time, one pattern was discovered that indicated there was a connection between population growth and the economic development of a country. It was observed that in countries with high standards of living, the population grew at a slow rate, while in countries with low standards of living, the population grew more rapidly.

This discovery resulted in the creation of the concept of demographic transition, which is a series of stages that a country goes through when transitioning from non-industrial to industrial. The demographic transition concept involves four stages that are based on changes to population size and social behaviors.

Demographic transition is a model used to represent the movement of high birth and death rates to low birth and death rates as a country develops from a pre-industrial to an industrialized economic system. It works on the premise that birth and death rates are

connected to and correlate with stages of industrial development. The demographic transition model is sometimes referred to as "DTM" and is based on historical data and trends.

#### **4.6.1. Stages of Demographic Transition**

##### **a) Pre-Industrial Stage**

The first stage of the demographic transition is the pre-industrial stage. During this stage, the population is stable, with both high birth rates and high death rates. The death rates are high because there is increased disease, minimal medical care, poor sanitation, and limited food supplies. As a result of the high death rate, people tend to produce more offspring to try to compensate for the mortality. Although the birth rate and death rate can fluctuate slightly, overall, they remain equal, which results in zero population growth.

- **Transitional Stage**

Following the pre-industrial stage is the transitional stage. During this stage, the human population begins to increase due to high birth rates and declining death rates. The death rates are decreasing because, as the country transitions into an industrial country, there are improvements in the economy and social conditions. These changes lead to the control of diseases, the production of more food, better jobs, and improved medical care and sanitation. As the death rates decrease, the birth rates remain high because people are still accustomed to producing more children, and during this stage, they have more food and resources to support larger families. As a result of the declining death rates and high birth rates, the human population will increase at a rapid pace.

- **Industrial Stage**

The third stage of demographic transition is the industrial stage, which is characterized by an increasing population with declining birth rates and low death rates. The death rates remain stable and low during this stage due to the continuation of the economic and social changes that improved the standard of living during the previous stage. During this stage, the birth rates begin to decline for many reasons. For the most part, people realize that they no longer have to produce large numbers of offsprings because the offspring they do produce have a higher chance of surviving to adulthood. Many people also start to prefer small families, where they can concentrate more resources on less people and increase overall livelihood.

- **Post-Industrial Stage**

Following the industrial stage is the fourth stage of the demographic transition. This stage is referred to as post-industrial stage and is characterized by a stable human population, with both low birth rates and low death rates, high and stable population size and higher standards of living than earlier periods. Most of the world's developing countries are in the middle phase of demographic transition and the developed countries are in the fourth phase.

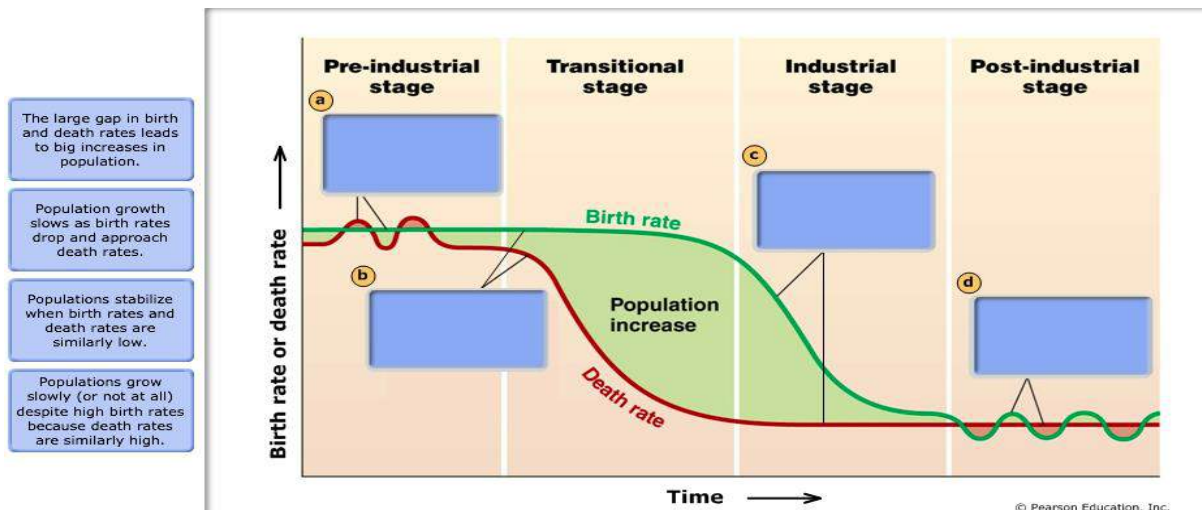


**Fig. 4.8: Different stages of demographic transition**

## Evaluation

### A) Long answer type Questions

Q.NO.1. Define population. What are the different factors that regulate a population?

Q.NO.2. What is demographic transition? What are its different stages?

Q.NO.3. What is logistic growth curve? What are its different phases?

### B) Short answer type Questions

Q.NO.1. Define age structure. Name some age pyramids.

Q.NO.2. Elaborate on Neo-Malthus theory of human population growth.

Q.NO.3. Write a short note on Malthus theory of human population growth.

Q.NO.4. What are density independent factors?

### C) Very short answer type Questions

Q.NO.1. Define a community.

Q.NO.2. Write a short note on dispersion.

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## Unit 5 -Energy Resources

### ❖ LEARNING OUTCOMES

- Understand the basic concept of energy resources
- Differentiate between renewable and non-renewable energy resources
- Interpret the generation of solar wind and hydropower
- Explain the formation of conventional energy resources (fossil fuels)
- Understand the various types of biofuels

### 5.1 Concept of Energy Resources

Everything that exists in our Universe is composed of either matter or energy. The co-operation of these two is essential, because energy is what makes matter change through time, which causes the shaping processes of our Planet.

The term energy was first used by the 17th century's iconic astronomers, mathematicians, philosophers and physicists such as Johannes Kepler, Sir Isaac Newton or Gottfried Wilhelm Leibniz. However, it was first formally used as a technical term in modern interpretations in 1807 by Thomas Young. Contemporary physicists state that energy is one of the most common and basic science concepts which, in a special sense, mean the ability to do work.

Any physical activity in this world, whether carried out by human beings or by nature, is caused due to flow of energy in one form or the other. Energy is required to do any kind of work. The word 'energy' is derived from the Greek word '*en-ergon*' which means 'in-work' or 'work content'. The work output depends on the energy input. The capability to do work depends on the amount of energy one can control and utilise.

The World Energy Council defines resources as "the occurrence of materials in the recognisable form" (WEC, 1998). For oil, it is essentially the amount of oil in the ground. Reserves represent a portion of resources and is the term used by the extraction industry. British Petroleum notes that proven reserves of oil are "generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions".

Energy is the prime mover of economic growth and is vital to sustenance of a modern economy. Primarily it is the gift of the nature to the mankind in various forms. The consumption of energy is directly proportional to the progress of mankind. With ever growing population, improvement in living standard of the humanity, industrialization of developing countries, the global demand of energy is expected to increase rather significantly in the near future. India rank fifth in the world in total energy consumption and needs to accelerate the development of the sector to meet its growth aspiration. India has one of the fastest and largest growing economies in the world, as well as an expensive populace of above 1.17 billion people. There is a very high demand for energy, which is currently satisfied mainly by coal, foreign oil, and petroleum, which apart from being a non – renewable resource, is also detrimental to the environment. Thus, it is essential to tackle the energy crisis through judicious utilization of energy resources.

The energy consumption of a nation now-a-days is usually considered as an index of its development. About 24 percent of energy consumed globally, is used for transportation, 40 percent for industries, 30 percent for domestic and commercial purposes and the rest 6 percent for other uses including agriculture.

### 5 .1.1 CLASSIFICATION OF ENERGY RESOURCES

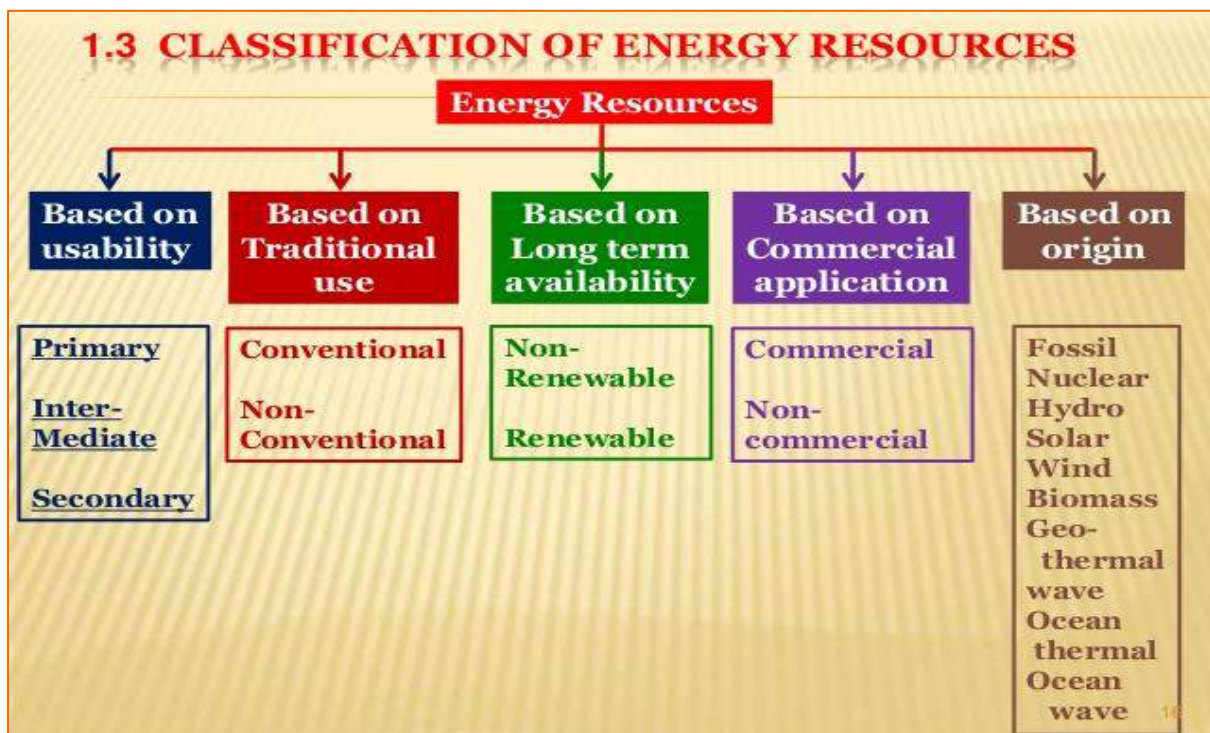


Fig 5.1 Classification of Energy Resources

Energy resources can be classified as in the following ways:

**1) Based on the usability of energy**

**(a) Primary Resources:** These are the resources embodied in nature prior to undergoing any human made conversions or transformations. They can be used directly without modification, for example: Coal, Crude oil, etc.

**(b) Intermediate Resources:** These are obtained from primary energy by one or more steps of transformation and are used as vehicles of energy e.g., electricity from black coal generated by a power station.

**(c) Secondary Resources:** The form of energy which is finally supplied to a consumer for utilisation is known as secondary or usable energy, e.g., electrical energy, thermal energy (in the form of steam or hot water), etc.

Some forms of energy may be categorised both in intermediate as well as secondary resources, e.g., electricity.

**2) Based on Traditional Use**

**(a) Conventional:** Energy resources which are being traditionally used for many decades and were in common use around the oil crisis of 1973, are called as conventional energy resources e.g., coal, petroleum, natural gas and hydro power. They are exhaustible except water and cause pollution when used, as they emit various types of pollutants.

**(b) Non-Conventional:** Energy resources which are considered for large-scale use after the oil crisis of 1973 are called non-conventional resources. They are inexhaustible and are generally pollution free e.g., solar, wind, tidal, biogas, and biomass, geothermal, etc.

**3) Based on Long-term Availability:**

**(a) Non-Renewable (Exhaustible):** Resources which are finite and do not get replenished after their consumption are called non-renewable resources e.g., fossil fuels, uranium, etc.

**(b) Renewable (Inexhaustible):** Resources which are renewed by nature again and again and their supply is not affected by the rate of their consumption are called renewable e.g., solar, wind, biomass, ocean (thermal, tide and wave), geothermal, hydro, etc.

4) **Based on Commercial Application:**

- (a) **Commercial Energy Resource:** The secondary usable forms of energy such as electricity, petrol, diesel, gas, etc., are essential for commercial activities and are categorised as commercial energy resources. The economy of a country depends on its ability to convert natural raw energy into commercial energy.
- (b) **Non-Commercial Energy Resource:** The energy derived from nature and used directly without passing through a commercial outlet is called a non-commercial resource, e.g., wood, animal dung cake, crop residue, etc.

5) **Based on Origin:**

- (a) Fossil fuels energy
- (b) Nuclear Energy
- (c) Hydro energy
- (d) Solar energy
- (e) Wind energy
- (f) Biomass energy
- (g) Geothermal energy
- (h) Tidal energy
- (i) Ocean thermal energy
- (j) Ocean wave energy

## 5.2 Non-renewable (Exhaustible) Energy Resources:

Non-renewable energy resources are available in limited amount and develop over a longer period of time. As a result of unlimited use, they are likely to be exhausted one day. These include various fossil fuels including petroleum products, coal and natural gas and nuclear energy. Nuclear energy is mainly obtained from the nuclear fission of the uranium and thorium. The global resources of fossil fuel and uranium and thorium are limited and will be eventually be depleted. Moreover, use of fossil fuels for energy has negative environmental consequences, such as air pollution, global warming, acid rains and oil spills. Thus, it has become essential to minimize the use of fossil fuels and to replace them with renewable resources.

### 5.2.1 COAL

Coal is one of the most important sources of energy and is being used for various purposes such as heating of houses, as fuel for boilers and steam engines and for generation of electricity by thermal plants.

Coal has also become a precious source of production of chemical of industrial importance coal is and will continue to be the mainstay of power generation in India. It constitutes about 70% of total commercial energy consumed in the country.

Coal was formed around 255-350 million years ago, during the Carboniferous age, in hot damp regions of the earth. The plants and animals that occurred during this period, along the banks of rivers and swamps, got buried alive or after their death into the soil and due to heat accompanied by pressures gradually got converted into peat and coal over a millions of years of period. Partially decomposed vegetation deeply buried in sedimentary environments slowly transformed into solid, brittle, carbonaceous rocks commonly known as coal.

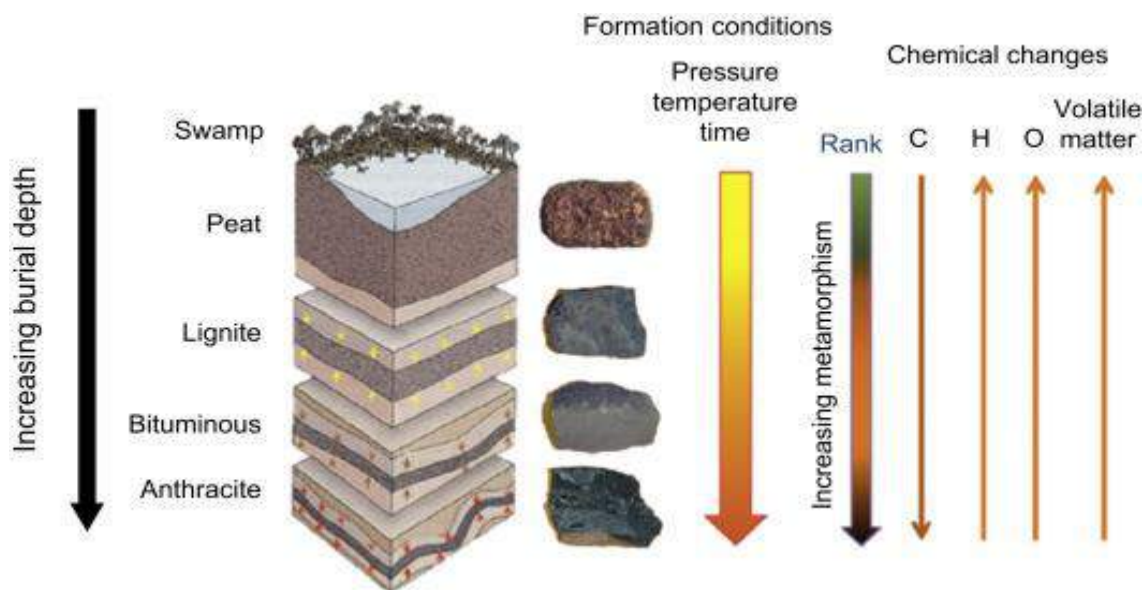


**Fig 5.2 Different forms of coal, formation conditions and chemical changes**

There are four major types (or “ranks”) of coal. Rank refers to steps in a slow, natural process called “coalification,” during which buried plant matter changes into an ever denser, drier, more carbon rich, and harder material. The four ranks are:

- Anthracite (hard coal): The highest rank of coal. It is a hard, brittle, and black lustrous coal, often referred to as hard coal, containing a high percentage of fixed carbon and a low percentage of volatile matter.
- Bituminous (soft coal): Bituminous coal is a middle rank coal between sub-bituminous and anthracite. Bituminous usually has a high heating (Btu) value and is the most common type of coal used in electricity generation in the United States. Bituminous coal appears shiny and smooth when you first see it, but look closer and you may see it has layers.
- Sub-bituminous: Sub-bituminous coal is black in color and dull (not shiny), and has a higher heating value than lignite.
- Lignite (Brown Coal): Lignite coal is the lowest grade coal with the least concentration of carbon.

Also, there is peat. Peat is not actually coal, but rather the precursor to coal. Peat is a soft organic material consisting of partly decayed plant and, in some cases, deposited mineral matter. When peat is placed under high pressure and heat, it becomes coal.

Table -1. % components in different forms of coal

| Type of coal          | %C (Carbon) | %O (Oxygen) | %Volatiles | % Moisture | Calorific Values |
|-----------------------|-------------|-------------|------------|------------|------------------|
| <b>Lignite</b>        | 60-70       | 16-18       | 45         | 35         | 5000-6000        |
| <b>Sub-bituminous</b> | 75-83       | 14-15       | 40         | 17         | 6100-6500        |
| <b>Bituminous</b>     | 78-90       | 9-10        | 20         | 06         | 6600-7500        |
| <b>Anthracite</b>     | 92-98       | 2-3         | 05         | 01         | 7500-8100        |

China is the leading producer of coal followed by USA. Coal is the most abundant fossil fuel in the world. At 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 65 years. India has about 5% of world's coal and Indian coal is not very good in terms of heat capacity. 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. Anthracite coal occurs only in J & K.

### 5.2.2 PETROLEUM (Crude Oil)

Petroleum (or crude oil) is a complex, naturally occurring liquid mixture containing mostly hydrocarbons, but containing also some compounds of oxygen, nitrogen and sulfur. It is often referred to as the “black gold.” The microscopic marine organisms that used to live in shallow coastal water when died got collected in bottom sediments. This buried material was subjected to high pressure and temperature with chemical reactions converting some of the organic matter to hydrocarbons (petroleum or crude oil).

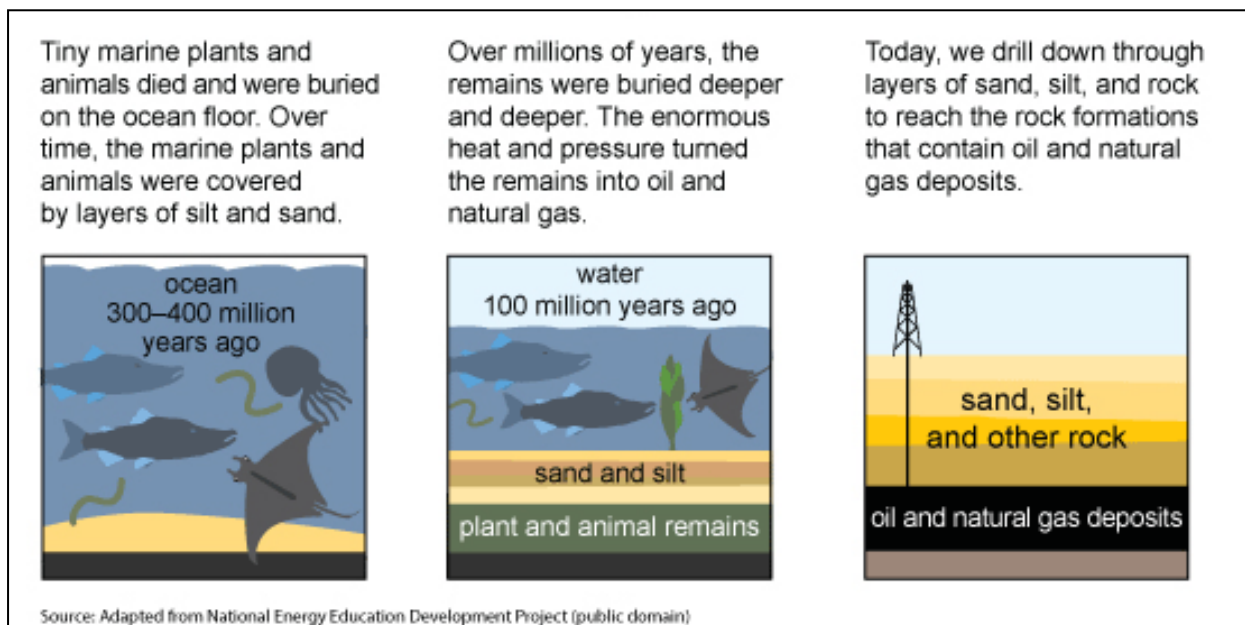


**Fig 5.3: Formation of Petroleum and Natural Gas**

It is believed that petroleum has been formed over a period of millions of years through conversion of remains of plants, animals and microorganism, living in sea, in hydrocarbon by heat, pressure and catalytic action. Because petroleum is a fluid, it is able to migrate through the earth as it forms. To form large, economically recoverable amounts of oil underground, two things are needed: an oil pool and an oil trap. An oil pool, which is the underground reservoir of oil, may literally be a pool or it could be droplets of oil collected in a highly porous rock such as sandstone. An oil trap is a non-porous rock formation that holds the oil pool in place. Obviously, in order to stay in the ground, the fluids – oil and associated gas – must be trapped, so that they cannot flow to the surface of the earth. The hydrocarbons accumulate in reservoir rock, the porous sandstone or limestone. The reservoir rock must have a covering of an impervious rock that will not allow the passage of the hydrocarbon fluids to the surface. The impervious rock covering the reservoir rocks is called a cap rock.

Oil traps consist of hydrocarbon fluids held in porous rock covered by a cap rock. As shown in the following figure, oil traps consist of hydrocarbon fluids held in porous rock covered by a cap rock.

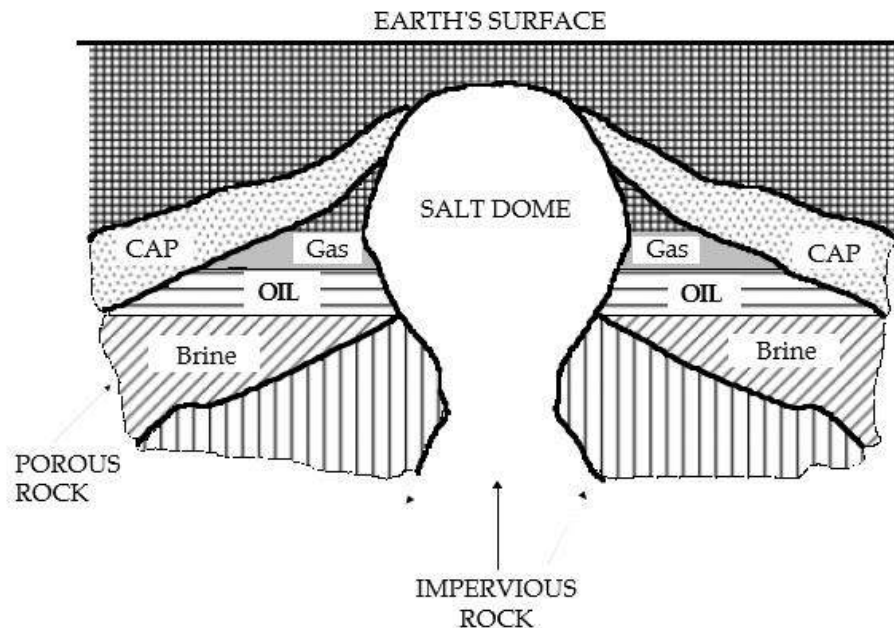


**Fig 5.4: Representative geologic structure of an oil trap: a salt dome**

Petroleum is a clear fuel as compared to coal as it burns completely and leaves no residue. It is also easier to transport and use. Petroleum is largely used in transportation, operating water lifting engines, generators etc.

Crude oil or petroleum, the lifeline of global economy, is contained mainly in 14 countries forming OPEC (Organization of the Petroleum Exporting Countries). About 70 percent of the global petroleum reserves occur in these countries. Of these, Saudi Arabia alone has one fourth of the oil reserves. OPEC was formed in 1960 with the purpose of jointly regulating the production and control of the price of the exported oil. OPEC discussions have a major impact on world oil price which largely depends upon political factors, global demand and the production politics of the organization.

**5.2.3 NATURAL GAS:** Natural gas, a fossil fuel, is composed of methane (96 %) with small amounts of ethane propane and butane. Natural gas deposits often accompany oil deposits or may occur independently. It is the cleanest source of energy among fossil fuels. Natural gas can easily be transported through pipelines. It has a high calorific value and burns without any smoke. Natural gas can be used as a source of energy for domestic or industrial use. It can be used for power generation and as a raw material for petrochemical industries and

fertilizer plants. It results as a byproduct during crude oil refining and from fractional distillation plants. About 40 percent of total natural gas is found in Kazakhstan, Russia.

Other forms of fuels in gaseous form are:

1. **LPG:** Liquefied Petroleum Gas (LPG), widely used as a domestic fuel for cooking, has its main content as odourless butane to which other gases like propane and ethyl mercaptan are added to give foul smell to identify leakage. It is obtained by converting petroleum into liquid form under pressure.
2. **CNG:** Compressed Natural Gas (CNG) is used as an alternative to petrol and diesel for transport of vehicles. CNG is a cleaner fuel than diesel, used currently in many cities and long distance transport across the country. It contains mostly methane, compressed to 80 atmospheres. It is an ideal cleanest burning alternative fuel.
3. **SNG:** Synthetic Natural Gas (SNG) is a mixture of carbon monoxide and hydrogen. It is a connecting link between a fossil fuel and substituted natural gas. Low grade coal is initially transformed into synthetic gas by gasification followed by catalytic conversion to methane.

### **5.3 Renewable (Inexhaustible) Energy Resources:**

Renewable energy resources are available in unlimited amount in nature since these can be renewed (i.e. regenerated in natural process) over relatively short period of time. Renewable energy sources are inexhaustible, i.e. they can be replaced after we use them and can produce energy again and again. These include, firewood (or fuelwood) obtained from forest, petroplants, plant biomass (as agricultural wastes like bagasse), animal dung, solar energy, wind energy, water energy (hydro-electrical, ocean thermal energy, wave and tidal energy), and geothermal energy etc. These can reproduce themselves in nature and can be harvested continuously through a sustained proper planning and management.

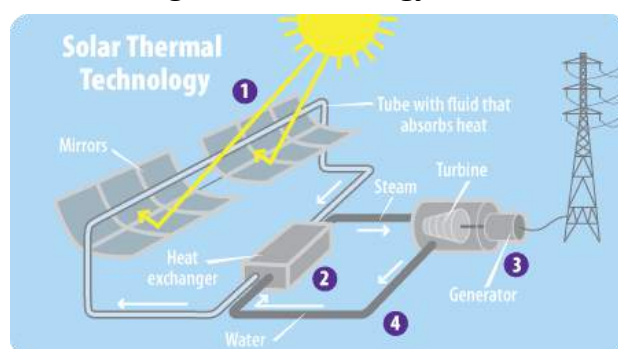
#### **5.3.1 SOLAR ENERGY**

Sun is the ultimate source of energy, directly or indirectly for all other forms of energy. The nuclear fusion reactions occurring inside the sun release enormous quantities of energy in the form of heat and light. The solar energy received by the near earth space is approximately 1.366 kilowatts per square metre known as solar constant.

Traditionally, we have been using solar energy for drying clothes and food-grains, preservation of eatables and for obtaining salt from sea-water. Now we have several techniques for harnessing solar energy. Some important solar energy harvesting devices are discussed here.

- (i) **Solar heat collectors:** These can be passive or active in nature. Passive solar heat collectors are natural materials like stones, bricks etc. or material like glass which absorb heat during the day time and release it slowly at night. Active solar collectors pump a heat absorbing medium (air or water) through a small collector which is normally placed on the top of the building.
- (ii) **Photovoltaic cells (PV Cells) or Solar cells** for direct conversion of solar radiations into electrical energy. Solar cell or PV cell is made of thin wafers of semiconductor material like silicon. When solar radiations fall on them, a potential difference is produced which causes flow of electrons and produces electricity. Silicon used in PV cells can be obtained from silica or sand, which is abundantly available and inexpensive. The potential difference produced by a single PV cell of  $4\text{ cm}^2$  size is about 0.4–0.5 volts, produces a current of 60–75 milli amperes, and has a rated power of about 0.3 watts.
- (iii) **Solar cooker:** Solar cookers make use of solar heat by reflecting the solar radiations using a mirror directly on to a glass sheet which covers the black insulated box within which the raw food is kept. A new design of solar cooker is now available which involves a spherical reflector (concave or parabolic reflector) instead of plane mirror that has more heating effect and hence greater efficiency.
- (iv) **Solar furnace:** Here thousands of small plane mirrors are arranged in concave reflectors, all of which collect the solar heat and produce as high a temperature as  $3000^\circ\text{C}$ .
- (v) **Solar power plant:** Solar energy is harnessed on a large scale by using concave reflectors which cause boiling of water to produce steam. The steam turbine drives a generator to produce electricity.

**Fig 5.5: Solar Energy**



### 5.3.2 WIND ENERGY

Wind energy is the kinetic energy associated with movement of large masses of air. These motions result from uneven heating of the atmosphere by sun, creating temperature, density and pressure differences. It is estimated that 1 percent of all solar radiation falling on the face of the earth is converted into kinetic energy of the atmosphere, 30 percent of which occurs in the lowest 100 m of elevation. It is thus an indirect form of solar energy.

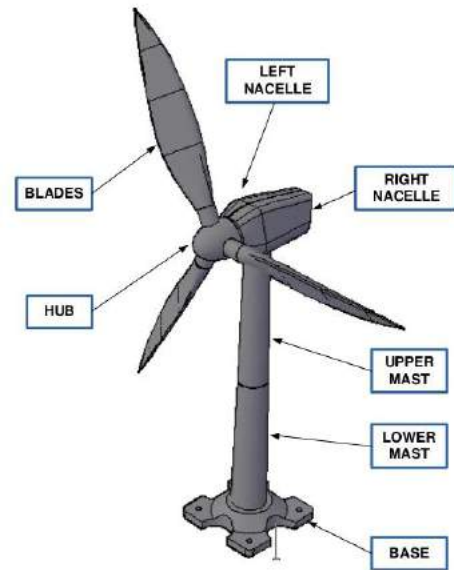


**Fig 5.6: A Wind Mill**

Wind power is harnessed by setting up a windmill which is used for pumping water, grinding grain and generating electricity. Harvesting wind energy is possible only in the areas that receive fairly continuous wind such as islands, coastal areas and mountain passes. Areas with constantly high speed preferably above 20 km per hour are well-suited for harnessing wind energy. A windmill is a structure consisting of blades radiating from a central axis at the top. The wind when blows against these huge blades, makes the axis to rotate and finally the rotational motion is used to generate electricity. Wind power is a renewable energy source, which has no waste by products, and causes no pollution. Tamil Nadu tops the list of states with the largest installed wind power generation capacity in the country followed by Gujarat and Maharashtra.

### 5.3.3 HYDROPOWER

The force of falling water has been mankind's important source of power and energy through the ages. Water-energy is most conventional renewable source of energy. Hydropower mainly is the gravitational force of falling water which can be utilized for the generation of electricity. Hydroelectricity refers to the generation of electrical power by the use of hydropower. This does not use any water in energy production unlike coal based power plants. In 2015, hydropower generated 16.6% of the world's total electricity and 70% of all renewable electricity.

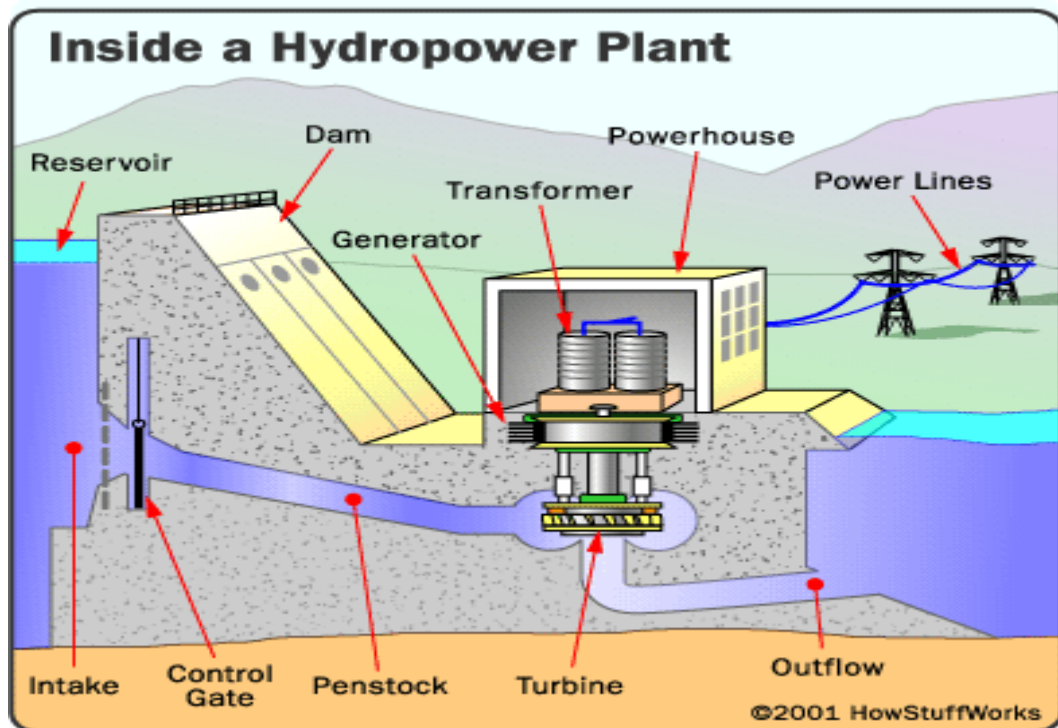


**Fig 5.7: A Hydropower Plant**

Hydroelectricity is produced by utilizing the gravitational force of falling water. To this end, the hydropower plant requires a dam. This dam is placed on a source of water, preferably a river. The dam is a massive wall that blocks the flow of the river; therefore, a lot of water collects behind the dam. Near the bottom of the dam, there is an intake from which the water is let into the dam. This intake leads to a drop through the penstock (a large pipe) inside the dam. The device used to obtain energy from the falling water is a turbine. The turbine is connected by a shaft to the generator. When the water rotates the turbine, electrical energy is generated.

The average cost of electricity for a large hydropower plant is very less. Energy production is dependent on the amount of water that is let out since this can be controlled; hydropower plants have the advantage of being flexible. The output can be controlled as required by the need. The reservoir that forms behind the dam can be used for irrigation or for leisure purposes. Also, once the construction is completed, there is a negligible amount of greenhouse gas emission.

China is the largest producer of hydroelectricity, followed by Canada, Brazil, and the United States.

## 5.4 NUCLEAR ENERGY (USES AND LIMITATIONS)

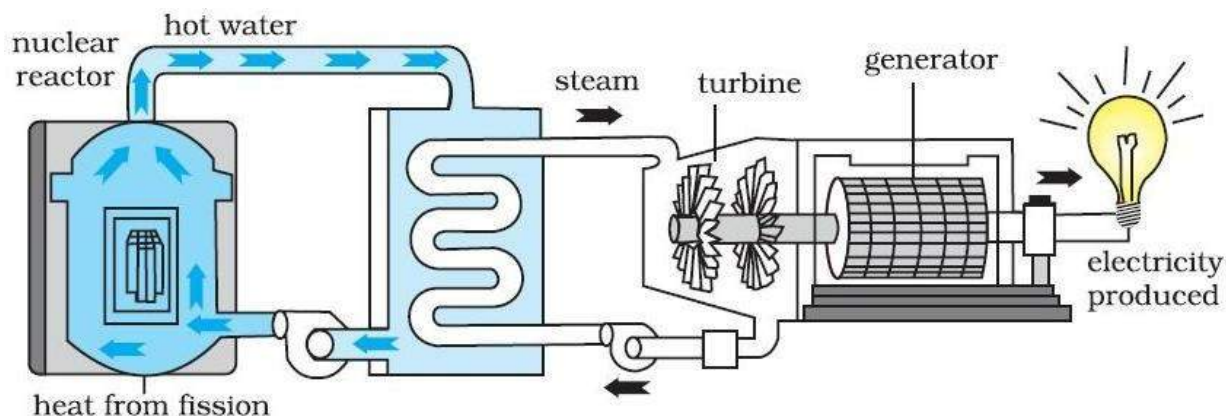
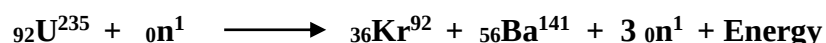


**Fig 5.8: Nuclear Power Reactor Generating Electricity**

Nuclear energy is the tremendous energy present in the nucleus of an atom. This energy can be harnessed from the atoms of some elements and can be utilised for fulfilling energy requirements at a large scale. It can be generated by two types of reactions:

**5.4.1 Nuclear Fission:** It is the nuclear change in which nucleus of certain isotopes with large mass numbers are split into lighter nuclei on bombardment by neutrons and a large amount of energy is released through a chain reaction. For example, Uranium atom is bombarded with a neutron and it releases huge amount of energy and Uranium atoms gets converted to Krypton and Barium.



Nuclear Reactors make use of nuclear chain reaction. In order to control the rate of fission, only 1 neutron is allowed to strike for splitting another nucleus.

**5.4.2 Nuclear fusion:** Here two isotopes of a light element are forced together at extremely high temperatures until they fuse together to form a heavier nucleus. It is difficult to initiate the process but it releases more energy than nuclear fission.



In the above example, two hydrogen-2 (Deuterium) atoms fuse to form the nucleus of Helium at very high temperature. The process releases a neutron a huge amount of energy. Nuclear fusion reaction can also take place between one Hydrogen-2 (Deuterium) and one Hydrogen-3 (Tritium) nucleus at 100 million °C forming Helium-4 nucleus, one neutron and

a huge amount of energy. The energy produced by the sun comes from nuclear fusion reactions. Nuclear energy has tremendous potential but any leakage from the reactor may cause devastating nuclear pollution e.g. the Chernobyl nuclear disaster (1986).

### **5.4.3 USES OF NUCLEAR ENERGY**

There are a number of beneficial uses of nuclear energy in addition to creating electricity. These are briefly explained as under:

- **Agriculture and Food**

In many parts of the world, agricultural workers use radiation to prevent harmful insects from reproducing. Reducing the numbers of pests and bugs protects crops, providing the world with more food.

Irradiation also kills bacteria and other harmful organisms in food. This type of sterilization occurs without making food radioactive or significantly affecting the nutritional value. In fact, irradiation is the only way to kill bacteria in raw and frozen foods effectively.

- **Health Care**

Nuclear technologies provide images inside the human body and can help to treat disease. For example, nuclear research has allowed doctors to predict precisely the amount of radiation required to kill cancer tumors without damaging healthy cells. Hospitals sterilize medical equipment with gamma rays safely and inexpensively.

- **Space Exploration**

Nuclear technology makes deep space exploration possible. The generators in unmanned spacecraft use the heat from plutonium to generate electricity and can operate unattended for years. This reliable, long-term source of electricity powers these spacecraft, even as they venture deep into space.

- **Water Desalination**

The World Nuclear Association notes that one-fifth of the world's population does not have access to safe drinking water and that number is expected to grow. Nuclear technology can play an important role in overcoming this challenge. Water desalination is the process of removing salt from saltwater to make the water drinkable. However, this process requires a lot of energy. Nuclear energy facilities can provide the large amount of energy that desalination plants need to provide fresh drinking water.

#### 5.4.4 LIMITATIONS OF NUCLEAR ENERGY

Enumerating some of the Nuclear Energy disadvantages are:

- **Toxic Radioactive waste-** The radioactive waste coming from Nuclear power plants is a great caution and peril to the environment. The catastrophic effects of Chernobyl disaster still linger in the minds of people. As per the records, 30, 000 people died in the Chernobyl disaster (1986), and over 2.5 million Ukrainians are still dealing with the health tribulations associated with the nuclear waste.
- **Incurs heavy initial capital costs-** Nuclear Energy entails immense investment to set up a nuclear power station. Constructing a nuclear power plant requires enormous capital outlay.
- **Hazardous implications on human lives** – Dating back to the shattering consequences of the Hiroshima and Nagasaki nuclear bombs during the Second World War. Children were and are still born with several malfunctions. This might pave way for a safe haven for terrorists.
- **Nuclear weapons can destroy humanity.** It has given the power to produce more weapons than to produce things that can make the world a better place to live in.
- **Thermal Pollution.** Local thermal pollution from wastewater affects marine life.
- **Accidents.** Large-scale accidents can be catastrophic as in the case of Chernobyl disaster (1986) and Fukushima Daiichi nuclear accident (2011).
- **Aquatic Life Dangers and Threats.** Pollutants released by nuclear plants are heavy metals and toxic pollutants that harm plant and animal life in aquatic bodies.

#### 5.5 BIOFUELS

**Biofuel** refers to any liquid or gaseous fuel that is produced from biomass (plant or algae material or animal waste) through various processes. Since such feedstock material can be replenished readily, biofuel is considered to be a source of renewable energy. More often than not, the word biomass simply denotes the biological raw material the fuel is made of. The word biofuel is usually reserved for liquid or gaseous fuels, used for transportation. Biofuel is commonly advocated as a cost-effective and environmentally benign alternative to petroleum and other fossil fuels, particularly within the context of their limited supply and contributions to global warming.

The various types of biofuels are as under:

- **Bioethanol:** Ethanol ( $C_2H_5OH$ ) is a colourless liquid biofuel produced by fermenting sugars and starches from sugar plants and cereal crops (sugarcane, corn, beet, cassava, wheat, sorghum). In the United States ethanol biofuel is made primarily from corn (maize) grain, and it is typically blended with gasoline to produce “**Gasohol**,” a fuel that is 10 percent ethanol. Ethanol can be used as a fuel for vehicles in its pure form as E100.
- **Biodiesel:** The second most common liquid biofuel is biodiesel which is made primarily from vegetable oils (such as soybean or palm oil) and to a lesser extent from other sources like animal fats and waste cooking fat from restaurants. Biodiesel, which has found greatest acceptance in Europe, is used in diesel engines and usually blended with petroleum diesel fuel in various percentages. B100 represents pure biodiesel without any blending.
- **Syngas or producer gas:** Biomass such as crop residue, wood chips, bagasse, rice husk, coconut shells, etc., can be transformed to producer gas or syngas by a method known as gasification of solid fuel. It is a mixture of carbon monoxide, Hydrogen, hydrocarbons like Methane and a little carbon dioxide.
- **Biogas:** It is a biofuel which is produced by the process of anaerobic digestion in a biogas digester. Biogas is chiefly composed of methane and carbon dioxide with a little hydrogen and nitrogen as well. It is used for cooking, lighting (using mantle lamps), heating and operating small engines. Use of biogas is wide spread in rural India and China.

## Evaluation

### a) Answer the following questions

- 1) What are renewable and non-renewable energy resources? Give examples.
- 2) What is hydro-electric energy? How is it generated?
- 3) Define Solar Energy. How can it be harnessed?
- 4) What is Nuclear Energy? What are its uses and limitations?
- 5) What are the different types of biofuels?

### b) Fill in the Blanks

- 6) ..... resources are inexhaustible resources which can be generated within a given span of time.
- 7) ..... is a mixture of carbon monoxide, Hydrogen, hydrocarbons like Methane and a little carbon dioxide.
- 8) Solar cell or PV cell is made of thin wafers of semiconductor material like.....
- 9) Gasohol is a mixture of ..... and .....
- 10) .....is the most abundant fossil fuel in the world.

### c) Choose the correct option

- 11) Which of the following types of coal has maximum carbon and calorific value?  
(a) Anthracite (b) Bituminous (c) Lignite (d) Peat.
- 12) Nuclear energy can be generated by:  
(a) Nuclear fusion (b) Nuclear fission (c) Both of these (d) None of these

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## Unit6- Earth's Environment and Natural Disasters

### ❖ LEARNING OUTCOMES

The student after completing this unit should be able to:

1. **Define atmosphere, hydrosphere and lithosphere**
2. **have knowledge of :**
  - a) composition of pure dry air.
  - b) distribution of water on earth.
  - c) types of lithosphere
3. **have an understanding of :**
  - a) structure of atmosphere
  - b) layers of Earth
  - c) the water cycle
4. know what is meant by nitrogen cycle, carbon cycle and phosphorus cycle.
5. describe the various steps/ processes involved in carbon cycle, nitrogen cycle and phosphorus cycle.
6. draw neat diagram of each nutrient cycle.
7. **know the role and importance of:**
  - a) micro-organisms in nitrogen cycle
  - b) weathering and living organisms in phosphorus cycle.
  - c) photosynthesis, respiration and oceans in carbon cycle.
8. have an understanding of what earthquakes, volcanoes and flood are
9. **know what:**
  - a) the different types of seismic waves are
  - b) the different types of volcanoes are
  - c) is the relationship between urbanization and floods
10. identify the various causes of floods, earthquakes and volcanic eruptions
11. learn how earthquakes, volcanoes and floods affect us
12. know the mitigation measures with respect to earthquakes, volcanic eruptions and floods.

## 6.1. ATMOSPHERE

Atmosphere is the envelope of air that surrounds the earth to a height of many kilometers. Air, a mixture of gases, is held to the earth by gravitational attraction. The mass of this envelope of air is about  $5.7 \times 10^{15}$  tons. 97% of the atmosphere lies within 30 km of the earth's surface. The upper limit of the atmosphere is at a height of approximately 10,000 Km above the earth's surface.

### 6.1.1. Composition of atmosphere

The chemical composition of air, in terms of proportion of gases, is uniform upto 80 Km from the earth's surface.

Nitrogen in the atmosphere exists as a molecule of two nitrogen atoms ( $N_2$ ). Even though nitrogen is present in large amounts in the air, the living organisms, in general cannot uptake it in this form. Only small amount of it is converted to an available form that the plants can uptake. On the other hand, oxygen is chemically very active. Oxygen is required for combustion, respiration, weathering of certain rocks and for conversion of food into energy in living organisms. 99% of pure dry air is made up of nitrogen and oxygen. The remaining 1% is mostly argon, an inactive gas of little importance in natural processes. 0.03% of the air is  $CO_2$ , which is an important greenhouse gas as it absorbs the long wave heat radiations that are radiated back by the earth.  $CO_2$  is also used by plants for photosynthesis.

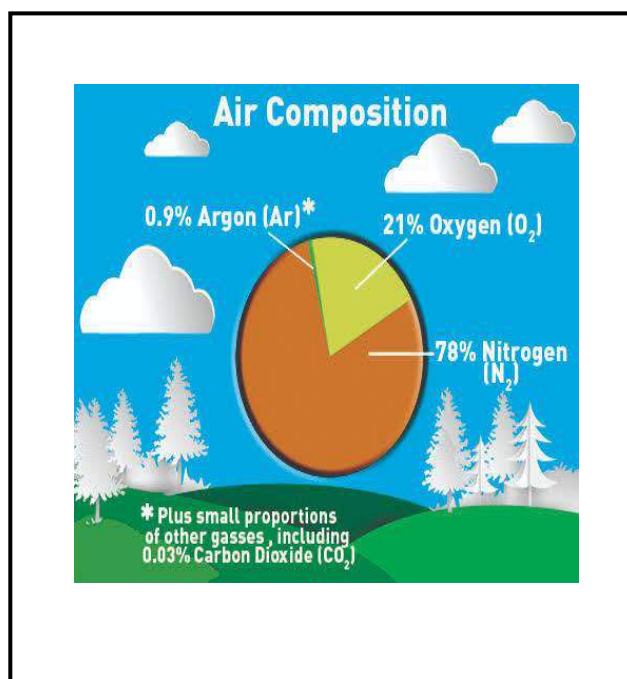


**Fig. 6.1. composition of atmosphere**

. Air also contains variable amounts of water vapour, on an average around 1% at sea level and 0.4% over the entire atmosphere. Water vapour, like  $CO_2$  is also a good absorber of heat radiation and hence plays a major role in warming the lower atmosphere.

The solid particles present in the atmosphere include dust particles, salt particles, pollen, volcanic ashes etc. these particles help in the scattering of solar radiation.

### 6.1.2. Profile / structure of atmosphere

Atmosphere is the blanket of air that surrounds the earth. 97% of the atmosphere is confined to an altitude of above 30 km above the earth's surface. We study the atmosphere by viewing it in layers that have distinctive properties and purposes. The atmosphere is classified on the basis of temperature and altitude into following 4 layers :

1. **Troposphere**: The lower most layer of Earth is known as the troposphere. Starting from the surface of the Earth upwards, the troposphere has a height of 18 Kms at equator and approximately 6 Km above the poles. All weather phenomenon like cloud formation, fog, rain, lightening etc occur in this layer. The temperature decreases with altitude in this layer at the rate of  $-6.5^{\circ}\text{C}/\text{Km}$ ; this is known as the Normal Lapse Rate. Troposphere, the layer that supports life, consists of different gases, water vapors and dust particles. The upper limit of troposphere is the tropopause where minimum temperatures are recorded (average being  $-57^{\circ}\text{C}$ ).

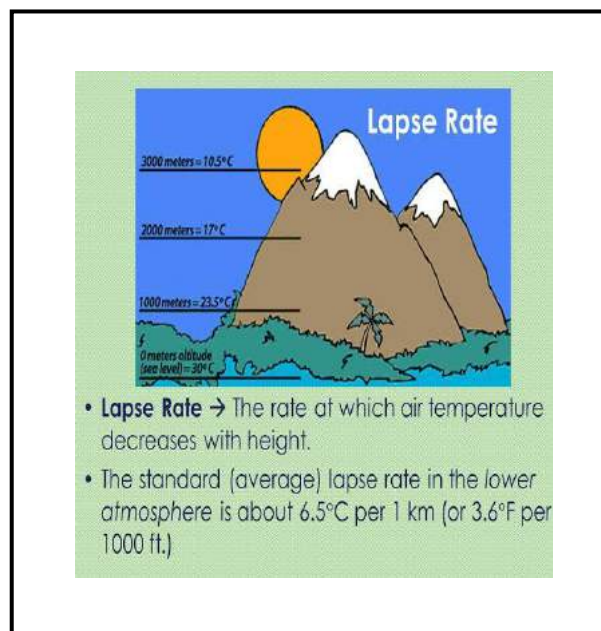


**Fig.6.2. lapse rate in troposphere**

2. **Stratosphere**: The layer just above the troposphere is called the stratosphere. It extends from 18 Km upto an altitude of 50 Km. The temperature increases with altitude in this layer. Stratosphere contains ozone ( $\text{O}_3$ ). The highest concentration of ozone is found in the lower portion of stratosphere known as ozonosphere. Ozone acts as a protective cover for living organisms on earth as it protects the biosphere from harmful ultra violet radiations by absorbing these radiations. It is because of the presence of ozone layer the temperature increases in stratosphere. The upper limit of stratosphere is the stratopause.

3. **Mesosphere:** The third layer of the atmosphere extends between 50 to 80 Km above the sea level. The temperature here decreases with increasing altitude and it declines till mesopause. Mesopause is the transitional layer. The meteors burn up in stratosphere while entering the atmosphere. The lowest temperature in the atmosphere occurs at mesopause (app.  $-90^{\circ}\text{C}$ )
4. **Thermosphere:** The portion of the atmosphere beyond the mesopause is known as thermosphere. It extends from 80-1000 Km. It is further divided into two layers:
  - a. **Ionosphere:** It extends from 90 to 640 Km above the sea level. It contains electrically charged particles known as ions. The radiowaves are reflected back to the earth by this layer.
  - b. **Exosphere:** It extends above 640 km to outer space. It is the upper most layer of the atmosphere. The density is very low in this layer. It gradually merges with outer space. The satellites (orbiting the earth) are normally placed in exosphere.

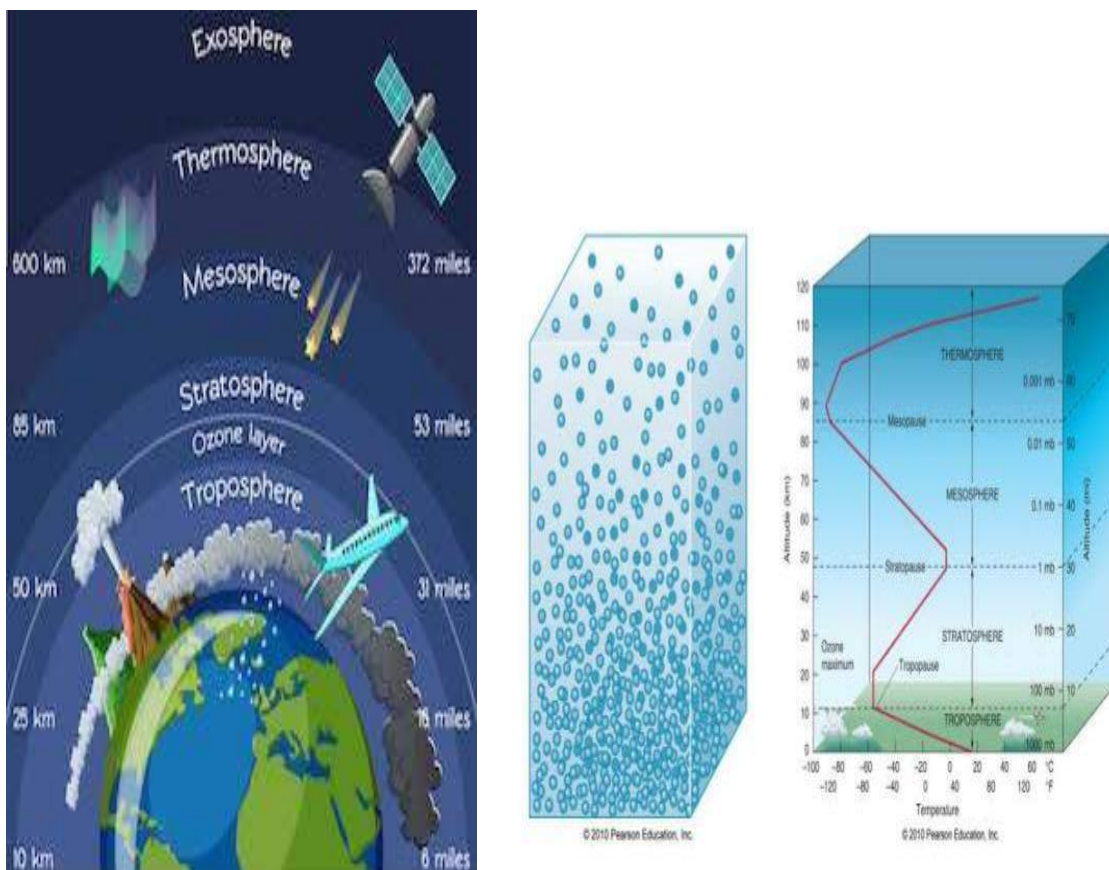


**Fig.6.3. Structure of atmosphere**

## 6.2. HYDROSPHERE

Water is critical to our daily lives and is an extraordinary compound in nature. It covers 71% of the earth. Water occurs in such significant quantities only on our planet. It constitutes nearly 70% of our bodies by weight and forms major part of plants, animals and our food. Water is the medium of life. Of all the substances on Earth, water is the only one that occurs naturally in all three phases: solid (ice and snow), liquid and vapour. Water in its various phases is distributed among oceanic, atmospheric and terrestrial reservoirs. Today, water is the most common compound on the surface of Earth, having attained the present volume of 1.36 billion cubic kilometers approximately 2 billion years ago.

Hydrosphere is a discontinuous layer of water on the earth's surface which include surface waters, both frozen and liquid, ground water in soils and rocks and atmospheric vapours.

The figures given here describe the distribution of water on the Earth's surface.

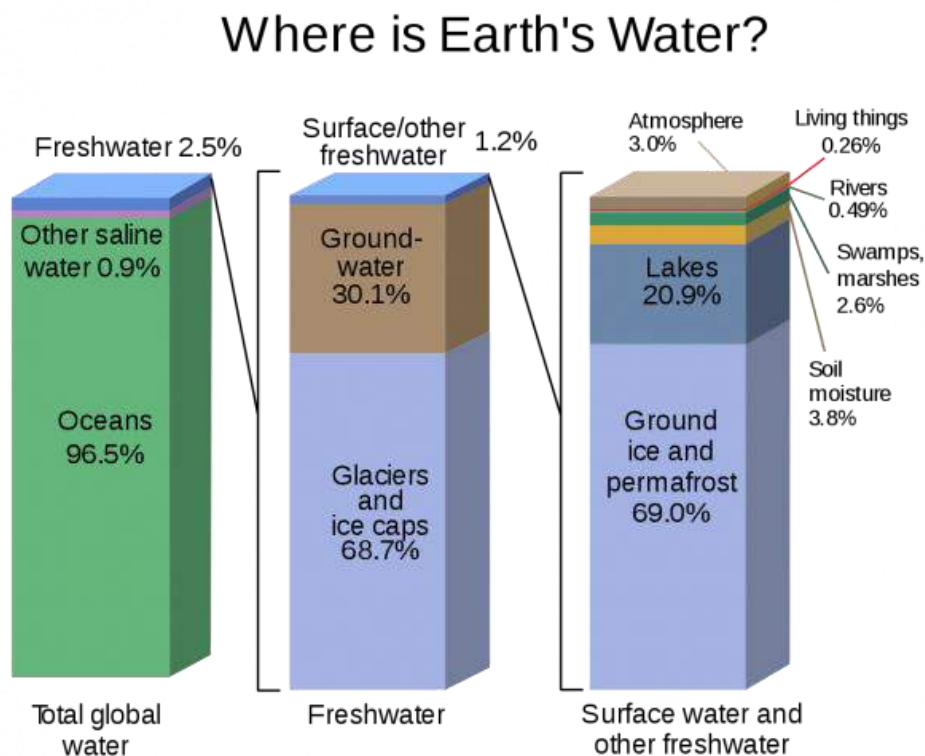


**Fig. 6.4. Global water budget.**

Thus, out the total global water, 96.5% is distributed in oceans of earth and only 2.5% of the total global water is fresh water. About 69% of this fresh water is stored in ice caps and glaciers. Rest of the fresh water is stored as ground water (30%) and surface and other fresh water (1.3%).

The oceans contain 96.5% of all the water on Earth. The four main oceanic bodies are (1) Pacific ocean (2) Atlantic ocean (3) Indian ocean (4) Arctic ocean. The first three of these together constitute 90% of the total area of water bodies on the earth. The Pacific is the largest ocean, both in surface area and volume.

### 6.2.1. The Hydrological or water cycle

The water cycle describes how water is cycled through hydrosphere on Earth. The water exists on the earth's surface in all three phases, i.e. solid (glaciers and ice sheets), liquid (lakes, rivers, oceans) and vapours (in air and clouds). The water cycle consists of four major processes i.e. evaporation, transpiration, condensation and precipitation.

- 1) **Evaporation**: It is the process of liquid changing into a gas. In the water cycle, liquid water (in oceans, lakes, rivers) evaporates and becomes water vapour. Water vapour is an important part of the air we breathe and also is a greenhouse gas. Evaporation is driven by the sun and is influenced by wind, temperature and density of the water body. Total annual evaporation from earth amounts to approximately 0.420 millions of cubic kilometers of water. 0.350 millions of cubic kilometers of which evaporates from oceans to the atmosphere annually.
- 2) **Transpiration**: It is the process of water being released from plants in the form of water vapours through stomata. Evapotranspiration is combined component of evaporation and transpiration.
- 3) **Condensation**: It is the process of a gas changing into a liquid. In the water cycle, water vapour in the atmosphere condenses and becomes liquid. The amount of water present in atmosphere in a year is approximately 0.013 millions of cubic kilometers. Clouds form as water vapour condenses. In the atmosphere, annually 0.030 millions of cubic kilometers of water vapour is transported from above the oceans over to land. Condensation is influenced by solar energy. As water vapour cools, it condenses.
- 4) **Precipitation**: It describes any liquid or solid water that falls on earth as a result of condensation in the atmosphere. Precipitation includes rain, snow and hail.

Approximately, 0.430 millions of cubic kilometers of water falls as precipitation each year on land and oceans. Precipitation is either absorbed into the ground (percolation) or runs off into the rivers. Water that is absorbed into the ground is taken up by the plants (interception) or reaches the ground water. The amount of ground water to a depth of 4 km is approximately 8.4 millions of cubic kilometers in a year. Plants lose water from their surface as water vapour (transpiration) back into the atmosphere. Water that runs off into rivers flow into ponds, lakes or oceans where it evaporates back into the atmosphere and the water cycle continues. Annually, approximately 0.030 millions of cubic kilometers of water runs off and enters the oceans.

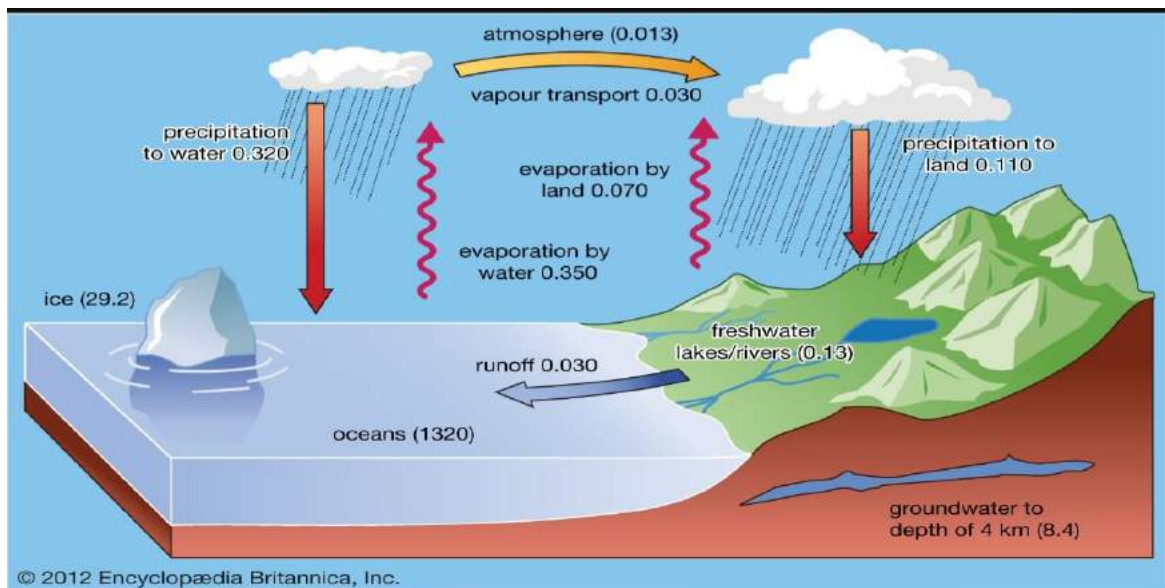


**Fig.6.5. Earth's hydrological cycle (Million cubic kms)**

## 6.3. LITHOSPHERE: STRUCTURE

### 6.3.1. Structure of the Earth

Four billion years ago, the earth started to form from a cloud of dust, gas and icy comets (nebula). As it solidified, because of its gravity the heavier substances such as iron moved to the center and lighter substances such as silica moved upwards to the surface. Hence, the earth's interior is divided into concentric layers depending upon their chemical composition and temperature.

Our earth is a spherical body with a mean diameter of 12,742Km and average density of approx.  $5.5\text{g/cm}^3$

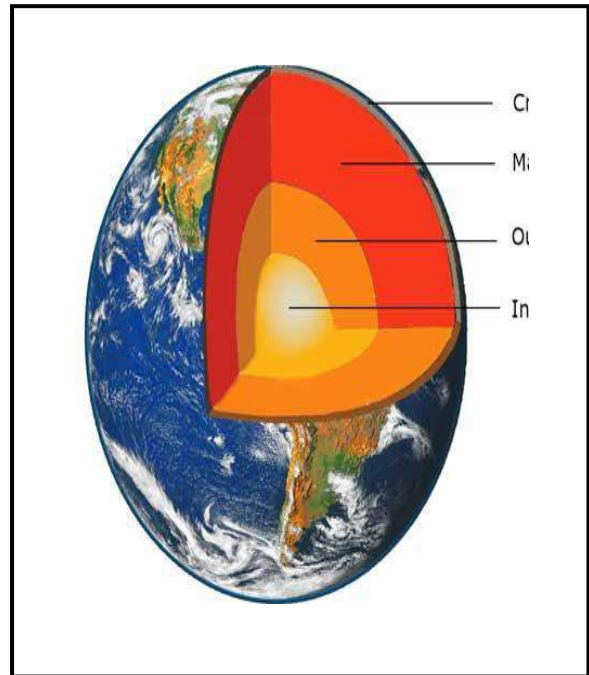
The three main layers into which the earth is being divided are :

- 1) **The core**, which occupies the centre of the Earth.
- 2) **The mantle**, which encloses the core.
- 3) **The crust**, the outer most shell of the earth.

1. **The Core**: The core occupies the centre of the earth as it is denser than the rest of the layers. The core is further divided into:

- a. **The inner core**: Thickness of the inner core is more than 1300 km.

It is metallic solid mostly composed of iron (about 90% by weight) with minor amounts of elements such as sulphur, oxygen and nickel.



( fig.

#### 6.6. structure of earth)

- b. **The outer core**: The outer core is liquid with composition similar to the inner core. Its thickness is just over 2000 Km. The temperature of the core is thought to be 3000°C to 5000°C. The transition zone between the core and mantle is called Gutenberg discontinuity.
2. **The Mantle**: Surrounding the central core, is the mantle. The mantle is nearly 3000 Km thick with an average density of 4.5 g/cm<sup>3</sup>. The mantle is further divided into three layers:
  - a. **Lower mantle**: The lower mantle is denser and contains a mixture of minerals like iron, magnesium, silicates and some calcium and aluminum.
  - b. **Upper mantle**: The upper mantle is divided into an upper layer and asthenosphere;
    - i. **Upper mantle**: is a rigid layer and is less dense than the lower mantle.
    - ii. **Asthenosphere**: or plastic layer is the least rigid region of the mantle. About 10% of the asthenosphere is molten having hot spots. The slow movements in this zone are responsible for tectonic plate movements. It has hotter areas because of decay of radioactive materials.

- iii. **Uppermost mantle:** Above the asthenosphere and just below the crust is the uppermost mantle which is a rigid and cooler layer. The uppermost mantle and the crust together make the lithosphere, approximately 45- 70 Km thick. The boundary between the uppermost mantle and crust is called the Mohorovicic (Moho) discontinuity.

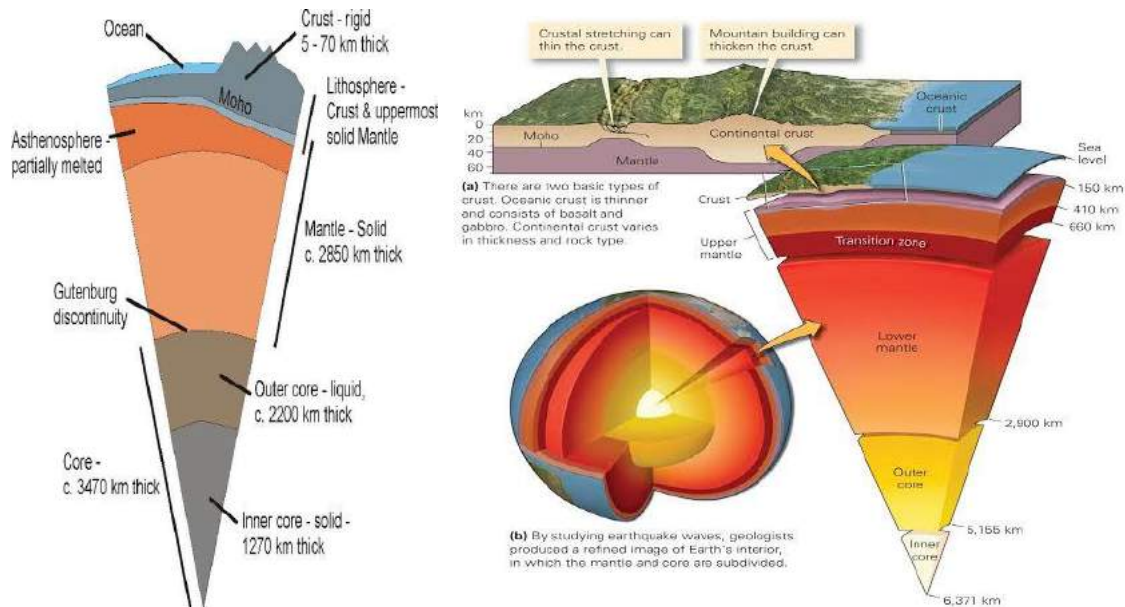


**Fig.6.7. Different layers of the earth**

### 6.3.2. Lithosphere: Structure

The crust is the outer most and thinnest layer of the earth and is normally 8 to 40 Km thick. The uppermost mantle (rigid, brittle rock layer) and the crust together are known as lithosphere. Lithosphere is derived from Greek word “Lithos” meaning rocky/stone. Lithosphere thus is a solid rigid outer part of earth which has atmosphere above and asthenosphere below it. The uppermost surface of lithosphere which reacts with atmosphere, hydrosphere and biosphere through soil formation process is known as pedosphere. The main components of the lithosphere are hard rocks and soil. Rocks are either igneous (formed due to solidification of lava), sedimentary (formed when loosed particles of other rocks are consolidated by temperature and pressure) and metamorphic (formed by melting, contorting and recrystallization of other rocks). The rocks when exposed to atmosphere, hydrosphere, changing temperature are broken down into smaller and finer particles by the process of weathering leading ultimately to the soil formation.

The lithosphere is of two types

1. **The oceanic lithosphere:** It is associated with the crust beneath the oceans. It is 7-10 km thick. And consist mainly of mafic (rich in magnesium and iron) crust (Basalt). It is sometimes also called **sim**a (si-silica, ma- magnesium). It is granular and is denser than the continental lithosphere. Oceanic crust is much thinner than the continental crust.
2. **The continental lithosphere:** It is also called continental crust. Its thickness varies from 25 to 70 km with a density of  $2.7 \text{ g/cm}^3$ . It is a layer of igneous and sedimentary rocks. It consists mostly of granitic rocks. It is crystalline and is high in silica, aluminum, potassium, calcium and sodium. It is sometimes called **sial** (si-silica, al- aluminum).

The lithosphere is broken down into large pieces known as tectonic plates or lithospheric plates that move relative to one another .A lithospheric plate may include a continent and a part of an ocean basin, or an ocean or a continent region alone. The lithosphere is divided into 7 major plates. Some are very large and some are relatively small. (See the Box). The boundaries between lithospheric plates are geologically very active and are sites for most of the earthquakes and volcanoes. These lithospheric plates move over the asthenosphere (think of a boat floating on water) and thus carry the continents with them, this is known as **continental drift**.

| TECTONIC PLATES                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The lithosphere is sub divided into tectonic plates. Tectonic plates are further subdivided into major (primary) and minor (secondary)plates.                                                                                                      |                                                                                                                                                                                                                                                                                 |
| Major plates                                                                                                                                                                                                                                       | <u>Minor plates</u>                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>• African plate</li> <li>• Antarctica plate</li> <li>• Euroasian plate</li> <li>• Indo-Australian plate</li> <li>• North American plate</li> <li>• Pacific plate</li> <li>• South American plate</li> </ul> | <ul style="list-style-type: none"> <li>• Arabian plate</li> <li>• Burma plate</li> <li>• Caribbean plate</li> <li>• Cocos plate</li> <li>• Nazca plate</li> <li>• New Hebrides plate</li> <li>• Philippine sea plate</li> <li>• Scotia plate</li> <li>• Somali plate</li> </ul> |

## 6.4. Biogeochemical Cycles

Biogeochemical cycles are any of the natural pathways by which essential elements of living matter are circulated. The term biogeochemical is a contraction that refers to the consideration of the biological, geological and chemical aspects of each cycle. It is the recycling of substances through pathways that involve biotic (biosphere) and abiotic (lithosphere, atmosphere and hydrosphere) compartments of earth. The recycling of nutrients such as carbon, nitrogen, oxygen, phosphorus and sulphur that are used in ecosystems by living organisms is known as nutrient cycles.

The elements are sometimes held for long periods of time in one place during its cycling. This place is called a reservoir. When elements are held for only short periods of time, they are being held in exchange pools. The amount of time that an element is held in one place is called its residence time. Biogeochemical cycles always involve an equilibrium/ balance in the cycling of the elements between compartments. The nutrient cycles are driven by energy and are essential for maintaining all life forms on earth. The nutrient cycles are either gaseous, where the reservoir is atmosphere or hydrosphere (C,N,O,H) or sedimentary type (S,P) where the reservoir is the lithosphere.

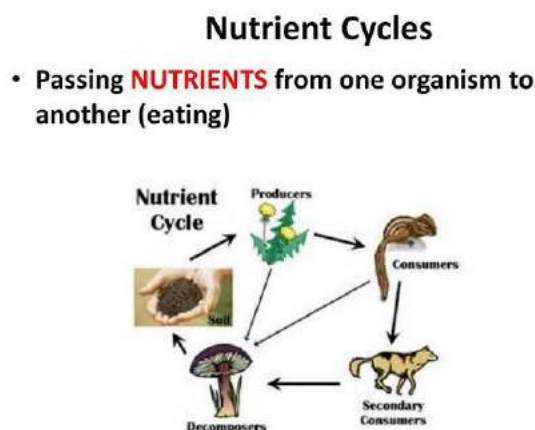


**Fig.6.8 Pathway of nutrients from different organisms.**

### 6.4.1. Carbon Cycle

Carbon accounts for about 49% of organisms dry weight. It is a structural component of organic molecules. Materials such as carbon continually cycle around the

globe. Carbon cycle is a gaseous cycle with major reservoir as atmosphere. The carbon cycle consists of major interlocking sub-cycles. A major sub-cycle involves interaction of organisms and atmosphere (fig). The green plants (producers) uptake  $\text{CO}_2$  from the atmosphere and incorporate it into sugars ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) by photosynthesis. Plants use this sugar to make other organic compounds including fats, proteins and other carbohydrates. The carbon in plants is transferred to the animals when plants are eaten by consumers in food chains. Both producers and consumers transform a portion of the carbon back to  $\text{CO}_2$  as a by-product of respiration. In this way, plants and animals release carbon dioxide back to the atmosphere. When plants and animals die, upon decomposition, the carbon is released back to the atmosphere through cellular respiration of decomposers and other detritivores. Some dead plant and animal materials become buried in sediments before being broken down completely by decomposers. This process has been going on for hundreds of millions of years by which these plant and animal remains were transformed into coal, oil and natural gas (fossil fuels). In certain marine environments, plant and animal remains were converted to oil and natural gas. When we burn these fossil fuels carbon dioxide is released, and with this the carbon is returned back to the atmosphere.

The exchange of carbon dioxide between the atmosphere and the oceans is a primary regulator of carbon dioxide levels in atmosphere. At the interface between air and water,  $\text{CO}_2$  continually moves between the two reservoirs. Some atmospheric  $\text{CO}_2$  dissolves in water and some dissolved  $\text{CO}_2$  escapes from ocean surface to atmosphere. The carbon dioxide that dissolves in water is available for photosynthesis by aquatic plants. Some  $\text{CO}_2$  that is incorporated into sugars during photosynthesis cycles through aquatic food webs.

Another sub-cycle of carbon cycles involves the formation of lime stone (calcium carbonate,  $\text{CaCO}_3$ ), dolomite (calcium magnesium carbonate ( $\text{CaMg}(\text{CO}_3)_2$ ) and other carbon containing rocks. As marine organisms die, their shells and skeletons settle to the bottom. Over long periods of time these are transformed into carbonate rocks. Subsequently these rocks when exposed and when they decompose, carbon dioxide is released which escapes into the atmosphere, thus completing the carbon cycle.

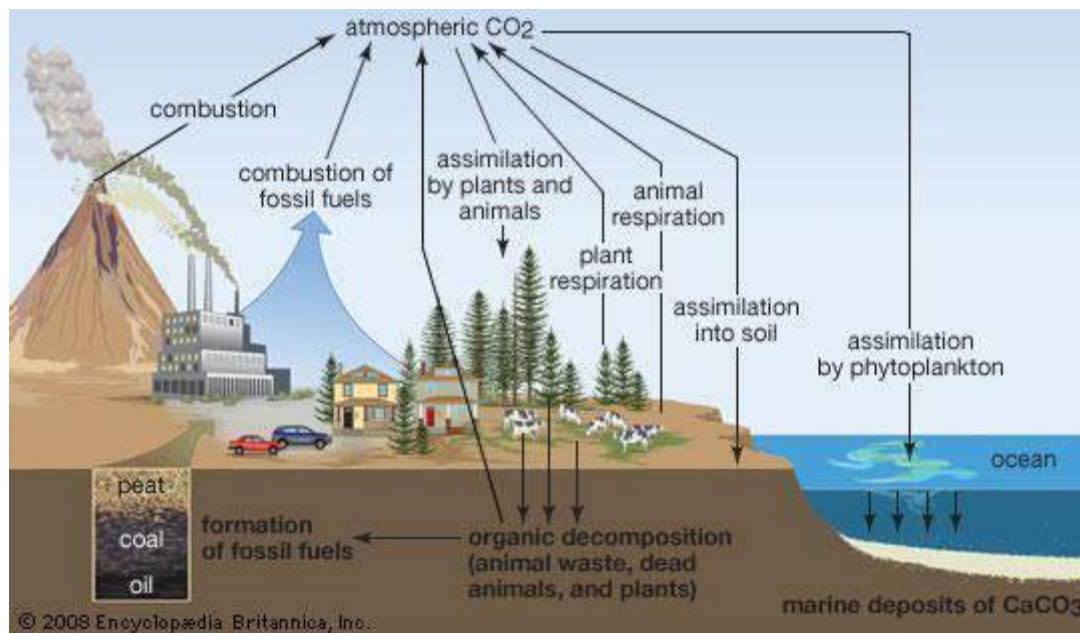


**Fig.6.8. The carbon cycle**

### (6.4.2) Nitrogen Cycle

Nitrogen, accounting for 78.08% of each breath we take, is the major constituent of air. Nitrogen which is present as N<sub>2</sub> (inert) gas in the atmosphere cannot be taken up by the plants or animals in this form. Nitrogen is important in the makeup of organic molecules, especially proteins and therefore is essential to living processes.

Nitrogen cycle is a biogeochemical process through which inert nitrogen present in the atmosphere is converted into many forms, consecutively passing from atmosphere to the soil to organism and back into the atmosphere.

The nitrogen cycle consists of following steps: Nitrogen fixation, Nitrification, Assimilation and Denitrification.

1. **Nitrogen fixation:** This is the initial step of the nitrogen cycle. Nitrogen fixation is the process by which atmospheric inert nitrogen is converted to the ammonia (NH<sub>3</sub>) which can be taken up by the plants. Nitrogen fixation is accomplished mainly in three ways:
  - a. **Biological nitrogen fixation:** Certain micro-organisms in the soil convert the inert nitrogen to ammonia. These are known as nitrogen fixing bacteria. These include free living bacteria like *Azotobacter* or some blue green algae. Another class consists of the symbiotic nitrogen fixing bacteria, of genus *Rhizobium*, which live in

the root nodules of leguminous plants such as soya beans, peas, peanuts etc. All these bacteria fix the atmospheric nitrogen and thus nitrogen is made available to plants.

- b. **Atmospheric fixation:** The energy of lightening can also fix nitrogen and make it available to plants.
  - c. **Industrial fixation:** Nitrogen is also fixed by industrial process that creates ammonia and nitrogen rich fertilisers.
2. **Nitrification:** The ammonia so formed is converted first to nitrite by *Nitrosomonas* bacteria and then to nitrates by *Nitrobacter*. This is known as nitrification.
  3. **Assimilation:** The uptake of nitrogen by plants in the form of ammonia, nitrite ions, nitrate ions or ammonium ions, by their roots is called assimilation. The nitrogen is important for the synthesis of proteins. This nitrogen gets transferred to animals when the animals feed on plants and with this it passes on in the food chain.
  4. **Ammonification:** When these plants and animals die, the decomposers decompose the dead bodies and nitrogen is released as ammonium into the environment which is then further used by living organisms.
  5. **Denitrification:** The nitrogen cycle is completed by the process of denitrification where certain denitrifying bacteria such *Clostridium* and *Pseudomonas* convert nitrate to nitrogen gas, which is released back to the atmosphere.

All these process discussed above repeat continuously and thus maintain the percentage of nitrogen in the atmosphere.

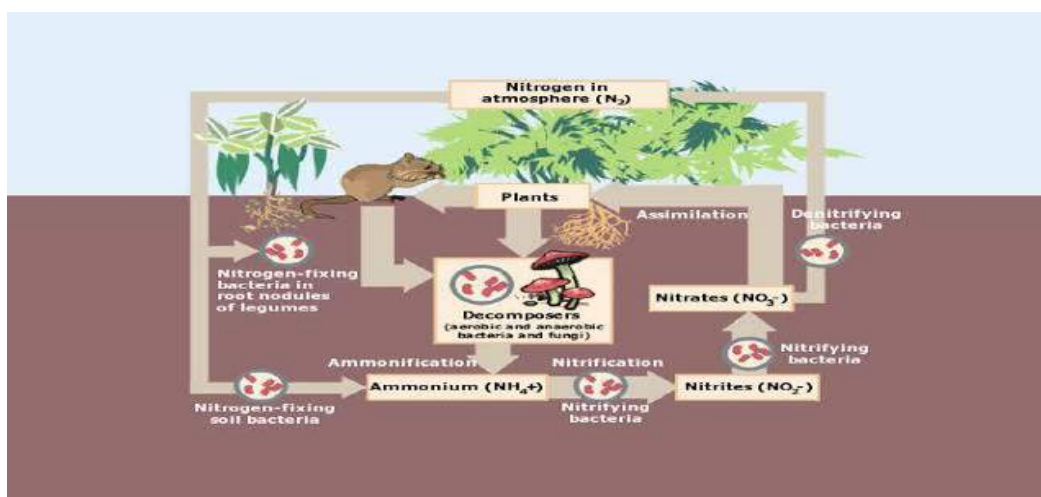


**Fig.6.9. The nitrogen cyle**

### (6.4.3. Phosphorus Cycle

Phosphorus is an important element for all living organisms. It forms an important constituent of DNA, RNA, ATP, teeth and bones. The phosphorus cycle is a biogeochemical cycle which involves the movement of phosphorus between rocks, soil, water and living organisms. Phosphorus cycle is sedimentary in nature as the greatest reservoir of phosphate in the world lies in rocks as insoluble ferric and calcium phosphate. Phosphorus is not present in the atmosphere, so atmosphere plays no significant role in phosphorus cycle.

The phosphorus cycle has the following steps.

1. **Weathering**: The Phosphorus cycle starts in the earth's crust as phosphorus is present in abundance in rocks. By the weathering (i.e., break down) of these rocks the phosphate is added to the soil.
2. **Uptake by plants**: The phosphate in water and soils are taken up by the plants through their roots.
3. **Absorption by animals**: When the animals eat plants, the phosphorous is transferred to animals and thus it enters the food chain.
4. **Decomposition**: When plants and animals die, the micro-organisms decompose the dead bodies and organic phosphorus is thus converted to inorganic phosphorus which enters the soil and water.

The phosphorus cycle is completed when soil and water end up in sediments and rocks. By the weathering of these rocks phosphorus is released and the cycle starts over again.

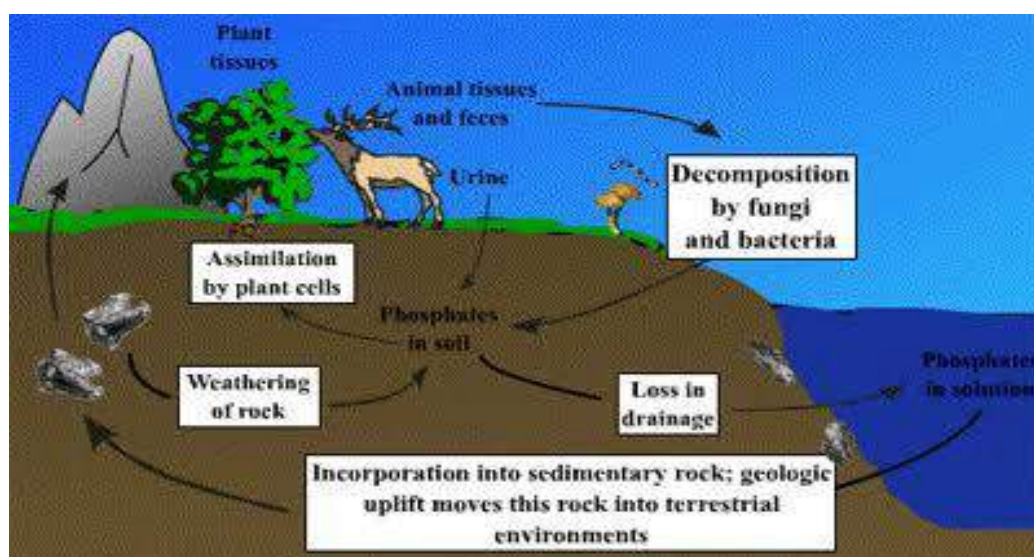


Fig.6.9. The Phosphorus Cycle

## 6.5. Natural Disasters

Natural hazards are circumstances in the natural environment that create extreme events. These events are termed as disasters when they cause harm to people or property or both. Natural disasters like earthquakes, floods and volcanic eruptions cause huge losses of life and property every year worldwide.

### 6.5.1. Earthquakes

An earthquake, a natural event, is the shaking of the earth due to release of energy which generates waves that travel in all directions in the earth. Earthquakes cause huge loss of life and property every year all around the world. Magnitude of an earthquake refers to the energy that it releases



while its intensity is the damage it causes to people and structures. Magnitude is measured on

| EARTHQUAKE      | MAGNITUDE  | INTENSITY (Mercalli scale)                                   |
|-----------------|------------|--------------------------------------------------------------|
| <b>GREAT</b>    | 8 or above | Catastrophic damage that is widespread and devastating (XII) |
| <b>MAJOR</b>    | 7 - 7.9    | Serious and widespread damage (X-XI)                         |
| <b>STRONG</b>   | 6-6.9      | Moderate damage (VIII-IX)                                    |
| <b>MODERATE</b> | 5 - 5.9    | Some damage to weak structures (V-VII)                       |
| <b>LIGHT</b>    | 4 - 4.9    | Minor breakage of objects (III-IV)                           |
| <b>MINOR</b>    | Below 4    | No Damage (I-II)                                             |

Richter scale between 0 to 9.8 while intensity is measured by Mercalli scale (Roman numeral scale I – XII)

**Table. 6.1. shows how magnitude and intensity of earthquake are related.**

The energy released in an earthquake travels like waves through the earth (just like ripples that are produced in a pond when a pebble is thrown into it- see picture).

The origin of the earthquake i.e., the point from where the sudden energy is released in the earth is called hypocenter or focus. The waves move outward in widening circles from this point. The area at the surface of the earth just directly above the hypocenter

is known as epicenter. The waves generated by an earthquake are called seismic waves. Earthquakes are recorded by an instrument called seismograph and the recordings they make are called seismogram. The scientific study of earthquakes and seismic waves is called seismology.

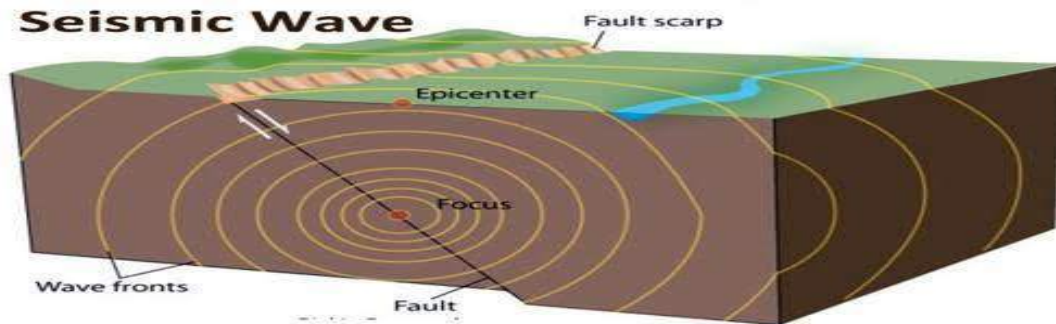
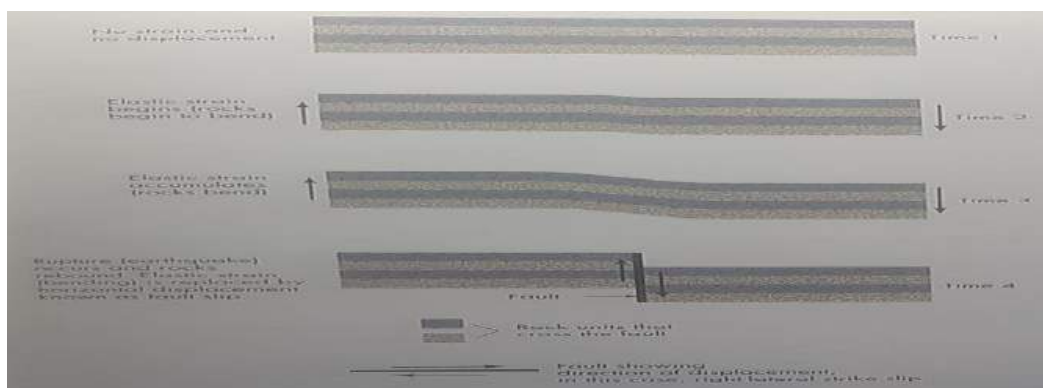


**Fig.6.10. Origin of earthquake**

### **6.5.2.Causes of earthquakes**

The main causes of earthquakes are as follows:

- 1) **Volcanic Eruptions:** One of the major cause of earthquake is volcanic eruption. During a volcanic eruption, the violent gases within the earth move upwards towards the crustal surface. They push and break the weak crust with great force. This results in tremors which results in volcanic eruptions and shaking of ground.
- 2) **Elastic rebound theory:** The underground rocks in the earth have forces ( stress) that are always acting upon them. These forces stretch and pull the rocks. The rocks act as rubber bands that stretch when pulled. When the forces acting on the rocks exceed the elasticity of the rocks the rock breaks. And this rupture( known as fault) releases energy, as the broken rock blocks try to get back to their original positions ( like the broken ends of a stretched and broken rubber band).



- 3) **Plate tectonics**: The lithosphere is broken into large pieces called lithospheric plates which are constantly moving in relation to one another. There is a force (stress) acting on the rocks at the boundaries of these plates. When two such plates move past one another they are slowed due to friction at the boundaries this leads to deformation (strain). When the stress exceeds the strength of the rocks, the rocks rupture giving rise to a fracture called fault. This sudden rupture of rocks along the fault releases the pent up energy in the form of seismic waves that shake the ground.

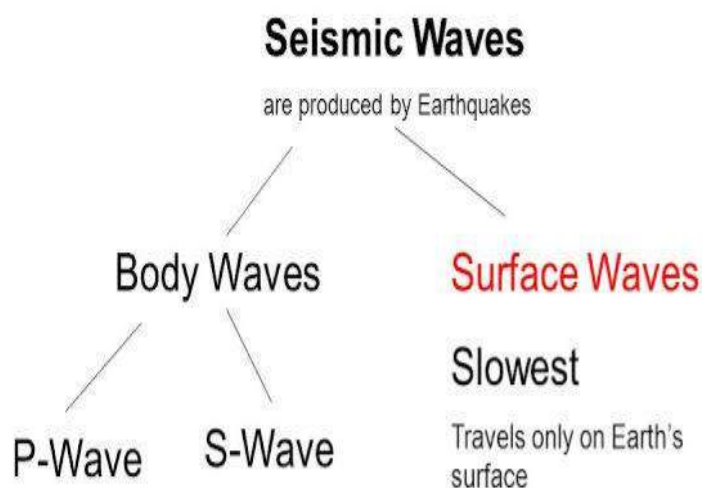
A lithospheric plate may include an ocean region or a continent alone or both a continent and part of an ocean. There are 6 major and 20 minor plates. The processes associated with the creation, movement, destruction of these lithospheric plates are called plate tectonics.

- 4) **Anthropogenic/ human activities**: Some human activities also cause earth tremor. These include deep underground mining, blasting of rocks, pumping ground water or oil, construction of dams and reservoirs and underground nuclear explosions.

### **6.5.3. Earthquake or seismic waves**

The energy released in an earthquake due to rupture of rocks travels as waves through earth. These waves called seismic waves which are of two types.

- 1) Body waves      2) Surface waves



- 1) **Body waves**: These waves travel within the earth. They are of two types:

- a. **Primary or P-waves:** These are called longitudinal or compressional waves. They can travel through solid, liquid or gaseous materials. The particles subjected to these waves travel in the direction of the wave. They are the fastest moving waves and are recorded first on a seismograph.
- b. **Secondary or S-Waves:** These are slower than P-waves and travel through solids only. They produce an up and down motion at right angles to the direction of wave propagation.
- 1. **Long or L waves or surface waves:** These waves are the slowest of the three and travel along the surface of earth. These waves cause much of the damage to buildings and structures. They have horizontal ground movements or rolling motion.

#### 6.5.4. Hazardous effects of earthquakes:

Some of the hazardous effects of earthquakes are as follows:

- Damage and destruction of human structures such as buildings, roads, dams, factories, human settlements etc.
- Earthquakes sometimes cause landslides.
- Damages to wildlife, forests, drainage system are also caused by earthquakes.
- Strong seismic waves can lead to fires and flash floods, disruption of electricity, road blocks, damage to vegetation etc.
- Seismic waves travelling through oceanic crusts can cause Tsunamis that damage life and property in coastal areas.

#### 6.5.5. Mitigation measures:

Earthquakes are difficult to predicate but certain measures can be taken to reduce the damage and casualties.

- The strength of the buildings needs to be improved to withstand the earthquakes.
- Buildings having structural deficiencies need to be replaced with seismicity resistant buildings.
- Construction of new facilities for rehabilitation.
- Provision of food, water, medical facilities etc have to be made.

A Tsunami is a series of waves in a water body caused by the displacement of a large volume of water, generally in an ocean or a large lake. Earthquakes, volcanic eruptions and other underwater explosions above or below water all have a potential to generate tsunami.

## 6.4.. FLOODS

The hydrological cycle involves the transport of water by evaporation from earth's surface (mostly the oceans) to the atmosphere and by way of surface and sub-surface runoff from land and back again to the oceans. The streams and rivers form a part of this hydrological cycle. When rain falls on earth some of it that falls on land infiltrates into soils and rocks; some evaporates and rest moves over the land (runoff). This runoff finds its way to streams that join to form larger streams or rivers. The area that drains its water (rainfall, snowmelt, groundwater) into a stream, river or river system is called its drainage basin or watershed. In the seasons of heavy rainfall, when there is abundant surface runoff and high water table, the supply of water is more than what the river channel can accommodate (more than the capacity of the river). The river water thus overflows the natural banks of the river and inundates the area adjacent to the river channel (flood plain). This condition is called the flood. Flood simply means inundation of large land area with water for several days in continuation.

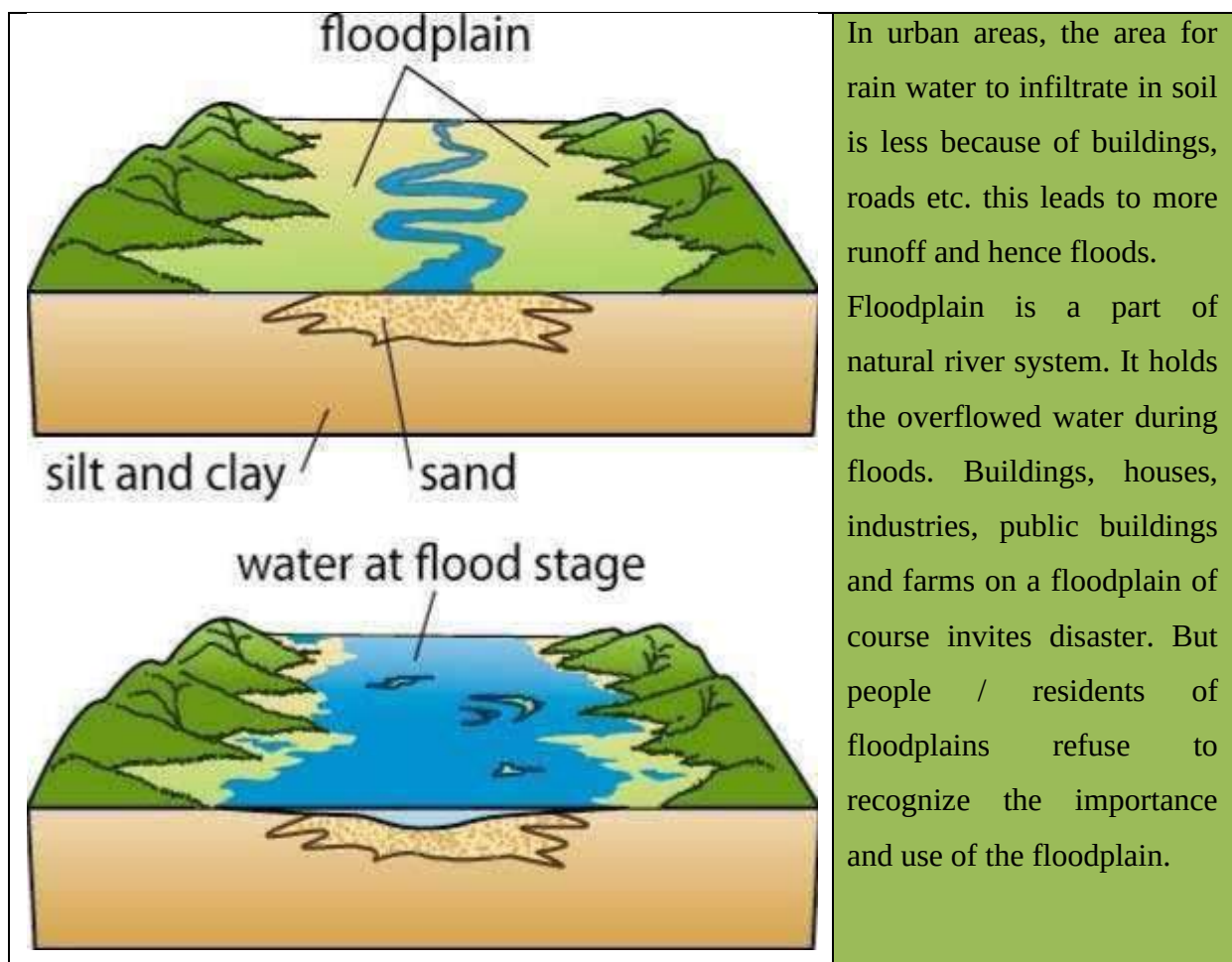


**Fig. 6.11. River and flood plain**

### 6.4.1.CAUSES OF FLOODS

The main causes of the flood are as follows:

- 1) **Deforestation**: large scale deforestation particularly in the watershed area causes flooding.
- 2) **Prolonged rainfall**: heavy rainfall for long periods is the root cause of floods.
- 3) **Human /anthropogenic activities**: Activities like urbanization, changing river's course, building activities, agricultural practices and land use changes lead to floods.
- 4) **Blocking of free flow of the river**: The natural flow of the river is blocked by landslides and other natural factors and human activities because of enormous debris. This leads to flash floods.

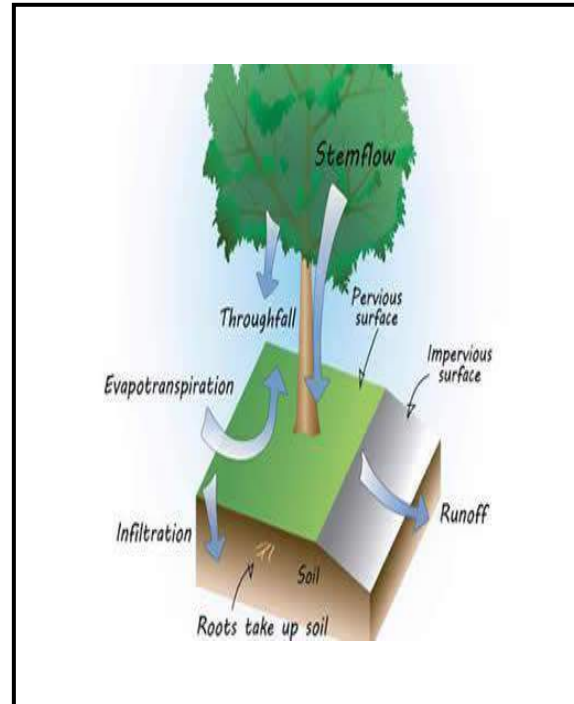
| <b><u>Flash floods:</u></b>                                                                                                                                                                                                                                                                                                                              | <b><u>Floods in Kashmir</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Flash flood is a rapid flooding of low lying areas like rivers, dry lakes and depressions. It may be caused by heavy rain associated with severe thunderstorms, hurricanes, tropical storm or melt water from ice or snow. Flash floods differ from regular floods in having a time scale of fever than six hours between rainfall and onset of flooding | In Sep. 2014, the Kashmir region suffered disastrous floods across many of its districts caused by torrential rains. On 5 <sup>th</sup> September 2014, the Jehlum river in Srinagar was reported to be flowing at 22.40 feet which was 4.40 feet above the danger mark. On 8 <sup>th</sup> September in many places of Srinagar neighborhood the water about 12 feet (3.7m) deep submerging entire houses. The discharge rate in the river was recorded as 70,000 cusecs against normal discharge of 25,000 cusecs. The areas affected by floods were mostly districts of south Kashmir and many areas of district Srinagar. Total deaths were 557 (227 in India and 280 in Pakistan). 2550 villages affected and 80,000 people evacuated across India Pakistan. |



fig.6.12 flood in kashmir ( 2014). photo: courtesy, India today

### 6.6.3. EFFECTS OF FLOODS:

- 1) Floods damage buildings and houses, railroads, bridges and communication systems.
- 2) Flood waters that remain in areas for longer periods can lead to increase in mosquito populations leading to diseases like malaria and dengue. People are exposed to epidemics.
- 3) Floods lead to biodiversity loss as many plants and animals die during the floods and also because habitats of many organisms are lost.
- 4) Floods can damage the agricultural lands and can result in dispersal of weed species.
- 5) Floods also lead to soil erosion.
- 6) Pollution of rivers is also an effect of flooding.



### 6.6.4. Control Measures/ Prevention Of Floods

The floods can be prevented to a large extent by taking some measures like:

- 1) Construction of physical barriers like levees or flood walls can prevent the river water from overflowing the banks (Levee is a low wall, made of land or other material, build at the side of a river to prevent it from flooding)
- 2) Construction of reservoirs to store water
- 3) Afforestation as Forests play a major role in preventing controlling floods . Tree stores water in its tree roots So, forests allow the water to go into the soil . Forests also act as natural absorber of water. They also prevent the extreme water run - off and hence prevents landslides and topsoil erosion
- 4) Channelization of streams that involve deepening, widening, clearing existing channels.
- 5) Minimizing the encroachment in floodplain.

### 6.5.3. VOLCANIC ERUPTIONS

Below the surface of the earth, as the depth increases, the temperature also increases and this causes the interiors of the earth to be in a semi-molten state. This semi-molten state comprising the solid, liquid and gaseous material in the mantle is known as magma. The eruption of this magma and its surface flow leads to the formation of cone shaped structure called volcano. A pressure builds up in the earth's crust which results in disturbance and magma being lighter than the surrounding rock moves upwards towards the surface and erupts. Magma that emerges on the surface of the earth is known as lava. As volcano continues to erupt, a new layer of lava is added to the surface accumulating to form a mountain. When lava cools, igneous rocks are formed. The depressions found at the top of volcanoes by explosion may be flat or funnel shaped, these are called craters. Sometimes much bigger depressions are formed on the top of volcanic cones, these are called caldera. The openings through which volcanic materials are erupted at the surface of earth are called vents. Vents are connected to the interior of earth by the narrow pipe called volcanic pipe.

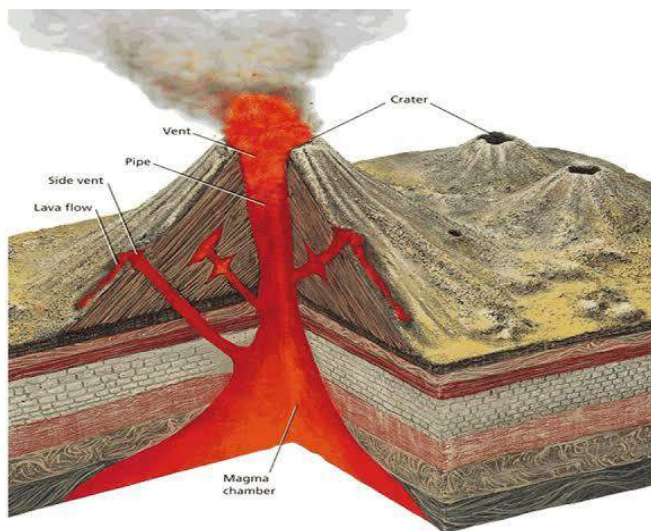


**Fig.6.13.different openings through which volcanic materials are erupted**

#### Five deadliest volcanoes of the world.

1. Mount Tambora, Indonesia
2. Mt. Krakatoa, Indonesia
3. Mt. Pelee, Caribbean Island.
4. Mt. Ruiz, Columbia, S. America
5. Mt. Vesuvius, Italy

All these volcanoes have killed thousands of people.

### 6.5.4. Causes Of Volcanic Eruption

Volcanic eruptions are closely related to plate tectonics and hot spot activity, as world's active volcanoes are formed at the plate boundaries. The friction during the movements of plates causes volcanic eruptions as magma finds way to reach the surface.

About 15% of the world's active volcanoes are found along the mid ocean ridges, where two plates move in opposite directions, whereas 80% volcanoes are present at boundaries where the plates collide while some volcanoes are found in intra plate regions.

#### 6.5.5.Types Of Volcanoes

- 1) **Shield volcanoes**: These are the largest volcanoes characterized by non-explosive eruptions due to low silica content (about 50%) of the magma. Those are arch or shield shaped. The common rock formed by magma is basalt. Example: Hawaiian Island.
- 2) **Composite volcanoes**: These are cone shaped. Magma has about 60% silica content. The common rocks formed are andesite. They are characterized by a mixture of explosive activity or lava flows. They are known to cause death and destructions. e.g. Mount St. Helens, Washington
- 3) **Volcanic Domes**: These are characterized by magma having high silica content (about 70%). The common rock type formed is rhyolite. These are mostly explosive and hence dangerous.
- 4) **Cinder cones**: These are circular or oval cones made up of small fragments of lava from single vent that have blown into air, cooled and fallen around the vent.
- 5) **Lava domes**: These are formed when erupting lava is too thick to flow and makes an overturned bowl mound as the lava piles up near the vent.

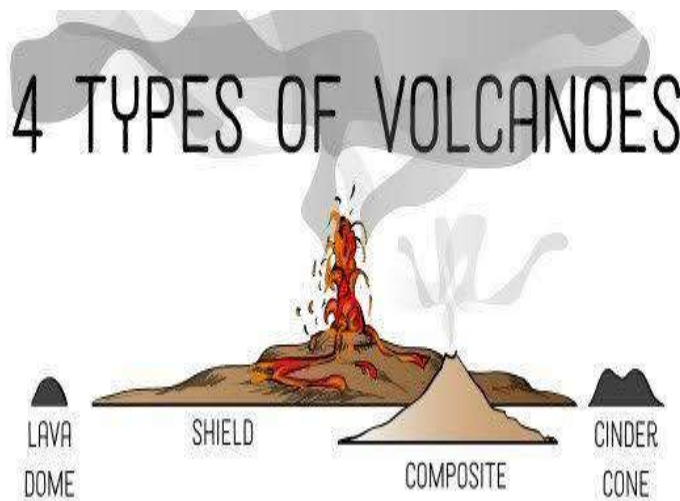


**Fig.6.13. Types of volcanoes**

#### **The ring of fire**

Ring of fire or circumpacific belt is a major area in the basin of pacific ocean where many earthquakes and volcanic eruptions occur. It is a large 40,000 Km horse shoe shaped area. it has 452 volcanoes which include more than 75% of world's active and dormant volcanoes

### 6.5.6.Types Of Volcanoes On The Basis Of Periodicity Of Eruption:

1. **Extinct Volcanoes**: These volcanoes are those which do not show any indication of eruption and have not erupted for longer periods e.g.. Mt. Kilimanjaro.
2. **Active volcanoes**: These volcanoes are those which constantly erupt. E.g. Mt. Etna and Mt. Stromboli.
3. **Dormant Volcanoes**: These volcanoes are those which become quite after their eruption for some time but suddenly they erupt very violently and cause enormous damage. E.g. Mt. Vesuvius.

Extinction of dinosaurs about 6000 million years has been related to increased worldwide volcanic activity.

### 6.5.7. Effects of volcanic eruptions

The volcanic eruptions may have the following effects:

- 1) Volcanic eruptions cause damage to human lives and properties such as buildings, factories, rails, roads, dams etc.
- 2) Huge amounts of hot and molten lava damage natural ecosystems such as forests, grasslands, lakes, pastures and kill animals and destroy wildlife.
- 3) Poisonous gases emitted create health hazards and cause acid rains.
- 4) Earthquakes associated with volcanic eruptions cause Tsunami waves.
- 5) The volcanic dust and ashes reduce the amount of solar radiations reaching the earth.
- 6) These eruptions cause mass extinction of species.

**Hot springs**: sometimes the hot molten rock comes in contact with ground water. This heated ground water discharges at the surface as hot spring or thermal spring.

**Geysers**: Rarely, because of certain heating and circulation pattern of the hot water, along with hot water some steam is also released at the surface. This phenomenon is called a geyser.

### 6.5.8.Mitigation measures:

To reduce the harmful effects of volcanic eruptions following measures can be taken:

1. Replacement of buildings that are located near high hazards zones.
2. Developing evacuation plans.
3. Providing safe rehabilitation place.
4. Awareness among local population

## Evaluation

### A) Long answer type

Q.NO.1.Explain the structure of atmosphere with the help of a neat diagram.

Q.NO.2. Describe the four layers of atmosphere.

Q.NO.3. What is hydrosphere? Give its distribution on Earth?

Q.NO.4.Discuss all the steps in nitrogen cycle.

Q.NO.5. What is an earthquake? Discuss various causes of earthquakes.

### B) Short answer type

Q.NO.1.What is lithosphere? Explain briefly its types.

Q.NO.2 .What are seismic waves? Explain its types.

Q.NO.3.How is oceanic lithosphere different from continental lithosphere.

Q.NO.4. Outline the salient features of carbon cycling in nature

Q.NO.5.When does an earthquake cause Tsunami?

Q.NO.6. Explain the types of volcanoes.

### C) Very short answer type

Q.NO.1. Define atmosphere.

Q.NO.2.What is seismograph?

Q.NO.3.What are floods?

Q.NO.4. What is a volcano?

### d) Multiple choice/objective

1. Which of the gases is responsible for primarily heating up of the atmosphere?

a) CO<sub>2</sub>

b) Oxygen

c) Nitrogen

d) None of the above

2. Which of the following options correctly describes the altitude of stratosphere?

a) 5 km to 30 km

b) 50 km to 90 km

c) 18 km to 50 km

d) 0 km to 50 km

3. Out of the total freshwater on earth, the minimum percentage of it is found as:

a) Surface water

b) Glaciers

c) Ground water

d) None of these

3. The lithosphere is made up of:

a. The upper most mantle and crust

- b. The crust and asthenosphere
  - c. The crust and core
  - d. None of the above
5. Which earthquake wave is more destructive?
- 1. P- wave
  - 2. S-wave
  - 3. Surface wave
  - 4. None of these
  - 5.

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For more information on this unit the students can consult:

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## Unit 7 - Environment Education Awareness

### ❖ Learning outcomes

- to acquaint the student with knowledge, values, attitude, commitment and skill to protect and improve the environment.
- Understand the significance of the non-violent environmental movements
- To acquaint the students about the origin of the Chipko Movement and the Gandhian mode of resistance against forest resource exploitation
- To develop understanding of the beginning of the 'eco-feminism' in India.
- To have the knowledge about the post independent era's planning and development through large dams
- Develop the understanding of different impact of large dams on the livelihoods of the local population and the objectives of a non-violent struggle against large dam constructions

### 7.0. Introduction

Our mounting concern with the environment is not just for ourselves, but for the entire mankind now existing and the generations to follow. This agreed that children are nation's greatest resource and that the future of civilization depends on them. There has been sudden increase in the activities for Environmental Education (E.E.) during the last two decades. This has resulted in the development of different kinds of curricula, out of school activities and literature.

The purpose is to regenerate man's interest in preservation, conservation and improvement of the environment before it is too late and reaches the point of no return. E.E. has been perceived differently by various educationalist and thinkers. They differ in its objectives, the kinds of activities that are used to achieve the objectives and resources to attain these ends. It is the vastness and variety of the area of E.E. that necessitates to take a holistic view of the various aspects of E.E.. This will help us to see its strength and weakness and draw conclusions for the future. The purpose is to make a review of the situation in this context and examine different roles played by E.E. at school level and see how these are achieved.

## 7.1. Definition

Environmental education has been defined and redefined over the last twenty five years. Definitional issues are inherent in a field this broad and encompassing. It is generally agreed that environmental education is a process that creates awareness and understanding of the relationship between humans and their many environments - natural, man-made, cultural and technology. Environmental education is concerned with knowledge, values, attitudes, application and has as its aim responsible environmental behavior (NEEAC,1996)\*.



Environmental education (EE) teaches children and adults how to learn about and investigate their environment, and to make intelligent, informed decisions about how they can take care of it.

Environmental education does not advocate a particular viewpoint or course of action. Rather, environmental education teaches individuals how to weigh various sides of an issue through critical thinking and it enhances their own problem-solving and decision-making skills. (U.S. EPA)

### 7.1.1. Components of Environmental Education

The Environmental Protection Agency defines the components of environmental education as follows:

- Awareness and sensitivity to the environment and environmental challenges
- Knowledge and understanding of the environment and environmental challenges
- Attitudes of concern for the environment and motivation to improve or maintain environmental quality
- Skills to identify and help resolve environmental challenges
- Participation in activities that lead to the resolution of environmental challenges

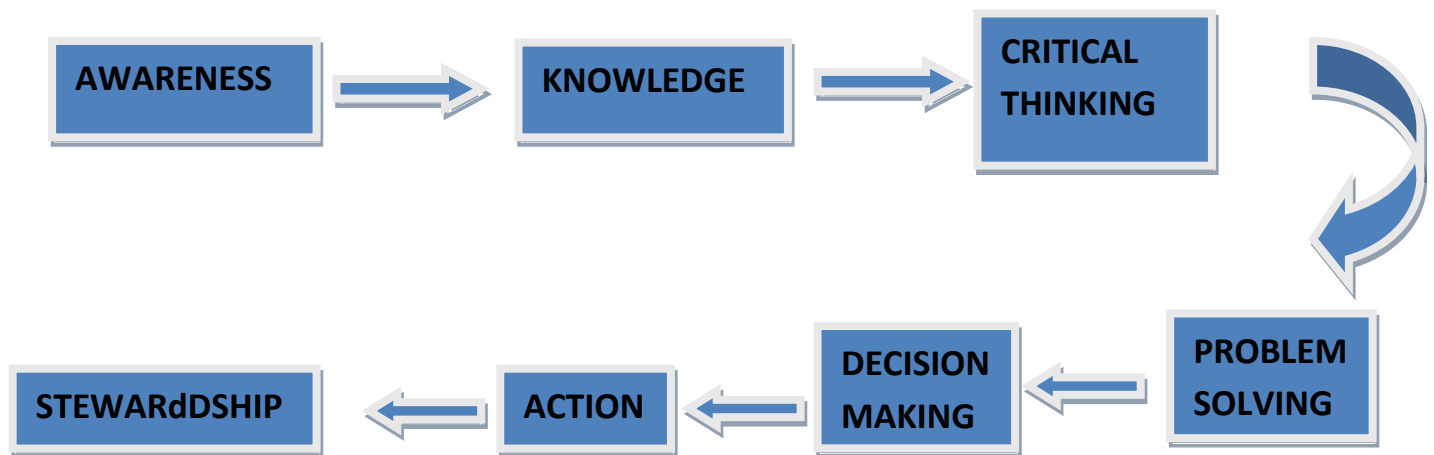


**Fig.1. The Southeast Environmental Education Alliance places the components of environmental education into a continuum representing the learning process**

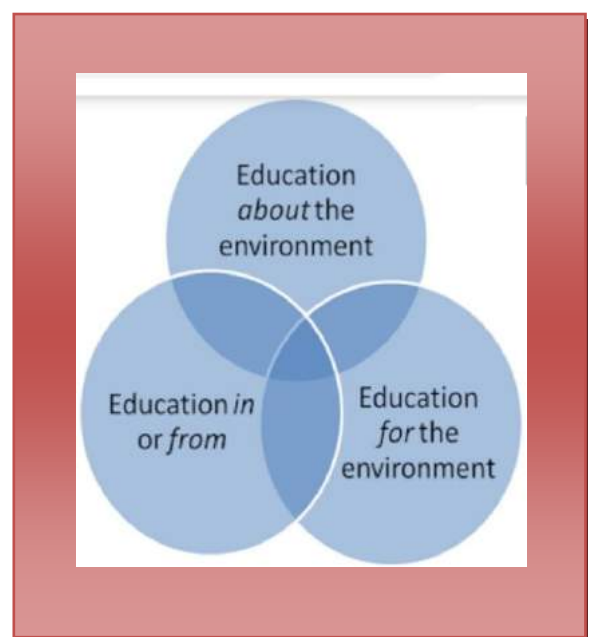
## 7.2 .Concept of Environmental Education

Defining 'environmental education' is not an easy task. Unlike other curriculum areas, the specific content of E.E. has never been well defined. It is universally agreed, however, that environmental education should be interdisciplinary, drawing from biological, sociological, anthropological, economic, political and human resources. It is also agreed that a conceptual approach to teaching E.E. is best. The majority also agrees that E.E. is the process of recognizing values and clarifying concept related with environment and its problems in order to develop skills and attitudes necessary to understand surroundings. It also entails practices in decision making and self formulating a code of behavior about issues concerning environmental quality. The most relevant opinion is that

E.E. can be treated as 'discipline' which heavily banks upon basics of existing subjects such as Physics Chemistry, Mathematics, Zoology and Botany. This opinion supports the training of specialists in E.E. which will be much needed for planning, management, development and taking remedial steps for existing problems.

The concept of environmental education can be classified as:

- i) Education for the environment
- ii) Education about the environment and
- iii) Education through the environment.



### **7.2.1. Education for the environment**

Environmental education is a pragmatic response of the defacement of the environment. Environmental education is a kind of education which will seek to make pupils fully aware of the problems connected with their environment so that they will be able to tackle these problems with a sense of responsibility and with the technical skills which will enable them to contribute to their solutions along with other members of their community.

### **7. 2.2.Education about the environment**

Environmental Education includes conservation, outdoor and natural resource education, as well as nature study. It also includes everything that relates to man and his environment. E.E. is the study of man and how he shapes his natural and cultural surroundings for good or ill. Man cannot be separated from the earth's ecosystem for he 'is the only conscious manipulator of the environment and his manipulation must be directed towards enhancing the quality of the environment.

### **7.2.3. Education through the Environment**

Environmental education is not a separate subject. It is a multi-disciplinary approach both to education and to the problem of environment. The multidisciplinary approach integrates environmental education into all learning, in all subject in all grades all year long and beyond the formal school years to a lifelong education. Environmental education should result in the knowledge, desires and ability necessary to direct one's conduct to it and improving the quality of life. It should enable the individual to perceive the problems that exist and to devise solutions to them. In order for students to develop an environmental ethic; "Man is a part of this earth rather than careless exploiter of it. If we exploit the nature in unwise manner, it will be difficult to support even a small population. But if we protect the nature, it will continue to meet the needs of all living things and not only for man. The consideration of environment as natural heritage may be the integral part of environmental education. Only when our life is guided by respect for the earth and all living things, we will be able to live in harmony with our environment. Their energies will have shifted from material growth to environmental protection. In short, the environmental ethic must provide them with a new rationale for their existence, or all the technology and power will not sustain their existence.

### **7.3. The Evolution of Environmental Education- global perspectives**

The concept of Environmental education (EE) was first formalized by the International Union for the Conservation of Nature (IUCN), in 1970 at a meeting in Nevada, USA, as a process of recognizing values and classifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness

among man, his culture and his biophysical surroundings. Environmental Education also entails practice in decision-making and self-formulating of a code of behavior about the issues concerning environmental quality (IUCN, 1970). Subsequently, Environmental Education was recognized and its development was recommended by the World Community as a measure for the understanding, protection and improvement of the environment and its quality (United Nations, 1972; UNESCO-UNEP, 1976).

The Belgrade Charter was developed in 1975 at the United Nations Educational, Scientific, and Cultural Organization Conference in Yugoslavia, and it provides a widely accepted goal statement for environmental education: The goal of environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively towards obtaining solutions for current problems and the prevention from forthcoming ones.

Following Belgrade, the world's first Intergovernmental Conference on Environmental Education was held in Tbilisi, Georgia. The representatives at the Tbilisi Conference adopted the Tbilisi Declaration, which challenged environmental education to create awareness and values amongst humankind in order to improve the qualities of life and the environment. A major outcome of Tbilisi, gave detailed description on the objectives of environmental education *viz*:

- **Awareness**—to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems.
- **Knowledge**—to help social groups and individuals gain a variety of experience in, and to acquire a basic understanding of, the environment and its associated problems
- **Attitudes**—to help social groups and individuals acquire a set of values and feelings of concern for the environment and the motivation for actively participating in environmental improvement and protection.



- **Skills**-to help social groups and individuals acquire the skills for identifying and solving environmental problems.
- **Participation**-to provide social groups and individuals with an opportunity to actively involve at all levels in working toward resolution of environmental problems.

After Tbilisi Declaration the 4<sup>th</sup> International Conference on Environmental Education was held at Centre for Environment Education, Ahmadabad from November 24<sup>th</sup> to November 28<sup>th</sup>, 2007. The five day Conference was attended by over 1500 participants from 97 countries. The Conference was hosted by the Centre for Environment Education on behalf of the Government of India. The aim of this Conference was to understand what has emerged out of the discipline of Environment Education (EE) since Tbilisi declaration and the role of EE within Education for Sustainable Development (ESD). The conference provided an opportunity to consider how EE and ESD can partner and strengthen each other towards building a sustainable future.

The outcomes of Tbilisi, Belgrade and Ahmadabad conferences have, in many ways, provided the basis for many environmental education programs. Certainly, having both a commonly accepted goal statement and associated set of objectives has allowed many educators to better address the desired outcomes through the programs. Equal to the need to identify both a common goal and set of objectives, requires consideration of the characteristics of environmental education.

### **7.3.1. Environmental Education-An Indian perspective**

The Honourable Supreme Court of India in 1991 made environment education compulsory at all levels of education. A curriculum framework prepared by the NCERT has been accepted by the Court as the guideline for State Education Departments to develop textbooks for schools from 2004-2005 onward. The State's responsibility with regard to environmental protection has been laid down under Article 48-A of our Constitution, which reads as follows: "The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country". Environmental protection is a fundamental duty of every citizen of this country under Article 51-A (g) of our Constitution which reads as follows: "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures."

Article 21 of the Constitution is a fundamental right which reads as follows: "No person shall be deprived of his life or personal liberty except according to procedure established by law." The State's responsibility with regard to raising the level of nutrition and the standard of living and to improve public health has been laid down under Article 47 of the Constitution.

The National Policy on Education 1986 (renewed in 1992) stated: There is a paramount need to create a consciousness of the environment. It must permeate all ages and all sections of society, beginning with the child.

The National Curriculum Framework 2005 envisages that Environmental Education to be imparted in an infusion model in the Upper Primary and Secondary stages of school education with an aim to bring about sensitivity towards the environment. The basis of Environmental Education as discussed in NCF-2005, emphasizes that EE with its holistic approach will form the new paradigm and replace sectoral thinking by multidisciplinary thinking. Further it states that the very nature of EE will help in building capacity for critical thinking and problem solving instead of rote memorization.

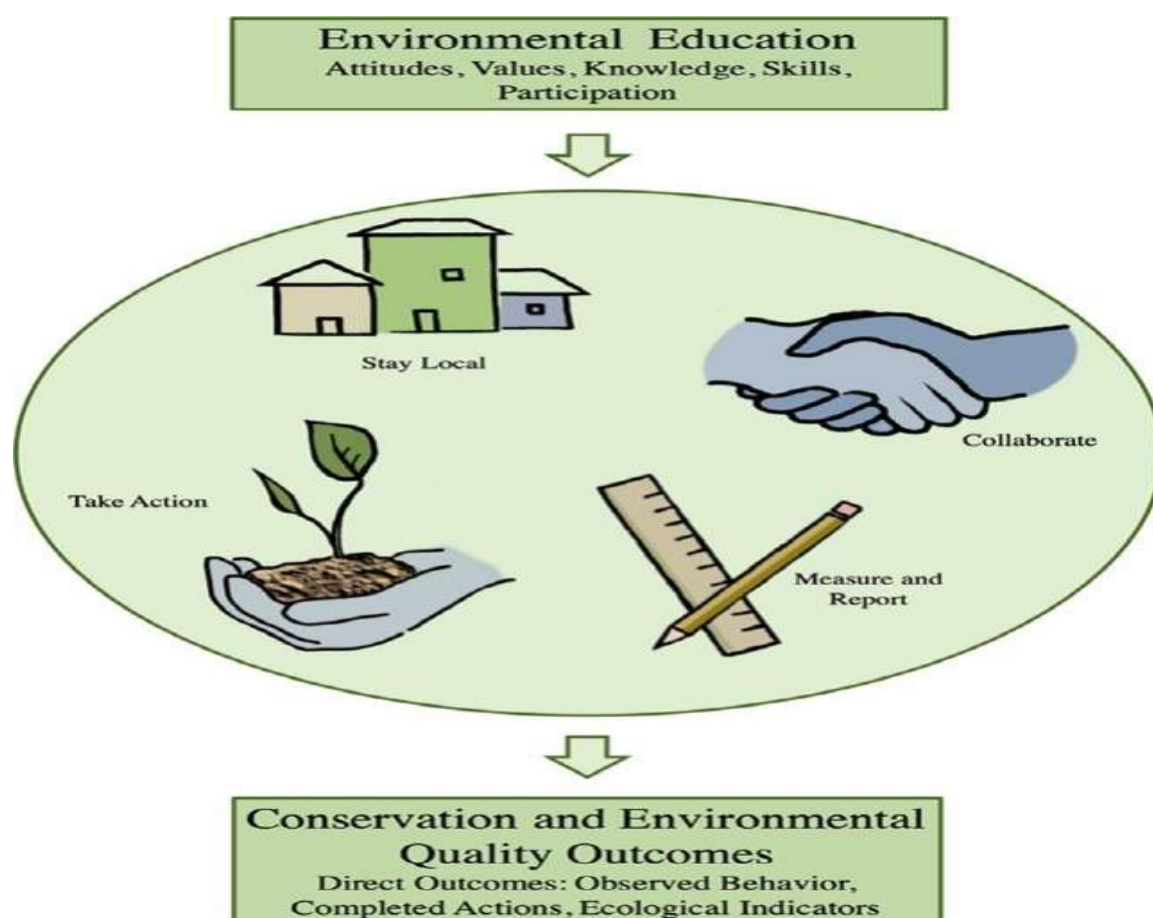


**Fig.7.2.outcomes of environmental education**

#### 7.4. Need for Environmental Education

Education forms the basis of everything in today's world including environment. Environmental education imparts knowledge about the current situation and future prospects of nature. It teaches people to explore all the problems related to environment and engage in wise ways of preserving it. Besides this it fosters a sense of connection to the natural world, promotes sustainable development and encourages conservation of irreplaceable natural resources and vulnerable plant and animal species.

The rationale for environmental education can be summarized as the following

- A major goal of environmental education in India as entrenched in National Policy on Education is the provision of the expertise that can utilize scientific knowledge towards the preservation and solution of environmental problems. Knowledge about the changes that have altered the environment - land, water, weather, and vegetation; social, cultural and political environment are essential components of environmental education. Consequently, the general public should be equipped with all these to be able to solve the problems of the environment.
- India's socio-economic development (like any other less developed country) is firmly rooted on the exploitation of the natural resources in our environment. Land, water, forest and other mineral resources utilization is the dominant feature of rural economy with agriculture the driving force. Uncontrolled and improper exploitation of these resources have implications on the environment causing disruption in the living standard, starvation, displacement and human suffering. Environmental Education is therefore necessary to create awareness of the causes and effects of these problems viz: food and water scarcity, pollution, outbreak of epidemics and natural disaster such as flood, erosion and desert encroachment.
- Environmental education is needed to foster international co-operation and understanding. The developed countries rely on the high technology for the exploitation of natural resources while developing countries like India totally depend on agriculture, forestry and the mineral resources thereby leading to intensive and over-exploitation of the natural resources and these have serious implications on the resources.
- Public enlightenment on the impact of government policies on local environment should be useful both to the government and the local people.
- Awareness of such global environmental issues is an essential component of environmental education which ordinary citizen should be aware of.

- Environmental education for the over-all social and economic emancipation of women and children. These form a substantial percentage in the utilization of natural resources especially at the rural setting.
- Environmental education is very essential for the lack of it. Environmental Education is virtually a new thing in this part of the world.
- Environment education is also very essential for our survival on earth. The natural resources and cultural heritage need to be protected not only for this generation but for future generation.

#### **7.4.1. Guiding principles**

The guiding principles jotted down and endorsed at Tbilisi Conference ( 1977) are as follows;

- Consider the environment in its totality, natural and built technological and social structures (economic, political, technological, cultural, historical, moral and aesthetic).
- Environmental education to be a continuous life saving process (beginning at the pre-school level continuing through all formal and non-formal stages).
- Environmental education to be interdisciplinary in its approach.
- Examine major environmental issues from local, national and international point of view.
- Environmental education to focus on current and potential environmental situations.
- Promote the values and necessity of local, national and international cooperation in the prevention and solution to environmental problems.
- Explicitly consider environmental aspects of plan for development and growth.
- Enhance the position of learners in making decision concerning their environment and accept responsibility.
- Enable learners to discover symptoms and real and potential causes of environmental problems.
- Enhance the learners' ability to develop critical thinking and problem solving skills.
- Utilize different learning environment and approaches to learning/teaching about and form of the environment with emphasis on first hand information

In the context of the above guiding principles, environmental education is an educational process which is imparted to different individuals and groups in schools, homes, farms etc. It imparts environmental concern, sensitivity, awareness, knowledge, understanding, skills,

attitude, commitments and civic actions necessary for protection and improvement of environment and prevention and solution to its associated problems. The mission of environmental education seems to be to foster environmental literacy among masses. It enables the citizens to make sound judgments' and decisions and to have ethical responsibility about environment and its allied problems. It advocated the problem solving approach of citizens as a skill which could help them in solving current and future environmental issues. Hence environmental education is a process that helps the individuals to explore environmental issues, master in problem solving and actively participate to improve the environment. As a result, individuals develop a deep understanding of different environmental issues and have the skills to make responsible decisions.

### 7.5. MEANS OF ENVIRONMENTAL EDUCATION

Education forms the basis for everything in today's world and environmental education needs to be one of the pillars of modern education systems. It imparts knowledge about the current environmental condition and future perspective of nature. It teaches the people to understand and explore all the problems related to environment and to get involved in wise and sustainable ways of preserving it. It creates awareness and understanding about environmental issues which leads to responsible individual and collective actions. A successful environmental education programme focuses on processes that promote critical thinking, problem solving and effective decision making skills. Recent developments from union ministry of human resource development on deteriorating environmental conditions has led to the initiation of several means of imparting environmental education to the citizens. The two basic means of organizing environmental education are as follows:



**Fig.7.3.Means of environmental education**

### **7.5.1. Formal Education:-**

It refers to the hierarchically structured and chronically graded learning organized and provided by the formal school system and for which certification is required in order for the learner to progress through the grades or move to higher levels. Formal education is given in schools, colleges and universities in a limited and specific time period having a well defined and systematic curriculum. Formal environmental education should begin at the primary level up to post graduate level.

#### **Characteristics of formal education**

- It has an end goal. Each education institution has its own purpose. Education is received through direct instructions, tuition and schooling
- There should be a well defined curriculum set which should be specific to their class and age. The content of the curriculum is presented in an understandable manner and made easily accessible to the young minds of students in order to build up effective environmental awareness in the child. Presently, NCERT has designed a curriculum framework based on several good books, charts and other effective teaching material. Besides UGC also has the main responsibility to look for the environmental education at university level.
- In this type of education, teacher needs to be specially qualified and to give effective instructions.
- Formal education institutions instill strict discipline on the students. Both the teacher and the student realize that they are engaged in the education process and both know their duties.
- It has a time frame and strict regulations. This means that the educational institutions have limited time to teach the students a set amount of things. It cannot be changed or prolonged.

For the development of environmental education and its incorporation into different education processes, there is a need of its authorization and responsibility of the education institutions to respond actively. Without these two aspects, environmental education will stay away as a peripheral subject and may never be established as a core content of the curriculum for students and teachers. Environmental education needs to be incorporated as core or main stream subjects in different institutions. There is a need to prepare a well defined and

comprehensive curriculum for all age groups designed by the experts to be taught in all these institutions. For curriculum preparation, help must be sought from curriculum experts, experienced teachers, environmentalists and representative of local communities and curriculum needs to be regularly upgraded and modified from time to time. The services of the expert committee should be employed for designing environmental education objectives for different education programmes and to examine the curriculum of the schools and identify the key concepts of environmental education already covered under syllabus and the remaining portions to be included in the curriculum. Moreover, identifying

Imparting formal environmental education to different age level students within educational institutes could be achieved through following stages;

- **Primary School Stage**

Vital role is being played by NCERT in school education in terms of environmental education by designing the curriculum, text books, guide books, charts, maps, kits, help books and teaching aids for both teachers as well as students. At this level, the students should be emphasized to develop general environmental awareness, understanding of real life situations and least thrust on environmental conservation. The main target should be to sensitize the student community about environment. Students should be made to understand their environment of their schools and at their homes using audio visual aids and conducting field trips in natural ecosystems.

- **Secondary and Higher Secondary Stage**

From the secondary stage of the school, environmental education should involve increased knowledge of real life situations followed by conservation and sustainable development rather than general awareness. At this stage the priority will be given to real life experiences and problem identification in the surroundings and the content to be followed would be supplemented with practical teaching, general science and regular field visits. At higher secondary level, environmental education should emphasize on assimilation of knowledge, problem identification, conservation and action skills supplemented by science based and action oriented content. There need to be effective teaching, well defined practical work and field surveys for efficient results.

- **College Level**

Higher education plays an important role in designing curriculum and other requirements for imparting environmental education with emphasis on knowledge regarding sustainable development based on experience. This would be followed by conservation, understanding

real life situations and environmental awareness. The content needed must be of college or university level supplemented with science and technology, teaching, action oriented practical work and knowledge of the natural ecosystems by means of field work.

- **University Level**

For imparting environmental education at university level, UGC plays a vital role in framing the curriculum and providing infrastructure and other required economic assistance by getting recommendations from a high power committee. There are tens of university level courses being taught in environmental science and parallel courses being offered in environmental engineering by various engineering colleges and research institutes at post graduate level. At postgraduate level the various recognised areas for environmental education are environmental engineering, Resource conservation and management, Environmental health and social ecology. Besides, research programmes are being offered by hundreds of universities regarding a wide range of environmental issues whereby the students undertake the research under extreme guidance of experts from different fields and the outcome of such research is extremely helpful in resolving various issues of the present day environment.

### **7.5.2.Non-Formal Education**

As majority of the population still does not have an adequate access to formal education, the goal of environmental education could be achieved by processes and programmes that fall outside the formal education system. Environmental education needs to be a lifelong affair rather than a matter of formal schooling that is limited and for a specific time period. This has given rise to an increased realization to non formal education that fall outside the framework of established formal education system

Learning resulting from daily activities related to work, family or leisure is non formal education. It is not organized or structured in terms of objectives, time or learning support. The various methods involved in non formal environmental education are extra-curricular activities like, essay writing competitions, seminars, exhibitions, eco development camps, club activities, audio visuals, presentation of ideas through posters, plantation drives etc. Non-formal environmental educational activities exist alongside the formal educational systems, at curricular and extra curricular levels, in occupational training, and through wide public awareness activities through non-formal channels such as mass media, and voluntary organizations. Different communities, institutions and individuals choose methods and practices that best suit their local needs and capacities. similarly, government agencies as

well as NGOs have developed a wide array of outdoor activities which expose people to different aspects of environmental awareness, action and understanding.

- **Learning by Doing**

It refers to the theory of education expounded by American philosopher John dewy. It is hands- on approach to learning, meaning student must interact with their environment in order to adapt and learn.It is that type of approach in which learning takes place by the student carrying out physical activities, rather than listening to a lecture or watching demonstrations.

In Sri Lanka, a WWF-supported innovative environmental education programme involving over 750 schools has been implementing an approach called ‘**greening of learning**’. In this, students are encouraged to beautify the school garden, start a plant nursery or engage in other ‘green’ activities within the school premises. Due to its success the WWF has started introducing the same concepts and approaches in other countries.

Similarly, Development Alternatives (DA) located in India, has launched the **Community Led Environmental Action Network (CLEAN)** which promotes among school children and communities activities based on the “four r” concept: refuse, reduce, recycle and reuse (DA 1998). In several countries, government agencies or NGOs support nature clubs or environmental societies in schools as a means of encouraging and inspiring students to undertake non-formal environmental activities.

- **Outdoor Activities**

Government agencies as well as NGOs have developed a wide array of outdoor activities that expose youth and adults to different aspects of environmental awareness, action and understanding For example in Nepal, Environmental Camps for Conservation Awareness (ECCA), a local NGO, has been active for over a decade in organising outdoor environmental activities aimed at children, both able and disabled. These camps are held at places of environmental significance and aim to raise awareness about conservation issues, and to potential careers in conservation. Similar environmental camps have become a regular feature in many countries. For example, in Malaysia, environmental awareness camps are regularly organized by the Department of Environment. In Singapore, the Ministry of Environment allocates small portions of the beach to volunteering schools under an ‘Adopt a Beach’ programme. Students are then responsible for keeping that stretch of the beach clean, and in that process learn aspects of the coastal and marine environment.

- **Innovative Approaches**

New strategies and innovations for environmental education have been developed and applied through out the region. For example, in Singapore, the Ministry of Environment in 1996 published the ‘Fun and Discovery Through Environmental Clubs’, outlining environmental activities and clubs. Similar publications have been developed in Japan, India and Bangladesh. The observation of National Environment Days and Weeks across the region, provide a focal point for environmental activities, including seminars and exhibitions

Rising to the challenge of going beyond mere awareness raising, the Centre for Environment Education (CEE) in India has produced an exhibition package called ‘Act Now’. It focuses on some actions that people can take in their everyday lives to help improve the environment. Another environmental education package produced by CEE consists of a one-hour video story in Hindi called *Dhraki*, which discusses some concepts of drought, conservation of water, land and vegetation, and the management of exotic plant species.

### **7.5.3. Informal environmental education**

Informal education is a general term for education that can occur outside of a structured curriculum. Informal education encompasses student interests within a curriculum in a regular classroom, but is not limited to that setting. It works through conversation, and the exploration and enlargement of experience. It can refer to various forms of alternative education, such as unschooling or homeschooling, autodidacticism (self-teaching), and youth work. Informal education consists of an accidental and purposeful ways of collaborating on new information about different environmental components and issues. It can be discussion based and focuses on bridging the gaps between traditional classroom settings and life outside of the classroom. Informal education is less role controlled than the average classroom setting, which is why informal education can be so powerful. Informal education can help individuals to learn to different environmental conditions and help to conserve different environmental components (biological or physical). This type of education is a spontaneous process, which helps people to learn information in a new way. It helps to cultivate communities, associations and relationships that make for a positive learning environment.

**Table.7.1.Types of Environmental education**

|                         | <b>Formal education</b>                   | <b>Non -formal education</b>                             | <b>Informal education</b>        |
|-------------------------|-------------------------------------------|----------------------------------------------------------|----------------------------------|
| 1.Concerned             | Educational growth<br>Of children & youth | actual life situation                                    | Incidental learning              |
| 2.Attendance            | compulsory                                | voluntary                                                |                                  |
| 3.Learners              | Homogeneous                               | heterogeneous                                            | Individual learning<br>processes |
| 4.Preconceived<br>ideas | No                                        | Have preconceived<br>ideas & notion (past<br>experience) | May /maynot have                 |
| 5.Curriculum            | fixed &pre decided                        | No fixed -flexible                                       | On spot learning                 |
| 6.Teaching              | Formal-textbooks,<br>class room ,exams    | Informal- specific<br>&problem oriented                  | Self learning                    |

## 7.6. Modes of Environmental Awareness

Environmental awareness is to understand the fragility of our environment and the importance of its protection. Promoting environmental awareness is an easy way to become an environmental steward and participate in creating a responsibility of humans to respect, protect and preserve the natural world from its anthropogenic afflictions. By teaching our friends and family that the physical environment is fragile and indispensable we can begin fixing the problems that threaten it. Numerous resources are available "to promote environmental awareness that can be used in promoting the environment. These are

- **Formal Education**
- **Non-formal education**
- **Public Awareness through Population Education Programmes.**
- **National Environmental Awareness Campaign**
- **Informational and spiritual seminars,**
- **Environmental books and brochures,**
- **Media etc.**

Environmental education starts within the family with the birth of the child and continues throughout his primary and higher education. However, Environmental education can not be

limited to formal institutions since an individual also acquires awareness through his social life and social contacts

The system of education in which education is carried out in accordance with some established or prescribed rules, is called as Formal Education System. In India, the formal education is the mandate of the Ministry of Human Resources Development (MHRD), However, the Ministry of Environment and Forests has been consulting and infracting with MHRD, National Council of Educational Research and Training- the apical body of shaping education in schools in India, and HRD- departments of different states to include the Environmental Education in the curricula at various levels.

The system of education in which education is carried out without any pre-established and prescribed rules and the body concerned with educating the public is free to design the course module, the activity schedule or the programme concerning environmental awareness, is called as Non- Formal Education. The Non-Formal Environmental Education for building of Environmental Awareness is imparted through various means like- through Eco- clubs, Population Education Programmes, Environmental Campaigns, and through other means.

The Population Education is a very important part of education which acts as a powerful agent of building awareness regarding development and environment. It encourages the learners to understand the impacts of population growth on environment in general and about the impact of population growth on natural resourced in particular. It teaches about the impact of population on civic amenities and spread of various types of general and Sexually Transmitted Diseases (STDs) like Acquired Irnmuno Deficiency Syndrome (AIDS).The population education incorporates Sex Education which is essential for good reproductive health, maintaining the size of the family and keeping away from STD

The National Environmental Awareness Campaign is a large scale programme of the Ministry of Environment and Forests, which was started during rnid- 1986. It is organized every year on a particular theme decided by the ministry. This campaign is designed to disseminate environmental messages to a wide range of target groups utilizing conventional and nonconventional methods of communication.

Under the NEAC nominal financial assistance is provided to registered NGOs , schools, colleges, universities, research institutions, women and youth organizations, army units, state governments' departments etc. through Nodal Agencies, These institutions organize

awareness activities fixed by the ministry for a particular year. Presently, the campaign is implemented through 29 regional resource agencies (RRAs) for specific states or region of the country. These agencies are responsible for the physical monitoring of activities of different organizations. In the year 1986 the number of participating organizations was 115 which increased up to 7588 in 2004. Up to 2005 the number of participating organizations rose up to 9566. The RRAs help the ministry in the conduction, supervision and monitoring of the NEAC Campaign across the country. It also brings awareness through publication and distribution of resource material, Green Olympiad, seminars, workshops and environmental information system (ENVIS)

Another tool which is key in bringing environmental awareness is media. Environmental education through media consists of development of environmental awareness in all segments of society by raising environmental consciousness among individuals including positive enduring behaviour. Media plays an important role in forming the positive attitude towards the environment as it reaches a vast percentage of global population. It acts as a force which plays an active role in alerting people about environmental damage, corporate failures to meet its obligations, truthful analysis of new legislations and steps for protection and conservation of environment. Various international organisations as well as conferences have also emphasized the importance of different types of media such as newspapers, radio, TV, electronic or print in creating environmental awareness among people of both rural as well as urban areas. Getting all individuals in society to receive environmental education is critical and media is an effective mean for calling attention to environmental issues, making the public aware about problems created by pollution and hence can be instrumental in creating public pressure to do a handfull for the environment.

## **7.7. Environmental Education Organizations**

Although raising awareness about environment cannot undo the damage caused already to it by human activities but it can definitely prevent the further damage and can restore the environment to some extent. Various environmental organisations which impart environmental education are as follows:

### **7.7.1. Government Organizations**

The ministry of environment and forests in the centre formulates strategies for environmental awareness and education and under its guidance works the department of environment established in every state. Both these agencies hold seminars and workshops, produce movies, bring out posters, give advertisements in newspapers, magazines, radio, TV, organise

exhibitions and celebrate days of international importance such as world environment day in order to raise general awareness about environment among the masses. Such programmes provide a first hand experiences to the people to understand the importance of their environment and to acquire skills to deal with the day to day environmental issues. NCERT has designed the curriculum based on environmental education as per the recommendations of the national education policy objectives and different state boards have produced written material in terms of text books for imparting environmental education in school from primary to higher secondary level. University grants commission has also designed syllabus for different courses being offered by colleges and universities. Central government has also established the Centre of Environmental Education, Central board for Workers Education and Indian institute of ecology and management for imparting environmental education. Besides, government has also launched Environmental Information System (ENVIS) in 1982 which provides information about environment, forests, wild life and climate change for decision makers, policy planners, scientists, engineers and research workers. It is a decentralized system using a network of data bases spread in different states used for collection of information on environment. There are 10 ENVIS centres established in various institutions of the country which are working on diverse areas of environment. Besides this, government celebrates World environment day every year from 1974 on 5<sup>th</sup> June which acts as a principle vehicle for encouraging awareness and action for the protection of our environment. It was established on the first day of Stockholm conference 1972 by UN General Assembly resulting from discussions on the integration of human interactions and the environment. The day is celebrated annually with every year having a different theme and rotation of centre of these activities in different host countries. The day is celebrated with the aim to bring up many activities from different corners such as;

- Special supplements are brought about by the states in leading newspapers to highlight the need and importance of environment and the ways to keep it clean.
- People from different sectors especially school children and teachers organise environmental rallies, seminars, quiz competitions etc to carry the message of clean and green environment.
- Painting competitions, quiz competitions, essay writing and poster making events are organised in different institutes highlighting the importance of environment, its allied issues and means of conserving it. Different plays are being organised by environmental societies to mark the enthusiasm about environment.

- Various projects are launched both at centre as well state level for environmental conservation and restoration.
- Special training programmes are organised for teachers involved in environmental education process to enable them to develop handy skills for dealing with different environmental problems.
- Environmental societies organize special programmes where experts from different fields interact to discuss ways and means to tackle current environmental issues.

It is the day which reminds us to reaffirm our commitment to protect, conserve and improve our surroundings for present as well as future generations. Thus it is the biggest annual event for positive environmental action with an opportunity to broaden the basis for an enlightened opinion and responsible conduct by individuals, enterprise and communities in preserving and enhancing the environment.

#### **7.7.2.Non Governmental Organizations**

NGOs are non-governmental organizations usually referred to as organizations which are not part of government though could be funded by the government. The primary objective of these organizations is public service. As per one estimate, there are more than 3.3 million NGOs in India in 2009. In India, for an entity to become an NGO, it has to register either as a trust, society or a private limited nonprofit company, under section-25, Company of the Indian Companies Act, 1956. NGOs involved in environmental governance are highly diverse, including local, national, regional and international groups with various missions dedicated to environmental protection, sustainable development, poverty alleviation, animal welfare and other issues. In recent years, the range of activities undertaken by environmental NGOs and other major groups has broadened. They now undertake a much wider range of activities than simply raising environmental awareness and/or acting as pressure groups. Their activities now include environmental monitoring, promoting environmental education, training and capacity building, implementing demonstration projects, conducting advocacy work in partnership with the government and the promotion of regional and international cooperation on environment. Many also get involved in the practical management of conservation areas and promote community or individual action and campaign for greater accountability on the part of the government and corporate sector. Many countries in the world are facing the profound environmental, social and economic impacts of rapid population growth, development and natural resource constraints. Having a strong NGO community with a clear mandate to engage civil society, businesses and the public sector can

help countries to tackle these issues more successfully. However, NGOs face many barriers in pursuing their missions, such as a lack of understanding about their role in civil society and public perception that the government alone is responsible for the well-being of its citizens and residents. Environmental NGOs can play a crucial role in helping to plug gaps by conducting research to facilitate policy development, building institutional capacity and facilitating independent dialogue with civil society to help people live more sustainable lifestyles. Environmental NGOs typically take up causes related to the environment such as climate change, air pollution, deforestation, ozone layer depletion, waste management, biodiversity and land use, energy, conservation, environmental degradation, land degradation. Some of the prominent examples of environmental NGOs working in India are Bombay Natural History, Assam Science Society, Centre for Environmental Education, Centre for Science Education, Kerala Sahitya Parishad, Greenpeace India, and etc. NGOs have played an active role in the protection of environment in India. These NGOs have been successful in protecting the environment to a great extent.

1. To outline role played by NGOs in involving community participation for environmental protection and sustainable living in India.
2. To highlight role of NGOs in the environment protection and to specify the aims and objectives of environmental NGOs

### **7.7.3.Characteristics of NGOs**

- Environmental monitoring and reporting.
- Protecting the environment.
- Management of resources and environment: Community based project.
- Providing basic social services.
- Awareness-raising, campaigning and advocacy.
- Education, training and capacity building.
- Government and NGOs partnership.
- Regional and international cooperation and networking.
- Engaging in suffering relief activities.
- Promoting interest of the poor.
- Advocating community development .
- Environmental management plans.
- Biodiversity and wildlife conservation.

#### 7.7.4. Role of NGOs in protecting the environment

The NGOs that work to save the environment conduct campaigns across the country to create awareness among people about the depleting natural resources. Moreover, due to the increasing number of factories, chemical waste gets mixed with clean drinking water causing health problems. NGOs for environment in India have helped reduce deforestation, soil erosion and they educate the people on the significance of segregating waste material into biodegradable waste. NGOs for environment in India, take steps to educate people and make them aware of the perishing environment. There are NGOs in India that help in preserving the environment: Creating awareness among the public on current environmental issues and solutions. These also help in

- i. Facilitating the participation of various categories of stakeholders in the discussion on environmental issues.
- ii. Conducting participatory rural appraisal.
- iii. Being involved in the protection of human rights to have a clean environment.
- iv. Protecting the natural resources and entrusting the equitable use of resources.
- v. Data generation on natural resources, time line history of villages.
- vi. Analysis and monitoring of environmental quality.
- vii. Transferring information through newsletters, brochures, articles, audio visuals, etc.
- viii. Organizing seminars, lectures and group discussion for promotion of environmental awareness.
- ix. Helping the village's administrative officials in preparation, application and execution of projects on environmental protection.

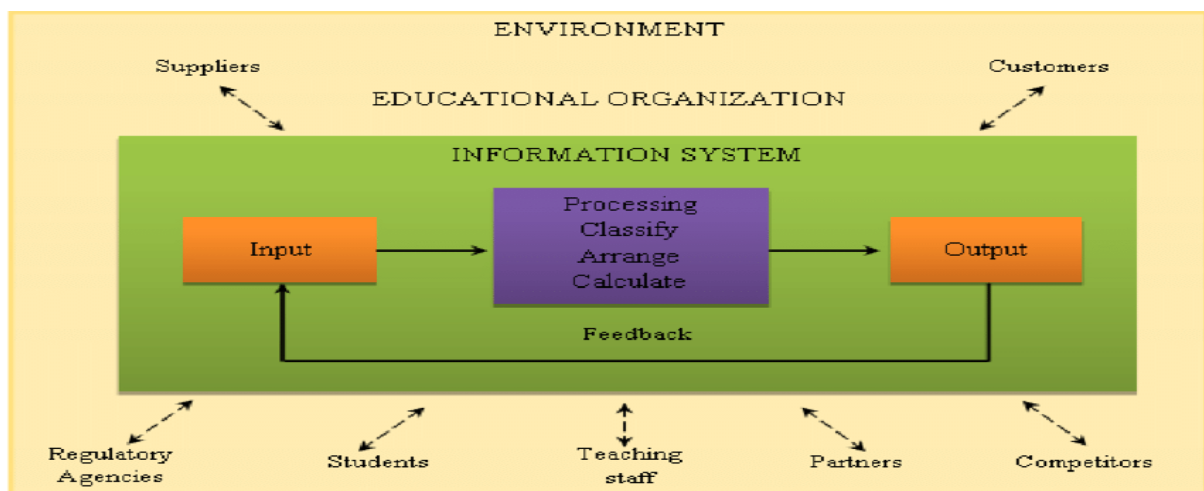


**Fig. functions of environmental organizations.**

### 7.7.5. International Non Governmental Organizations

NGOs focusing their activities on environmental issues are generally called environmental NGOs. There are a number of NGOs at global and national level working in different areas of environment, forestry and wildlife for the betterment of the environment. These organizations offer an insight into promoting and enhancing conservation efforts and try their best to make the world a better place to live. Some of these international NGOs are;

#### a. Green peace

A well known independent campaigning organisation with its presence in about 40 countries across the globe, Green peace has been active since 1971 in exposing various environmental issues in a non violent and creative way to force solutions essential for a peaceful and green future. It was founded by Irving Stove and Dorothy Stove, Canadian and US environmental activists. It does not accept donations from governments but raises its contributions from individual support and foundation grants. It campaigns on crucial global threats to the environment like climate change, Deforestation, overfishing, saving oceans, stopping nuclear threat, eliminating toxics, enabling sustainable trade and it exposes environmental criminals and challenges the governments when their policies fail to safeguard the environment.

#### b. World wildlife fund

It is an international non-governmental organisation founded in 1961 with its headquarter in Gland, Switzerland. It is working for reduction of human impact on environment and preservation of wilderness. WWF is working on 1300 environmental conservation projects in more than 100 countries with over five million supporters. After every two years it publishes living planet report which is based on living planet index and ecological foot print calculation and its current work is organized for food, climate, freshwater, wildlife, forests and oceans.

#### c. World Land Trust

It is an international conservation charity working for the protection of world's most threatened and biologically active habitats. Since its establishment in 1989, it has formed other organisations around the world to give permanent protection to wildlife and habitats in areas of risk. It provides funds to local NGOs to purchase land plots with the purpose of protecting it. Affiliated to WCU, it runs a wide spread tree planting operation. It also helps in in-situ conservation measures by providing training and equipment in economically backward areas for environmental conservation.

#### **d. Earth watch**

It is an international environmental charity founded in 1971 near Boston USA by Robert A Citron. It brings individuals from different fields with world class scientists to work for the betterment of the planet earth. It is one of the global organizations involved in scientific field research in archaeology, Paleontology, biodiversity, marine biota and wildlife. It delivers a citizen science model to raise funds and recruiting individuals, teachers, students and corporate fellows to actively participate in field research in understanding effect of global change on environment. Earth watch's Research Program provides vital support where funding is typically limited, to scientists from developing countries, women in science, and long-term monitoring projects. Other roles are

**i) Education** — Earth watch is a respected leader in the field of experiential education, with programs ranging from improving the quality of geography instruction to "live from the field," web-based virtual expeditions reaching classrooms worldwide

**ii) Climatic change and Conservation**—Earth Watch established strategic international and community partnerships to support multi-disciplinary research projects in some of the world's outstanding areas of ecological and cultural value. Earth Watch's major working area is Climate Change and the following are the major activities on climate change.

- Promotes public understanding of the impact of climate change
- It works to help mitigate negative impacts.
- It also shapes human responses to the environment
- Mission is to engage people to promote the sustainable environment
- Action for understanding the sustainable environment

Earthwatch's regular activities are communicating with scientists (130+ annually) about proposed research projects, recent findings, and research results, building networks of students and teachers (700 annually) to share expedition-based curricula and lesson plans, collaborating with global partner organizations (50 worldwide) on conservation and management plans, sharing program results and upcoming events with Earthwatch members (20,000 members), matching eager volunteers (4,000 annually) from all over the world with the right research project and engaging corporate partners (more than 50) and thousands of individuals to further support Earthwatch's successes.

#### **e. Environmental Defence Fund**

It is a US based nonprofit environment advocacy group founded in 1967 with scientists and policy specialists working world wide. It works on issues like global warming, ecosystem restoration, Corporate partnerships, oceans and human health. Its mission is to preserve all the natural ecosystems on which all the life depends. It uses sound science, economics and law to find practical and long lasting solutions to the world's most detrimental environmental challenges..

#### **f. Global Witness**

With its office in Washington, it is an international organisation established in 1993 that works to break the links between natural resource exploitation, poverty, conflict, resource corruption, and human rights abuses at global level. Its goal is to expose the corrupt natural resource exploitation and international trade systems to start campaigns that end resource linked conflict and environmental abuses. It carries out investigations into illegal activities such as forest exploitation, corruption in oil, gas and mineral exploration. It carries out investigative research and publishes reports which are later made available to governments, civil societies, other organisations and media to change international thinking about extracting and trading of resources and the impact of their unsustainable extraction on economic and ecosystem stability.

### **7.7.6. Environmental NGOs in India**

There are NGOs working in the field of environmental protection at national and local levels. These organizations use various means to achieve their objective. The environmental NGOs in different areas and the impact they have created in the respective locale is enumerated below

#### **a. Bombay natural history society**

The Bombay natural history society<sup>12</sup>, founded on 15 September 1883, is one of the largest non-governmental organizations in India engaged in conservation and biodiversity research. It supports many research efforts through grants and publishes the Journal of the Bombay Natural History Society. Many prominent naturalists, including the ornithologists Salim Ali and S. Dillon Ripley have been associated with it. The society is commonly known by its initials, BNHS. Aims to disseminate knowledge of flora and fauna by means of lectures, field trips, literature and expeditions and to study wildlife related problems and recommend

management plans to conserve wildlife and its habitat. It conducts field research projects on bird migration and studies on the movement and population structure of Indian avifauna.

### **b. Centre for Environmental Education (CEE)**

Centre for Environment Education<sup>13</sup> was established in August 1984 as a Centre of Excellence supported by the Ministry of Environment and Forests, Government of India. CEE, a national institution with its headquarters in Ahmedabad, has a mandate to promote environmental awareness nationwide. CEE is affiliated to the Nehru Foundation for Development and inherits the rich multidisciplinary resource base and varied experience of Nehru Foundation for Development. CEE is committed to ensuring that due recognition is given to the role of Education in the promotion of sustainable development. They mainly aim to create environmental awareness in the communities, conduct widespread environmental education and training programmes through a very vast network. Publications and database, they have a vast range of publications, books, posters, educational packages, bibliographies and directories. There is also a large computerized database, the Environment Education bank, which has a collection of more than 800 environment concepts, about 2500 environment related activities and 100s of case studies.

### **c. Centre for Science and Environment (CSE)**

Centre for Science and Environment (CSE) is an independent, public interest organization which aims to increase public awareness on science, technology, environment and development. The centre was started in 1980. For more than two decades, CSE has been creating awareness about the environmental challenges facing our nation. Searching for solutions that people and communities can implement themselves. CSE has been creating public environmental awareness, pushing the government to create frameworks for individual and community actions and seeking balanced and informed analysis of the global politics of environment. More importantly, CSE is working for clean air by introducing CNG buses in Delhi. This leads to reduce particulate pollution and also campaigning for air pollution and it causes one death every hour. Involved in research, investigative and educational work in the field of pollution, forest, wildlife, land and water use.

### **d. CPR Environmental Education Centre (C.P. Ramaswami Aiyar foundation)**

C.P.R. Environmental Education Centre (CPREEC)<sup>15</sup> is a Centre of Excellence of the Ministry of Environment and Forests, Government of India, established jointly by the Ministry and the C.P. Ramaswami Aiyar Foundation. The centre has been set up to increase

consciousness and knowledge about the environment and the major environmental problems facing the country today. It has been conducting a variety of programmes to spread awareness and interest among teachers, NGOs, women and youth, on all aspects of the environment and ecology with the purpose of promoting conservation of nature and natural resources. The CPREEC is the Nodal Agency for the Ministry of Human Resource Development, Government of India for implementing the scheme of Environmental Orientation to School Education in the states of Andhra Pradesh, Karnataka, Kerala, Orissa, Pondicherry and Tamilnadu. Promotes environmental awareness, to produce and disseminate basic educational and reference material on environment and to take up environmental projects. It works in the field of environmental education.

#### **e. Kerala sastra sahitya parishad**

Kerala SastraSahitya Parishad<sup>16</sup> is a Peoples Science Movement of Kerala, India. Founded in 1962. It started its works at the science society interface with about 40 members as an organization of science writers in Malayalam. Over the past four decades it has grown into a mass movement with a membership over 40000, distributed in more than two thousand units spread all over Kerala. It work to preserve the environment, to provide alternative models for development and topopularize science among the people. They have worked in the field of eco-development, creating awareness about water and energy conservation and encouraging the use of nonconventional energy sources such as smokeless chulhas, etc.

#### **f. Kalpavriksh**

Kalpavriksh<sup>17</sup> is a non profit organisation working on environmental and social issues. The group began in 1979 with a campaign led by students to save Delhi's Ridge Forest. They work on local, national and global levels, are registered under the Societies Registration Act (S-17439) and are based in Delhi and Pune. It is a citizen action group set up to inculcate understanding and concern on environmental issues, especially among the youth. It also aims to conduct research in environmental problems, to campaign on environmental issues and to evolve a holistic environmental perspective. It imparts environmental education in schools and colleges by forming a network of nature clubs, conducting bird watching expeditions and nature trails and has developed workbooks for the school level.

#### **g. Narmada bachao andalon**

Set up in 1986 under the leadership of Medha Patkar. It aims mainly to educate those directly affected by large development projects, such as tribals, on the social and environmental

impact of such projects. To protest against the construction of dams in the Narmada Valley in general; struggling towards a right to information and new environmentally sustainable water policy. To help the tribals get a substantial share of the government and development schemes/services and to enable them to undertake development activities themselves. They mainly educate, mobilize and organize residents of the Narmada Valley on human rights and justice, alternative development policies, environmental issues related to big dams in general and the Narmada project in particular. They undertake surveys of the affected villages, protest against land and forest issues and government interference in this regard. They are fighting against displacement and disregard of the rights of the people.

#### **h. Tata Energy and Research Institute (TERI)**

TERI is established in 1974 as independent not-for-profit research institute. Its mission is to develop and promote technologies, policies and institutions for efficient and sustainable use of natural resources. It has been imparting environmental education through projects, workshops, audio visual aids and quiz competitions. It deals with policy related work in the energy sector, research on environmental subjects development on renewable energy technologies and promotion of energy efficiency in the industry and transport. TERI also has a major programme in biotechnology, the applications of which are oriented towards increased biomass production, conversion of waste into useful products and mitigating the harmful environmental impacts of several economic activities. They have several books on energy, climate change, renewable energy, regulation, environment and sustainable development and forestry and biodiversity. Environmental activities are a road to greater profitability and would create within the organizations a productive workforce sensitive and proactive towards changes.

### **7.8. Environmental movements**

Environmental movements are generally understood as those movements that are taken up against the development projects as the latter depend on vast amounts of natural resources and their injudicious use and exploitation. The concept of development is usually prevalent in a market economy, where 'development' is associated with the material progress of the individual and the maximum extent to which he/she can enjoy the fruits of materialistic progress. It overlooks the fact that nature provides only to a certain extent and that resource depletion poses major threat to human survival. Therefore the movements are often organized to protest against the exploitation of the nature thus bringing in the concept of ecological and environmental sustainability.

According to the noted environmentalist, Dr. Vandana Shiva, ‘movements are major social and political processes, however, and they transcend individual actors. They are significant precisely because they involve a multiplicity of people and events which contribute to a reinforcement of social change. As stated by her

*. ‘Ecology movements are political movements for a non-violent world order in which nature is conserved for conserving the options for survival. These movements are small, but they are growing. They are local, but their success lies in non-local impact. They demand only the right to survival yet with that minimal demand is associated the right to live in a peaceful and just world. With the success of these grassroots movements is linked the global issue of survival. Unless the world is restructured ecologically at the level of world-views and life-styles, peace and justice will continue to be violated and ultimately the very survival of humanity will be threatened’.*

### **7.8.1. Evolution of environmental movements**

The modern environmental movements in the West started long after the industrial revolution set in and changed the lives of people into an affluent and consumerist lot. At first there was a movement for land and wildlife conservation, followed by pollution control measures and third related to lobbying for regulation to minimize industrial wastes. Grassroots green movements followed thus heralding a completely new era of voicing environmental concerns.

Unlike the West, India’s concern for environment and nature date back to centuries where the concern for natural resources and elements formed a part of the lifestyle of the people. The emphasis has been more on the spiritual and moral dimensions of life rather than materialism and affluence. Thus the care and concern for nature has been inherent since ages in our society. The post-independent and much later the liberalized economic phase saw many a structural changes in the economy thus exposing the nation to materialistic and consumerist lifestyle.

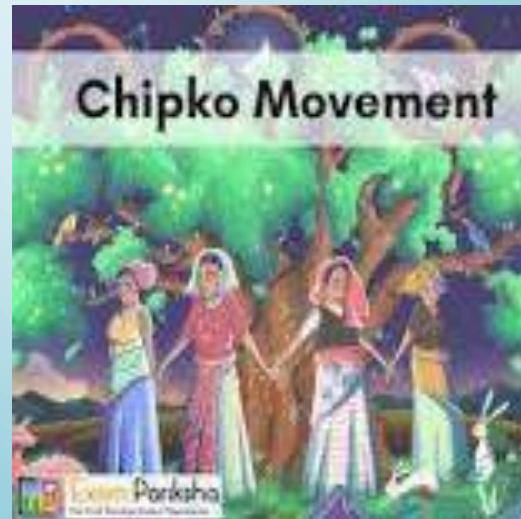
The 1970s saw the environmental issues coming to the international fora with the Stockholm Conference being one of the pioneering conventions on this issue. India committed itself to the protection of the natural environment according to the International norms and rules. Around the same time, the Chipko Movement or Andolan has already been in the making, which later inspired subsequent movements on environment.

Environmental movements in India have been more or less conducted at the grassroots level and more so not by the educated elite but by simple village folk and tribals depending on the region. These have been initially characterized by protests against the big companies indiscriminately using the forest resources for commercial purposes. Later the movements focused on water issues, flora and fauna, biodiversity, and massive deforestation till the recent river pollution, the prime examples being the Ganga and Yamuna clean-up action plans.

One of the earliest known cases of forest conservation dates back to 1730, is the Chipko Movement which is one such pioneering movement that set an example to be emulated by others.

### 7.8.2. CHIPKO ANDOLAN (MOVEMENT)

The Chipko Movement, which is also identified chiefly as a women's movement, originated in the Garhwal Himalayan mountain region of the present Uttarakhand state. The original 'Chipko movement' was started around 260 years back in the early part of the 18<sup>th</sup> century in Rajasthan by Bishnoi community. A large group of them from 84 villages led by a lady called Amrita Devi laid down their lives in an effort to protect the trees from being felled on the orders of the *Maharaja* (King) of Jodhpur. After this incident the *maharaja* gave a strong royal decree preventing the cutting of trees in all Bishnoi villages.



The 20th century, it began in the hills where the forests are the main source of livelihood, since agricultural activities cannot be carried out easily. The Chipko movement of 1973 was one of the most famous among these

- **Why the movement started**

The region is known for its fragile ecology, often prone to earthquakes, erosive rivers and steep valleys that are least conducive to agricultural growth. Its vast forest cover and reserves enables the local communities to pick the fodder, fuel and fibers that contribute to their daily sustenance. With no opportunities for viable income, the men folk search for income outside the region while the women are left in the villages often leaving them as the real custodians of the available resources.

The region was also prone to massive deforestation as the commercial exploitation of forests took place on a gigantic scale in order to meet the needs of ever growing population and urban settlers. It is important to note that the first forest laws were enacted during the British rule. With more demand for wood for commercial and rail link purposes, 'in Tehri Garhwal State, between 1840 and 1885, the forests were leased out to contractors for

exploitation. The forest laws were enacted to safeguard the vested interests of contractors. Power moved from the hands of the local people into those of government forest officials. The encroachment by the influential contractors was highly resented by the local population, an encroachment on the resources over which they had traditional rights.

With massive felling of trees and deforestation in the hills, and with the trees becoming few and far, the village women, who rely mainly on the forest resources for the sustenance, found it difficult to spend enormous time and energy in collecting the necessary fodder and fuel. They would, sometimes go to distance of atleast five kilometers to collect the necessary supplies. With the denuding forests, there was also a danger of devastating floods and landslides submerging the houses, crops, and affecting the movement of people and throwing out of gear the irrigation facilities.

- **Methods Adopted By the Movement**

Fully non co-operation tactics were adopted in the entire movement. Moreover, no question of violence was being used. Rallies and meetings were continuously held. A reading of Bhagawad Gita was also organized. Along with these, women tied „rakhees“ around the wounded spots signifying their close relationship with the trees. Finally, hunger fast was also adopted by the leaders like Sundarlal Bahuguna during the movement.

- **Start of the movement**

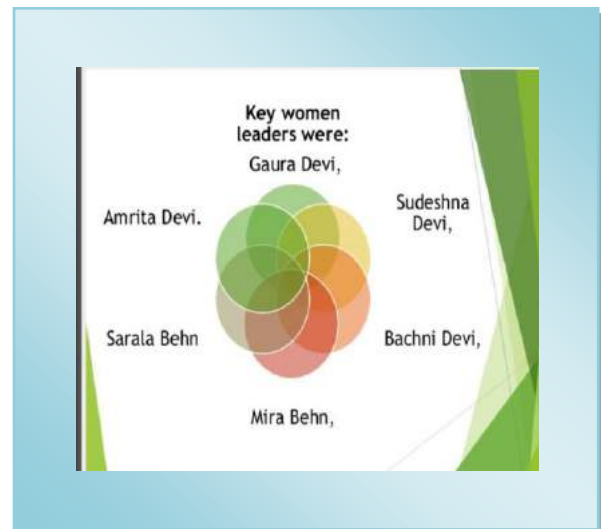
The organizational base of the women in the region at first found its origins in the anti- alcohol movement and later prohibition movement in 1965. It further spread to utilising the local forest resources by the local people and led to organised protests against the commercial exploitation of the forests.

One of the key events took place ‘in 1973 when around 300 ash trees had been auctioned in Mandal to a manufacturer of sports goods’. With the protest against it by the women of the region led by a 75 year old Shyama Devi, the contractor withdrew but the focus subsequently shifted to the Alaknanda valley, in the village of Reni. The region was already devastated by the massive floods of the 1970 wherein water inundated 100 sq.kms of motor roads, washed away 6 metal bridges, 10 kms of motor roads, 24 buses, 366 houses collapsed, 500 acres of paddy crops destroyed. It was attributed to the denuding of the forests for commercial purposes and felling of trees in the region. Large scale auction and plans for felling of trees in the region was planned by the commercial contractors but had to backtrack their activities because of the active role of the women and the villagers who kept constant vigil on the former’s activities. On one such occasion, sensing the absence of men from the village, the commercial contractors

sent their labour to axe the trees before the villagers get to mobilise and start protecting the trees. Later, as the women spotted the labour with axes, who came to cut the trees, they protested and vowed to protect the trees. Small groups of women kept constant vigilance and hugged the trees in order to prevent the felling. Led by Gauri (sometimes referred as Gaura) Devi and Gunga Devi, along with their co-workers, the movement was a much successful one. Consequently, the government imposed a ban on the commercial green felling in the region.

- **Active participants**

The significant catalysers of the movement are women like Mira Behn, Sarala Behn, Bimala Behn, Hima Devi, Gauri Devi, Gunga Devi, Bachni Devi, Itwari Devi, Chamun Devi and many others. Further, the philosophical and conceptual articulation of the ecological view of the Himalayan forests has been done by Mira Behn and Bahuguna. The organizational foundation for it being a women's movement was laid by Sarala Behn, Bimala Behn in Garhwal and Radha Bhatt in Kumaon. The men of the movement like Sunderlal Bahuguna, Chandi Prasad Bhatt, Ghanshyam Shailani and Dhoom Singh Negi were glad to acknowledge themselves as their students, messengers and followers and played crucial role in spreading the movement to different parts of the state.



- **Significance of the Movement**

- The significance of the Chipko movement can be analyzed through the following points .Firstly, the Chipko movement which later became a national campaign, was successful to challenge the activities of the state forest officials and also it had able to allow a 15 year ban on commercial felling of trees in the Himalaya and declared that area as protected area.
- Secondly, the movement stood for a broad purpose. Although, in the initial period, it fought for the village people's rights over the resources of the forest, but in the later phase, it fought for the ecological stability of the region. So, it had represented a heightened awareness to ecology.
- Thirdly, all social groups actively participated in the movement. Moreover, the active participation of women in a large scale made the movement more significant.

Because of the active participation of women in a large scale, many people regard the Chipko movement as „eco-feminist movement“.

- iv. The significance of Chipko can also be analyzed from the point of link between forest and people. Almost everyone was aware of the importance of forest cover in regulating soil and water regimes. The moral content of Chipko made it too significant. When the contractors abandoned their labourers, the locals fed them from village ration shops and petitioned the officials to alleviate their plight.
- v. The Chipko movement was also significant as it dealt with the question which was posed towards the livelihood of the people in the hills of Uttarpradesh because of the activities of the Government. As a result of the deterioration of the forest cover, the life of those people became threatened who were involved in labour intensive fodder and firewood collection. Because of the contribution made by the movement in this regard, it was awarded the „**RIGHT LIVELIHOOD AWARD**’ in 1988.
- vi. Last but not the least, the movement became a rallying point for many future environmentalists, environmental movements and protests all over the world and created precedence for non-violent protest. It occurred at a time when there was hardly any environmental movement in the developing world and its success meant that the world immediately took notice of this non-violent movement. It also revealed that even a Gandhian movement can become successful in this time also.

### • Outcome of the movement

- i. This incident gave the movement a further momentum to mobilise all the villages in the region to protest against the commercial felling of trees, as it led to the fragile ecology dwindling further. The women trekked far and wide for about 75 days appealing to their counterparts in the region to join the demonstrations and vehemently protest against the commercial exploitation of the forests. The method of hugging the trees to prevent their felling was actually used for the first time by Dhoom Singh Negi in Salet forest near the village of Pipleth in Henwal.
- i i. Another significant event that took place in 1977 was against the auction and cutting of trees in the Adwani forests, in the Narendernagar district. Bahuguna undertook a fast against this measure but the felling order was not withdrawn. The women, who became the ‘front-line soldiers’, gathered and tied sacred threads to the trees as a part of their vow to protect them and constantly guarded the forests. The axe-men returned with armed police to keep the people away from the area but the volunteers already took

positions to guard the trees. The movement, consequently, was successful and the **Adwani Satyagraha**, as it is known, gave new directions and strength to women especially to protect their forestry system and instilled in them a new confidence to continue the struggle.

- iii. The Chipko movement was not confined to Reni but spread to Tehri, Kumaon and other areas of the State like Adwani, Amarsar, Chanchnidhar, Dungari, Paintoli and Badiyagarh. The most beneficial outcome of the movement has been the Government's order imposing a ban on the felling of trees in the region apart from the joint forest management mechanisms that followed later. Chipko thus stands out as the most significant movement in the arena of environmental protection. It further highlights the role of women as the torchbearers of similar movements everywhere.
- iv. The Chipko protests in Uttar Pradesh achieved a major victory in 1980 with a 15-year ban on green felling in the Himalayan forests of that state by the order of Mrs Indira Gandhi, the then Prime Minister of India. Since then, the movement has spread to many states in the country. In addition to the 15-year ban in Uttarpradesh

### 7.8.3. Narmada Bachao Andolan (NBA)

India's first Prime Minister Mr. Pt. Jawahar Lal Nehru once said that the "Dams are the temples of the modern India". Such remark of his is considered the construction of the dams is quite essential part of the development of a country, although he reiterated them as "a disease of gigantism" which India should abandon.

- **The Narmada River**

Narmada, the largest west flowing river of the Peninsula, rises near Amarkantak range of m **Narmada River** it is the fifth largest river in the country and the largest one in

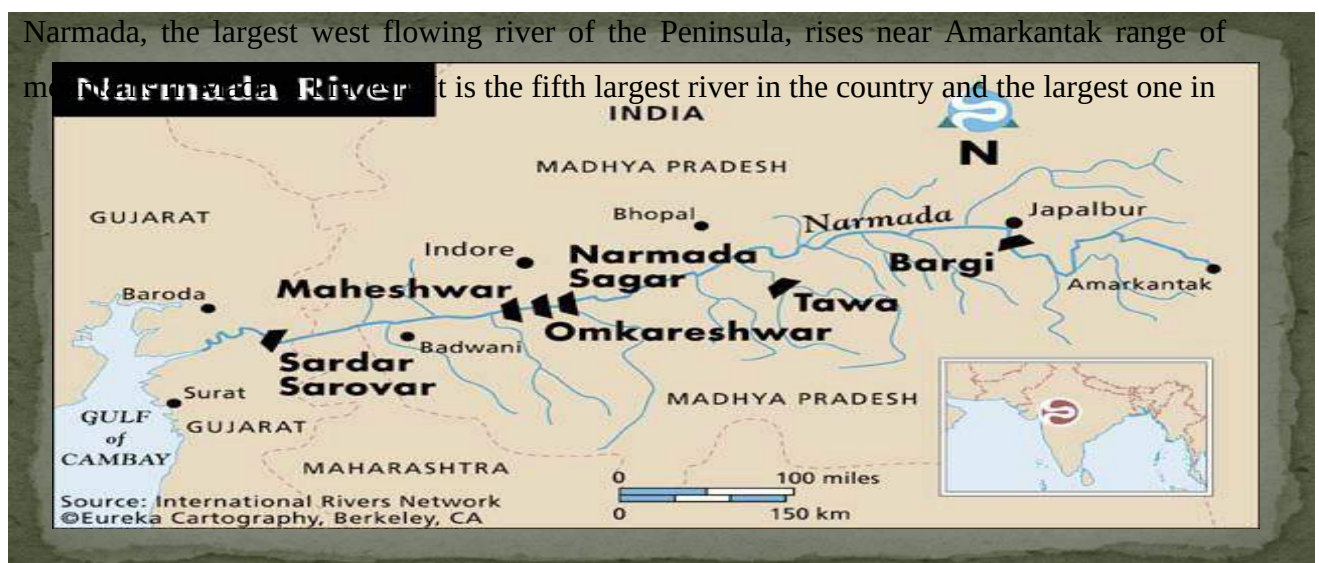


Fig.7.5. the course of Narmada river

Gujarat. It traverses Madhya Pradesh, Maharashtra and Gujarat and meets the Gulf of Cambay. The total length of the river from source to sea is 1312 kilometers (815 miles) while the length up to dam site is 1163 kilometers. (723 miles). The width of the river channel at dam site during high floods is 488 meter (1600 feet) and that during summer is 45.70 meter. (150 feet). The maximum recorded flood on 7th September 1994 was 70,847 cumecs (2.5 million cusecs) while minimum recorded flow in summer was 8.5 cumecs (300 cusecs). The dam is designed for 87,000 cumecs (3.07 million cusecs) flood.

- **Sardar Sarovar Project.**

The need of irrigation, electricity and many other requirements of the people in the name of development was the main source behind the drive of construction of thirty large dams, one hundred and thirty five medium dams and three thousands of small dams on the river Narmada of north western states of India: Gujarat, Madhya Pradesh and Maharashtra with the assistance of World Bank. This project is known as Sardar Sarovar Project.

The government of the country made the promise to provide the potable water, irrigation facilities and hydroelectric power for the concerned region. The most controversial enormous dam of SSP was in the state of Gujarat. The evident welfare of the individuals however would come at a high cost that includes the displacement of countless people and extensive environment harm. In spite of these predictable results, and no prior consultation with indigenous groups that would encounter the ecological effects and automatic removal or displacement of the local people or tribal people, the World Bank in 1985 agreed to finance the Sardar Sarovar dam.

- **Narmada Bachao Andolan (NBA)**

During 1970s govt of India formulated a plan to build 30 dams on the river Narmada that flows through Gujarat, MP and Maharashtra. The construction of two major dams Sardar Sarovar project in Gujarat and Indra Sagar project in Madhya Pradesh raised the main conflict among the masses of the Narmada valley. As a part of Narmada Dam Project the aim of these dams is to provide irrigation and electricity to these states. Thus the Narmada Bachao Andolan got developed gradually as a resistance movement spearheaded by native tribals, farmers, environmentalists and human rights activists against the construction of these dams. The mode of campaigning under this Andolan includes court actions, hunger strikes, rallies and gatherings and other support from notable persons. The chief leaders of this movement, Baba Amete and Medha Patkar later on received the Right Livelihood Award in 1991. Baba Amete registered a case in courts against both these projects in both the states. As per the

reports of MOEF, the environmental cost of Sardar Sarovar and Indra Sagar project will be the loss of forest area worth 30923 crores and 8190 crores respectively. About 80 million trees will be cut down in one go and the ecological balance of the area would be seriously damaged by changing the climate and hydrological cycle. As per the official report, about 130428 hectares of land area would be submerged including 55681 hectares of agricultural lands and 56066 hectares of forest land. Besides, there would be displacement of about thousands of inhabitants and thousands of livestock would be rendered devoid of grazing area. As a result, the report submitted by Forest Advisory Committee in 1990 advocated that work on project be stopped with an immediate effect. There were many stakeholders like Narmada Asar Grastha Samiti (Gujarat based), Narmada Ghati Nav Nirmaan Samiti (Madhya Pradesh) and Narmada Dharangrasta Samiti (Maharashtra based) who worked for the need of fair rehabilitation plans for the people and voluntarily opposed the dam construction. The movement was also joined by several environmental organisations, local people, professionals and activists as founders of a non violent movement to pressurize the world bank to stop the aid for the construction of the project. With the help of experts from different fields this Andolan has worked out alternate measures for both irrigation as well as electricity generation for these states. For energy scenario, a combination of energy conservation, decentralised power generation and natural gas plants was suggested to prove less harmful to the environment than the energy provided by Narmada project in terms of cheaper electricity, less displacement of people and less damage to the forest land. For ensuring safe supply of water to these states, stress was laid down on new strategy of water conservation and watershed development projects. These measures help in preserving and reviewing ground water and waters of many small and large surface water bodies. This is to be done in a non destructive manner with full public involvement which is beneficial to both environment and people to yield significant results. In reality, the project is neither modified nor stopped till date for any decisive conclusion.

#### **Actors involved/Participants of the movement-**

Early 1980s the Narmada project has confronted mounting resistance from different sources. Groups to protest formed in every one of the three devastated states and were bolstered by people facing displacement, students, social activists, Indian environmental NGOs, international NGOs and transnational systems. Nineteen villages in Gujarat, whose submersion was guaranteed by the Sardar Sarovar dam, formed the Chhatra Yuva Sangharsh

Vahini, a young protest group. The group engaged in protests and started court activities, at last driving the administration of Gujarat state to offer a more liberal resettlement package.

Since the agents of more intensive resource exploitation are bolstered by the state, neighborhood groups had no plan of action with the exception of direct activity of protest against injustice. Guha argues that these movements address another type of class struggle. This (NBA) movement against the development of a few dams over the river Narmada in center India has mobilized and united strikingly diverse social groups in its battle. On account of Sardar Sarovar dam, the movement unites poor hilly terrain adivasis with prosperous caste of hindu agriculturists of the plain.

A social movement is capable accurately in light of the fact that its implications are vague and moving: for some hilly terrain adivasis, the Narmada movement is a battle to clutch their valuable area; for the engineering student, it may epitomize the extent of a mechanically suitable ideal world.

### **History of the movement-**

In the beginning when villages of Maharashtra were a little less aware about the dam coming up in the Gujarat. These villages were not aware of the consequence of building the dam that includes the submergence of the villages to high extent and greater magnitude. They were not informed by any of the government officials. In these affected areas of district Dhule and Akkalkua and Akrani tehsil of Maharashtra state the tribal people started to mobilize themselves in 1985 and started asking the questions related to the construction of the dam, submergence, displacement and resettlement. They were facing the ultimatums given by higher authorities that “if you do not move, you will run like rats when the water rises.” Narmada Dharanagrast Samiti (NDS) was formed on February 16, 1986. The samiti escalated the displacement issue and their right to know and their participation in the decision making process. They asked whether the administration had enough land to resettle all the 33 adivasi towns appropriately. The tribals had, also, been casualties of coercion by backwoods and other government authorities for a considerable length of time. Several adivasi families in Akrani tehsil did not have area records, as there was no area settlement. They were along these lines considered "encroachers" all alone land! The NDS considered these issues and planned its position. A point by point procedure of dialogs inside of the towns, and in gatherings of the agents of towns, went before any strategy choice. Two noteworthy moves made spot in mid 1989. There were challenges against the Official Secrets Act that was clipped in the ten towns around the dam site on January 30, 1989. And afterward on February 22, 1989, there was a raging of the dam site by around 10,000 individuals from Nimad and

the tribal territories. The new motto of "Koi nahin hatega, baandh nahin banega!" ("No one will move out, the dam won't be manufactured") turned into a mantra for the battle against relocation. By this time, the individuals' resistance to the dam and their issue of displacement had solidified into a two-point program. Then on, the movement turned out to be more dynamic on bigger issues and battles in different parts of India against removal of development processes.

### **After effects of NBA-**

On October 18, 2000, subsequent to hearing the case, the Supreme Court of India at last pronounced its judgment with respect to the Sardar Sarovar Project in a ninety-five page request. The Court allowed the construction of the dam to a preparatory height of ninety meters. Further, the Supreme Court allowed the SSP contractors the privilege to continue to build the dam to the initially arranged height of 138 meters, in five meter additions, just once the legislature exhibited that there was a migration strategy as a result. Consequently, preceding the rise in height, regard must be allowed from the Relief and Rehabilitation Subgroup of the Narmada Control Authority.

The Court thought on this issue further for quite a long while yet at last maintained the Tribunal Award and permitted the development to continue, subject to conditions. The court acquainted a component with screen the advancement of resettlement "pari passu" with the raising of the height of the dam through the Grievance Redressal Authorities (GRA) in each of the affected states. The court's choice alluded in this report, given in the year 2000 following seven years of consultations, has prepared for finishing the task to achieve full visualized advantages. The court's last line of the request expresses, "Each endeavour should be made to see that the venture is finished as quickly as could reasonably be expected".

## Evaluation

### A) Long answer type

- Q.NO1. Elaborate on the concept need and for environmental education.
- Q.NO.2. What are formal, non-formal and informal means of environmental education.
- Q.NO.3. What are environmental movements. Elaborate on one of the movements in post independence era.

### B) Short answer type

- Q.NO.1. Wht are different modes of environmental education.
- Q.NO.2. briefly explain the role of NGO in imparting environmental education.
- Q.NO.3. Write a short note on Narmada Bacho Andolan.
- Q.NO.4: What are objectives of Environmental Education?
- Q.5: Write short notes on: a) Green peace b) WWF

### C). Very Short answer type.

- Q.NO.1.what are the goals of environmental education.
- Q.NO.2. Write short note on Earth watch.
- Q.4: Who is the pioneer of Chipko movement?

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## UNITT 8: - Environmental Health

### ❖ Learning Outcome

At the completion of the chapter it is expected that students will be able:

- To identify environmental hazards and harmful influences on human health.
- To investigate and assess problems to provide realistic solutions.
- To integrate health sciences to develop interdisciplinary approaches to problem-solving.
- To analyses information and data and compare it with known criteria to assess the impact on human health.
- To develop and implement plans to prevent or minimize any adverse effects on the community, or on individuals.

### 8.0. Introduction

- **Environmental Health**

Environmental health is the science and practice of preventing human injury and illness and promoting well-being by:

- Identifying and evaluating environmental sources and hazardous agents.
- Limiting exposures to hazardous physical, chemical, and biological agents in air, water, soil, food, and other environmental media or settings that may adversely affect human health.

Environmental health has been defined by the World Health Organization as aspects of human health and diseases that are determined by environmental factors. Environmental health also refers to the assessment and control of environmental factors that can potentially affect health. Environmental health focuses on the direct pathological effects of chemicals, radiation and certain biological agents in dwellings, urban, agricultural or natural environments, as well as their indirect effects on well-being. It connects the social and cultural environments, as well as genetic components.



Fig.8.1.(WHO prevention diseases info graphic)

- **Concept of health and diseases**

The word health refers to a state of complete physical and emotional well-being. Healthcare helps people to maintain this state of health which merely does not refer to absence of diseases but ability to recover from illness and other disturbances.

As per WHO (1948), health is a state of complete physical, mental and social wellbeing and not merely the absence of diseases or infirmity. Later in 1986, WHO clarified that health is a resource for everyday life, not the objective of living. It is appositive concept that emphasizes social and personal resources as well as physical capacities.

The most common types of health are physical, mental, social, spiritual, emotional and financial which have been linked to lower stress levels and physical and mental well-being of a person whose bodily functions are working at peak performance. Physical well-being is achieved not only because of lack of disease but by means of regular exercise, balanced nutrition and adequate rest. Physical well-being involves pursuing a healthy lifestyle to decrease the risk of diseases, injury or other health issues.

All the factors that determine health are interlinked and affect each other. Thus the concept of health is holistic contained in the expression of wholeness.

Thus, different concepts of health are;

- Biomedical concept- views health as absence of diseases.
- Ecological concept-Continuous adaptation and adjustment to the environment to reduce pain and discomfort.
- Psychosocial concept- considers health both biological as well as social phenomena.
- Holistic concept- takes health as a sound mind in a sound body in a sound Family in a sound environment i.e. every sector has an effect on health.

An organism is in a state of normal condition when there occurs a delicate physiological

**Middle East respiratory syndrome coronavirus (MERS-CoV):** caused by a novel coronavirus that was first identified in Saudi Arabia in 2012. MERS-CoV is a zoonotic virus, which means it is a virus that is transmitted between animals and people. Studies have shown that humans are infected through direct or indirect contact with infected dromedary camels. MERS-CoV has been identified in dromedaries in several countries in the Middle East, Africa and South Asia.

balance or homeostasis in terms of its functional processes. When this homeostatic control mechanism is broken, the structural and functional state of the organism gets deviated from the normal with certain signs or symptoms; the state of the organism is known to be a disease. A disease refers to a particular abnormal condition that negatively affects the structure or function of a part or all of an organism not due to an external injury. Diseases are always considered as medical conditions associated with certain specific indications that are indicative of its abnormal state are known as symptoms.

The study of a disease is called as pathology which involves the determination of its cause (etiology), the understanding of the mechanism of its development (pathogenesis), the morphological changes associated and the functional consequences of these changes. Correctly identifying, a disease is of prime importance for ensuring proper course of treatment for a particular

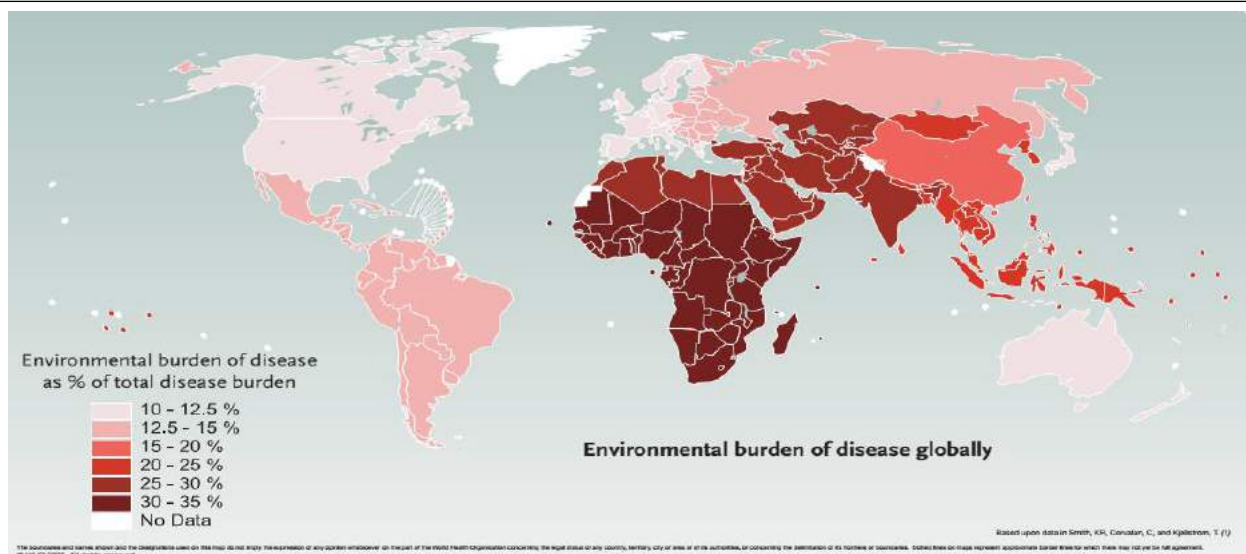
disease. A disease caused by some external agent which affects only the organism exposed to it is a non-communicable disease while as if the external agent is a living organism capable of multiplying within the host and subsequently infecting others, it is said to be a communicable disease.

## 8.1 Communicable Diseases.

Communicable Diseases are the diseases which are transmitted from person to person. Communicable Diseases can be transmitted from the reservoir or source of infection to a susceptible individual in many different ways depending upon the infectious agent, port of entry & the local ecological conditions. As a rule infectious disease is transmitted by only one route.

The mode of transmission of infectious diseases may be classified as follows:

- |                                    |                              |
|------------------------------------|------------------------------|
| 1. Direct transmission             | 7. Indirect transmission     |
| 2. Direct contact                  | 8. Vehicle borne             |
| 3. Droplet infection               | 9. Vector borne-Mechanical & |
| 4. Contact with soil               | Biological                   |
| 5. Inoculation into skin or mucosa | 10. Air borne                |
| 6. Trans placental                 | 11. Formite borne            |
| 12. Unclean hands & fingers        |                              |



Source: Health & Environment Report (UNEP &WHO)

Every minute, 5 children in developing countries die from malaria or diarrhoea. Every hour, 100 more children die as a result of exposure to indoor smoke from solid fuels.

Every day, almost 3000 people in low and middle-income countries die from road traffic injuries: in the poorest countries most of these deaths are among pedestrians.

Every month, nearly 19,000 people in developing countries die from unintentional poisonings, often as a result of exposure to toxic chemicals and pesticides in their work or home environments. Environmental hazards and related illnesses kill millions globally every year. But while the victims share a common fate, their problems are not necessarily linked in either today's

### ***Zika Virus Outbreak***

Zika, a flavivirus transmitted mainly by mosquitos in the genus *Aedes*, was discovered in 1947 in Uganda.<sup>1</sup> From the 1960s to 1980s, human infections were found across Africa and Asia, typically accompanied by mild illness. The first large outbreak of disease caused by Zika infection was reported from the island of Yap (Federated States of Micronesia) in 2007, as the virus moved from south-east Asia across the Pacific. During an outbreak in French Polynesia in 2013–2014, Guillain-Barré syndrome was linked to Zika infection and cases of microcephaly in newborn children were also retrospectively linked to this outbreak. The World Health Organization (WHO) received the first reports of locally-transmitted infection from Brazil in May 2015. In July 2015, health ministry officials from Brazil reported an association between Zika virus infection and Guillain-Barré syndrome in adults. In October 2015, WHO received reports from Brazil of microcephaly in babies whose mothers had been exposed to Zika during pregnancy. At this time, there was no proof of a causal link between Zika infection and these neurological complication

## **8.2.1 Influenza (FLU)**

Influenza (the flu) is a respiratory infection caused by the influenza virus which is typically spread by air or by direct contact with the infected person. Most influenza cases occur during the winter months due to epidemic conditions. Influenza virus can strike remarkably large numbers of people in a relatively short time. In the developed nations, about 10–15% of the people are infected each year. The two types of influenza virus are A and B. Influenza A is usually responsible for the annual epidemics. When a person gets infected, its immune system protects it against second infection. But the virus gradually mutates somewhat since the first infection and the change is enough to fool the immune system which later on responds slowly. The symptoms of the flu virus infection can be mild or severe depending upon the type of virus, age and overall health of a person. However, a person may develop chills, high fever, muscle pain, fatigue, dizziness, headache, cough, sore throat and running nose that last for 24 hours. Sometimes, flu may lead to pneumonia. The people who are more vulnerable to flu include infants, old age or people with weak immunity. Diagnosis of the disease includes blood test, x-ray, swab test of the nose and throat secretions. For better prevention of the disease, vaccination is recommended each year for people aged above 6 months and older, besides flu mist that is a vaccine spray recommended for ages of 2 and 49. As the virus passes through air by coughing or direct contact, maintaining a good hygiene will

be helpful to avoid getting the flu virus. Besides antiviral drugs like Zanamivir and Oseltamivir are given by inhalation by anebulizer and in a tablet form respectively as treatment options.

### **8.4.3 Coronavirus disease 2019(COVID-19)**

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease was first identified in December 2019 in Wuhan, the capital of China's Hubei province, and has since spread globally, resulting in the on-going 2019–20 coronavirus pandemic. First confirmed case of what was then an unknown coronavirus was traced back to November 2019 in Hubei province. Common symptoms include fever, cough, and shortness of breath. Other symptoms may include fatigue, muscle pain, diarrhoea, sore throat, loss of smell, and abdominal pain. The time from exposure to onset of symptoms is typically around five days but may range from two to fourteen days. While the majority of cases result in mild symptoms, some progress to viral pneumonia and multi-organ failure. As of 21 April 2020, more than 2.47 million cases have been reported across 185 countries and territories, resulting in more than 170,000 deaths. More than 651,000 people have recovered.

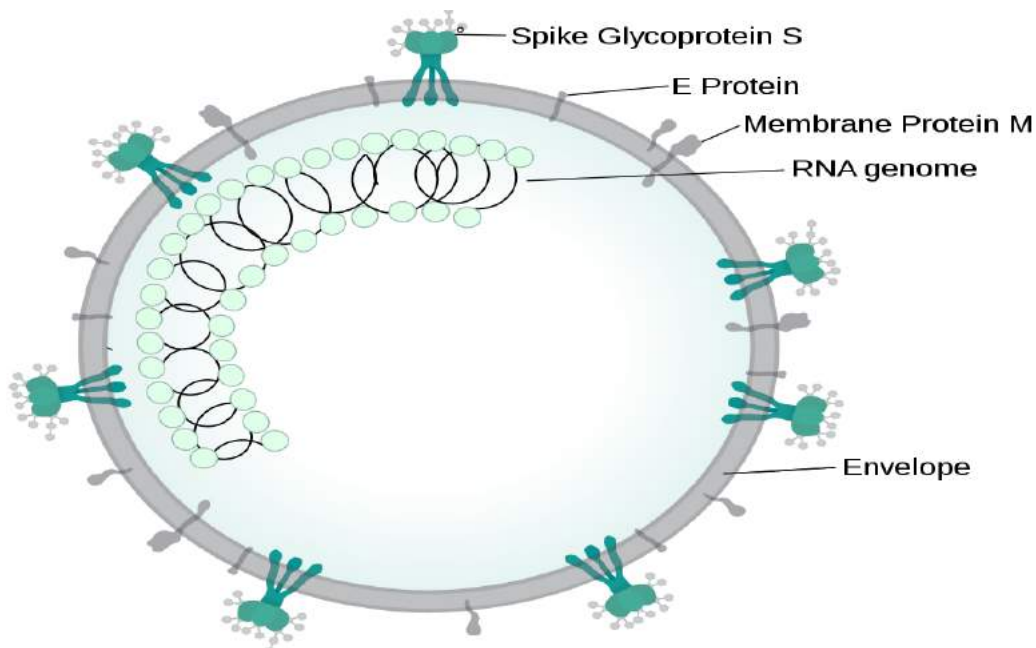
#### **Signs and symptoms:**

Those infected with the virus may be asymptomatic or develop flu-like symptoms such as fever, cough, fatigue, and shortness of breath. Emergency symptoms include difficulty in breathing, persistent chest pain or pressure, confusion, difficulty in walking, and bluish face or lips; immediate medical attention is advised if these symptoms are present. Less commonly, upper respiratory symptoms such as sneezing, runny nose or sore throat may be seen. Gastrointestinal symptoms such as nausea, vomiting and diarrhoea have been observed in varying percentages.

#### **Transmission**

Some details about how the disease is spread are still being determined. The WHO and the U.S. Centers for Disease Control and Prevention (CDC) say, it is primarily spread during close contact and by small droplets produced when people cough, sneeze or talk; with close contact being within approximately 1–3 m (3–10 ft). Both sputum and saliva can carry large viral loads. Loud talking releases more droplets than normal talking. A study in Singapore found that an uncovered cough can lead to droplets travelling up to 4.5 meters (15 feet). An article published in March 2020 argued that advice on droplet distance might be based on 1930s research which ignored the effects of warm moist outbreath surrounding the droplets and that an uncovered cough or sneeze can travel up to 8.2 metres (27 feet)

### Coronavirus virion structure:



Source: [https://commons.wikimedia.org/wiki/File:Coronavirus\\_virion\\_structure.svg](https://commons.wikimedia.org/wiki/File:Coronavirus_virion_structure.svg)

### Diagnosis

The WHO has published several testing protocols for the disease. The standard method of testing is real-time reverse transcription polymerase chain reaction (rRT-PCR). The test is typically done on respiratory samples obtained by a nasopharyngeal swab; however, a nasal swab or sputum sample may also be used.

### Prevention

Preventive measures to reduce the chances of infection include staying at home, avoiding crowded places, washing hands with soap and water often and for at least 20 seconds, practising good respiratory hygiene and avoiding touching the eyes, nose or mouth with unwashed hands. The CDC recommends covering the mouth and nose with a tissue when coughing or sneezing and recommends using the inside of the elbow if no tissue is available. Social distancing strategies aim to reduce contact of infected persons with large groups by closing schools and workplaces, restricting travel and cancelling large public gatherings. Distancing guidelines also include that people stay at least 6 feet (1.8 m) apart.

**There is no medication known to be effective at preventing COVID-19. (APRIL2020)**



*Mycobacterium tuberculosis*

**8.2.2 Tuberculosis (TB)** TB is an airborne disease caused by the bacterium *Mycobacterium tuberculosis* (*M. tuberculosis*). *M. tuberculosis* and seven very closely related mycobacterial species (*M. bovis*, *M. africanum*, *M. microti*, *M. caprae*, *M. pinnipedii*, *M. canetti* and *M. mungi*) together

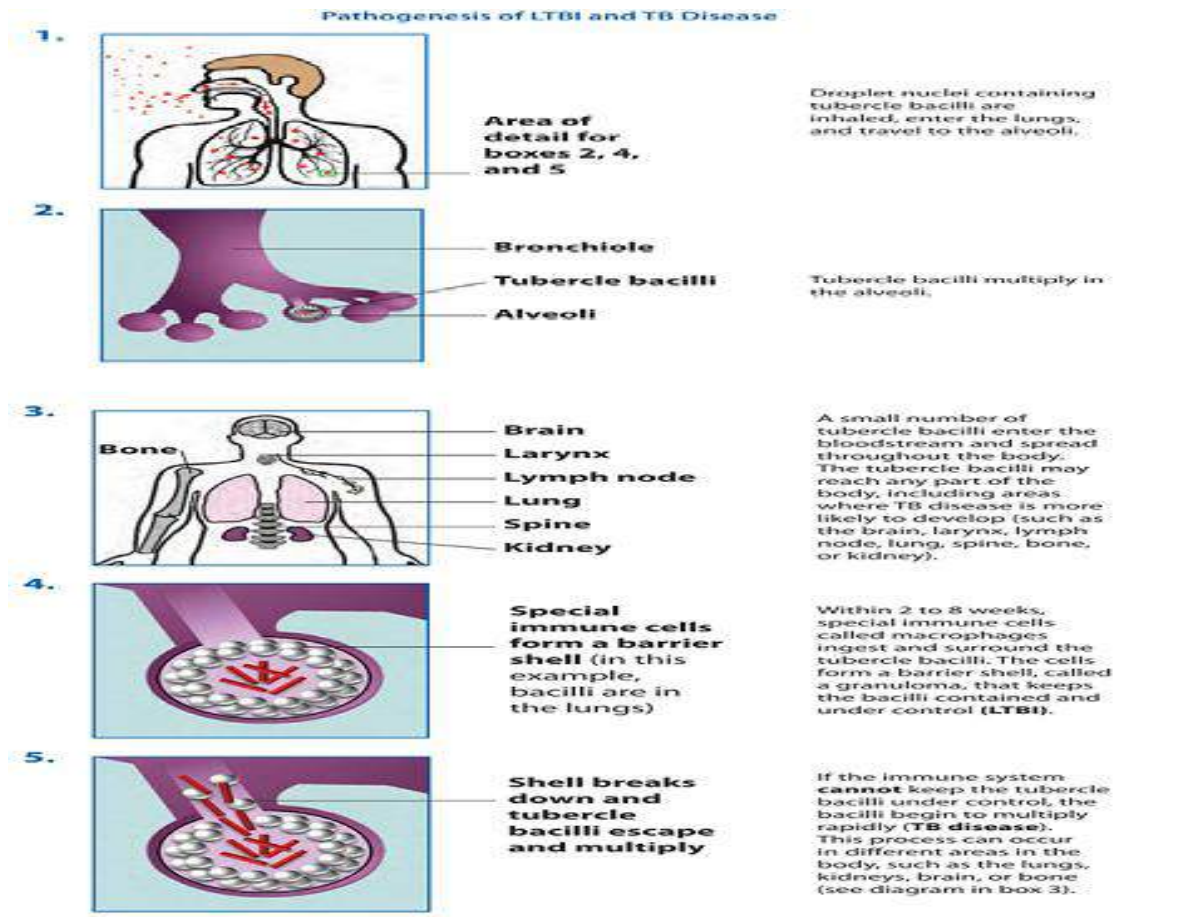
comprise what is known as the *M. tuberculosis* complex. Most, but not all, of these species have been found to cause disease in humans. In the United States, the majority of TB cases are caused by *M. tuberculosis*. *M. tuberculosis* organisms are also called tubercle bacilli.

### **Transmission of TB**

*M. tuberculosis* is carried in airborne particles, called droplet nuclei, of 1–5 microns in diameter. Infectious droplet nuclei are generated when persons who have pulmonary or laryngeal TB disease cough, sneeze, shout, or sing. Depending on the environment, these tiny particles can remain suspended in the air for several hours. *M. tuberculosis* is transmitted through the air, not by surface contact. Transmission occurs when a person inhales droplet nuclei containing *M. tuberculosis*, and the droplet nuclei traverse the mouth or nasal passages, upper respiratory tract, and bronchi to reach the alveoli of the lungs.

### **Pathogenesis of TB**

Infection occurs when a person inhales droplet nuclei containing tubercle bacilli that reach the alveoli of the lungs. These tubercle bacilli are ingested by alveolar macrophages; the majority of these bacilli are destroyed or inhibited. A small number may multiply intracellular and are released when the macrophages die. If alive, these bacilli may spread by way of lymphatic channels or through the bloodstream to more distant tissues and organs (including areas of the body in which TB diseases most likely to develop: regional lymph nodes, apex of the lung, kidneys, brain, and bone). This process of dissemination primes the immune system for a systemic response. Further details about pathogenesis of latent tuberculosis infection (LTBI) and TB disease.



Infection occurs when a person inhales droplet nuclei containing tubercle bacilli that reach the alveoli of the lungs.

### Types of Tuberculosis (TB)

There are two different types of tuberculosis:

- **Pulmonary Tuberculosis.**
- **Extra pulmonary Tuberculosis.**

#### Pulmonary Tuberculosis

It is an endemic infection affecting the lungs. It is further classified into:

**Primary Tuberculosis Pneumonia:** Associated symptoms include coughing and high fever.

It can also arise in patients with HIV/AIDS.

**Miliary Tuberculosis:** This form of TB is named so because of a distinctive pattern seen on a chest radiograph, where many small spots are distributed throughout the lung fields, bearing an appearance similar to millet seeds. The infection can eventually spread to the extra pulmonary organs, such as the spleen, liver, and kidneys.

**Latent Tuberculosis Infection:** This infection is mainly seen in those patients having the bacteria within their body but does not display any of the symptoms of the disease. This infection is primarily detected through the tuberculin skin test.

### **Extra pulmonary Tuberculosis**

It is usually seen in immune-compromised patients. There are several types:

- Tuberculosis Meningitis
- Osteal Tuberculosis
- Lymph Node Disease
- Renal Tuberculosis
- Adrenal Tuberculosis.

### **Diagnosis of Tuberculosis**

Apart from all the physical tests, other tests are available to diagnose the presence the infectious bacteria. These tests include certain body fluids test – blood and sputum, skin test and chest X-rays.

**Blood Test:** In this procedure, Blood samples are collected and are tested in the laboratories for the presence or absence of TB germs in the blood cells.

**Skin Test:** It is the most common type of test. In this procedure, a small sample of Tuberculin – a purified protein is injected under the patient's skin. If the skin around the site of the injection gets swollen more than five millimetres, then it is a clear indication of TB infection.

### **Symptoms of Tuberculosis**

TB bacteria or Mycobacterium tuberculosis multiply once it gets into the lungs. It can cause severe symptoms such as:

1. Coughing up blood and mucus from deep inside the lungs
  - A bad cough that lasts three weeks or longer.
  - Weakness or fatigue.
  - Sweating at night.
  - Pain in the chest.
  - Weight loss.
  - No appetite.
  - Chills and Fever.

### **Causes of Tuberculosis**

Infants and senile individuals are at a higher risk of catching TB infections. Individuals with a weak immune system are at increased risk. Metabolic diseases such as diabetes can also increase the risk of contracting TB. Tuberculosis is a contagious airborne disease, which can be acquired from close contact with an infected person. *Mycobacterium Tuberculosis* is one of the leading causes of this dreadful infectious disease. It is a pathogenic bacterial species and mainly comprises of four other types of TB-causing bacteria, namely:

- *Mycobacterium bovis*,
- *Mycobacterium canettii*,
- *Mycobacterium microti*,
- *Mycobacterium africanum*.

These bacteria could be cultured even in laboratories.

### **Treatment for Tuberculosis**

Drug treatment is one of the most efficient ways to treat this infectious disease. For patients with Latent TB infections, doctors generally prescribe an antibiotic called isoniazid for preventing the latent infection from becoming active.

Active TB Diseases will be deadly if left untreated. The procedure involves in taking a combination of ethambutol, INH, Prifitin and pyrazinamide for a term of three months, followed by a mix of INH and pyrazinamide for 12 months.

## **8.3 Water borne diseases:-**

The term water borne diseases is reserved for infections largely transmitted through contact with or consumption of infected water. It is condition caused by pathogens which are transmitted to humans through contaminated or untreated water. Diseases related to water can spread while bathing, washing, drinking water or taking food exposed to contaminated water. Usually the illness is caused by drinking water contaminated by human or animal faeces that contain pathogenic organisms. Contaminated water can cause many types of diarrhoeal diseases including cholera, and other serious illnesses such as typhoid and dysentery. Such diseases cause 3.4 million deaths every year worldwide. Majority of the water borne diseases worldwide mainly affect children due to poor hygiene and weak immunity. Most of these diseases are life threatening. The pathogens, their toxic exudates and other contaminants together cause serious conditions such as cholera, diarrhoea, hepatitis, typhoid, giardiasis and worm infections.

### 8.3.1 Malaria:-

Malaria is a protozoan diseases caused by infection with parasites of the genus plasmodium & transmitted to man by certain species of infected female Anopheline mosquito. Malaria is one of the oldest recorded diseases in the world. In 1880, Laveran, a French Army Surgeon discovered Malaria parasite in Algiers. The main credit goes to Sir Ronald Ross who while working in Secundrabed (Andhra Pradesh) in 1887 discovered transmission of Malaria by Anophiline mosquito.

According to WHO, malaria afflicts about 500 million people annually in the world & about 90% of the cases occur in Africa alone, & the rest mainly in India, Brazil, Srilanka, Afghanistan, Thailand & Vietnam. In 1976 the incidence of malaria rose to a peak of 64 million cases with 59lakh deaths. The entire population of India(95.9%) is now deemed to be under malaria risk.

#### Environmental Factors:-

1. Temperature(20-30<sup>0</sup>C)
2. Rainfall
3. Humid in condition
4. Seasonal disease maximum prevalence is from July-November

#### Agent Factors:-

Malaria is mainly caused by four different distinct species.

- Plasmodium vivax,
- P.Falciparum,
- P. Malariae&
- P.ovale.

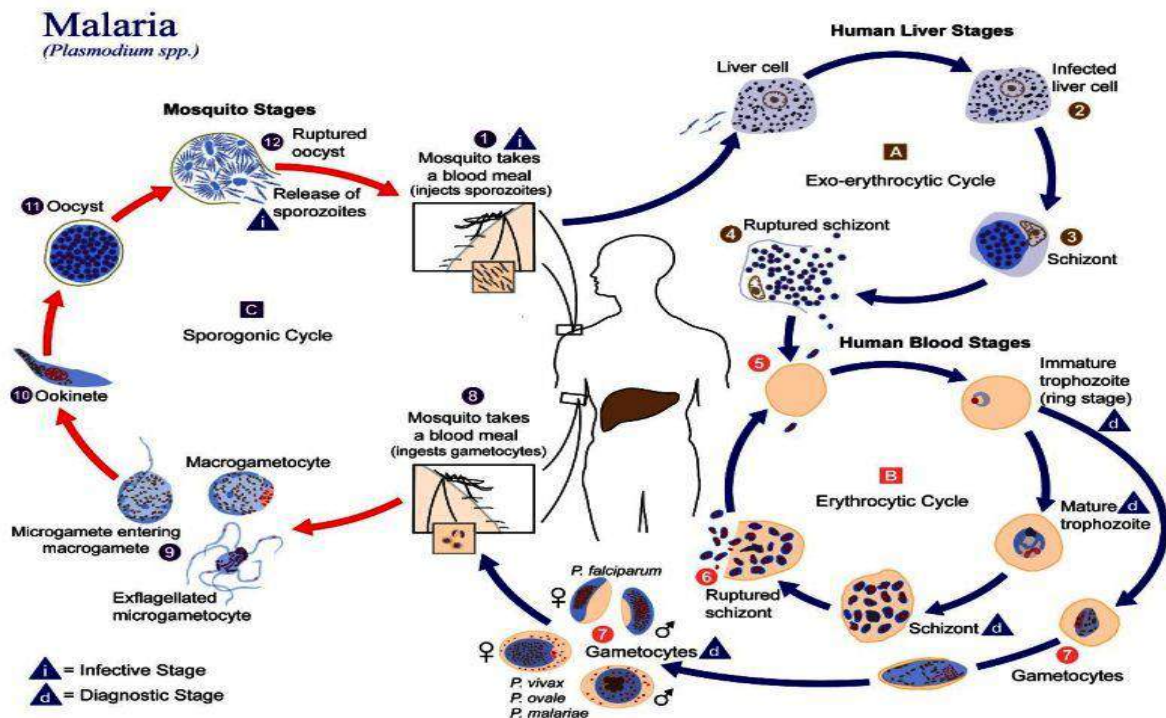
#### Host Factors:-

- Age; affects all ages
- Sex; Male are mostly affected.

#### Vector of malaria:-

Out of 45 species of anopheline mosquitoes in India only a few are regarded as vectors of importance.

Anopheles Culcifacies, A. Fluviatilis, A. Philippinensis.



.Source: [Centers for Disease Control and Prevention website](https://www.cdc.gov/malaria/about/life_cycle/index.html).

The malaria parasite life cycle involves two hosts. During a blood meal, a malaria-infected female *Anopheles* mosquito inoculates sporozoites into the human host.

Sporozoites infect liver cells and mature into schizonts, which rupture and release merozoite. (Of note, in *P. vivax* and *P. ovale* a dormant stage [hypnozoites] can persist in the liver and cause relapses by invading the bloodstream weeks, or even years later). After this initial replication in the liver (exo-erythrocytic schizogony), the parasites undergo asexual multiplication in the erythrocytes (erythrocytic schizogony). Merozoites infect red blood cells. The ring stage trophozoites mature into schizonts, which rupture releasing merozoites. Some parasites differentiate into sexual erythrocytic stages (gametocytes). Blood stage parasites are responsible for the clinical manifestations of the disease.

The gametocytes, male (microgametocytes) and female (macrogametocytes), are ingested by an *Anopheles* mosquito during a blood meal. The parasite's multiplication in the mosquito is known as the sporogonic cycle C. While in the mosquito's stomach, the microgametes penetrate the macrogametes generating zygotes. The zygotes in turn become motile and elongated (ookinetes) which invade the midgut wall of the mosquito where they develop into oocysts. The oocysts grow, rupture, and release sporozoites, which make their way to the mosquito's salivary glands. Inoculation of the sporozoites into a new human host perpetuates the malaria life cycle.

### Mode of Transmission:-

**Vector transmission:** Malaria is transmitted by the bite of certain species of infected female, anopheline mosquitoes.

**Direct transmission:** Malaria may be induced accidentally by hypodermic intramuscular & intravenous injections of blood or plasma.

**Congenital malaria:** Congenital infection of the new born from an infected mother.

**Malaria Control Strategies:** Malaria Control Strategies include programmes like Malaria Action Programme(MAP), Global Malaria Control Strategy(1992).

**Biological Control:** The fish *Gambusia affinis* popularly or commonly known as mosquito fish has been used throughout the tropical world to control malaria.

### 8.3.2 Cholera:

Cholera is both an epidemic & endemic disease. It has been present in India since antiquity. In the history of Cholera, four phases have been described

**Agent factors:** - Cholera is caused by *Vibrio Cholerae*

**Host factor:** - Cholera affects all ages & both sexes. In epidemic region, attack rate is highest in children.

**Environmental factors:-** *Vibrio* transmission is readily possible in a community with poor environmental sanitation. Important environmental factors are contaminated water & food.

### Mode of Transmission & Pathogenicity:

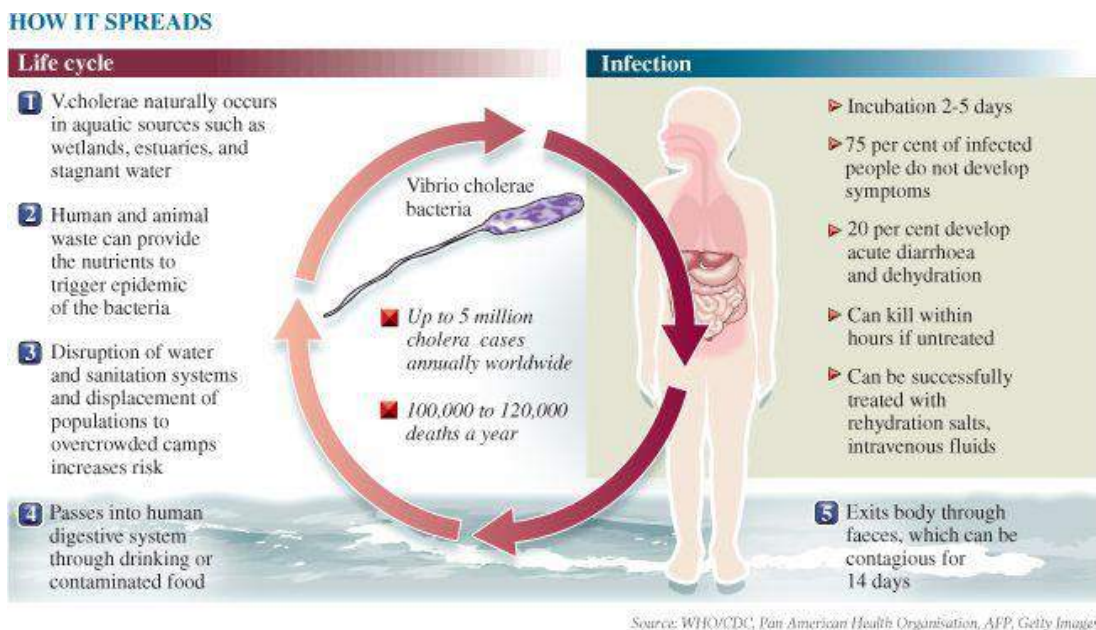


**Fig.8.2. *Vibrio cholera* life cycle**

Transmission occurs from man to man via fiscally contaminated water, contaminated food & drinks & the direct contact. The main symptoms of Cholera is diarrhoea. According to current concept, the Cholera, vibrio gets through the mucus which overlies the intestinal epithelium. It probably secretes mucin which helps to move rapidly through the mucus. Then it gets adhered to the intestinal epithelial cells with the help of probable adherence factor. After adhering the mucosa, the pathogen produces the enterotoxin. The enterotoxin consists of two parts L-toxin & H-toxin. The L-toxin combines with the substances in the epithelial cell membrane called gangliosides. The mode of H-toxin is not fully clear. Probably H-toxin activates adenylcyclase in the intestinal epithelial cells which causes rise in 3, 5-adenosine monophosphate which provides energy to divide fluid & ions into the lumen of the intestine. The increase in the fluid is the cause of diarrhoea.

#### **8.3.2.1 Control of Cholera:**

WHO has proposed guidelines for Cholera. These include verification of the diagnosis, notification, early case finding, establishment of treatment centres, oral rehydration & intravenous rehydration, epidemiological investigation, sanitation measures, vaccination & health education programme.

#### **8.3.3 Typhoid:-**

Also known as enteric fever, it spreads through contaminated food and water. It is a systematic infection caused by bacteria *Salmonella typhi*. The acute illness is characterized by prolonged fever, headache, nausea, loss of appetite vomiting and sometimes diarrhoea. The condition predominantly occurs with poor sanitation and lack of drinking water. The bacteria live in the intestines and bloodstream of humans that spreads by direct contact with the faeces of an infected person.

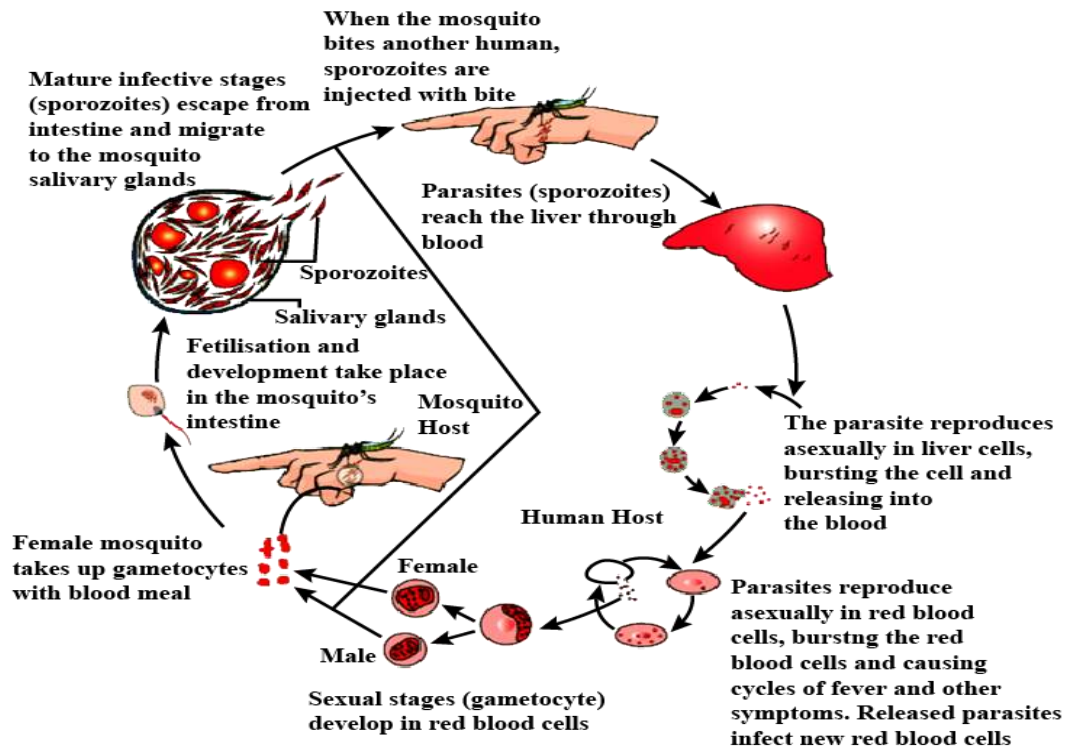


**Fig.8.3. .Life cycle of bacteria *Salmonella typhi* causing Typhoid.** (Source topper.com)

The bacteria enters into the body through faecal-oral route and spends 1 to 3 weeks in the intestines where from it makes its way through intestinal wall to the bloodstream and spreads to other parts and organs. It lives within the host cells safe from the immune system. Symptoms usually appear between 6 and 30 days after infection with two major indications as gradually increasing fever over several days and rose coloured spots on neck and abdomen, sweating, dry cough, weakness, abdominal pain, swollen abdomen, muscle aches etc. Other symptoms include weakness, abdominal pain and constipation. In serious untreated cases, the bowel can become perforated leading to (peritonitis) infection of the tissue forming the inside lining of the abdomen causing bleeding. Some people may carry the infection without being affected but still can spread the disease to others. These people can become long term carriers of the bacteria. The bacteria multiply in gall bladder, bile ducts or liver and pass into the bowel. Another infection known as paratyphoid is caused by *Salmonella enterica* with similar symptoms but less fatal.

The diagnosis of the typhoid fever could be done by analysing the samples of stool, blood or urine besides testing a sample of bone marrow that is more accurate. Sanitation and hygiene are important factors to prevent typhoid from spreading. It spreads in environments where human faeces come in contact with water or food and careful food preparation and washing of hands are crucial in controlling typhoid. Vaccination programmes started in 1999 by WHO

have proven to be great way at controlling out breaks in high incidence areas. Typhoid fever is treated with fluids and antibiotics with chloromphenicol being the drug of choice that kills the bacteria. With the help of antibiotics and supportive care, there is improvement usually within 1 to 2 days and recovery within 7 to 10 days. Commonly prescribed antibiotics include ciprofloxacin, azithromycin, ceftriaxone etc. However, the existence of antibiotic resistance is a growing problem in the treatment of typhoid in the developing countries.

Presently, two vaccines are licensed for use against typhoid as Ty21a and typhoid polysaccharide vaccine. Both are highly recommended for travellers to areas where typhoid is endemic. Keeping our food and water resources neat and clean and proper disposal of infected person's faeces could also prove to be very helpful in controlling this disease.

### **8.3.4 Hepatitis:-**

Liver is a vital organ that processes nutrients, filters the blood and fights infections. When the liver is inflamed or damaged by means of a virus, its functions get affected. Heavy alcohol consumption, toxins, some medicines and certain medical conditions can cause hepatitis. Hepatitis may be temporary (acute) or long term (chronic) that depends whether it lasts for less than or more than 6 months. Mostly acute hepatitis resolves on its own while as chronic form may progress to scarring of liver, liver failure or liver cancer. The most common cause of hepatitis is virus worldwide. There are five types of hepatitis namely hepatitis A, B,C,D and E. Hepatitis A and E are spread through contaminated food and water, B is mainly sexually transmitted but may be passed from mother to baby during pregnancy. Hepatitis B and C are commonly spread through infected blood or may occur during needle sharing by intravenous drug users. Hepatitis D can only infect people who are already infected with hepatitis B. Worldwide hepatitis A affected about 114 million people, B affected about 343 million and C affected 142 million people. People who are at risk for hepatitis B and C include workers in the health care profession, people with multiple sexual partners, intravenous drug abusers and people with haemophilia.

Some people have no symptoms while as others develop yellow discolouration of the skin and whiteness of eyes, poor appetite, vomiting, tiredness, abdominal pain or diarrhoea. The initial phase of hepatitis is known as acute phase where the symptoms include mild fever, fatigue, nausea, diarrhoea, reduced appetite, weight loss and jaundice. As the disease progresses chronic condition can lead to progressive liver failure, resulting in jaundice, swelling of limbs and bloody faeces followed by dark urine, itchy skin, light coloured faeces, yellow skin and whites of the eyes or tongue. As the symptoms of the different hepatitis are

similar, the type and severity of the disease may be diagnosed by blood test, nucleic acid test, liver biopsy, abdominal fluid analysis, elastography etc.

### Life Cycle of the Hepatitis B Virus (Binding and Entry)

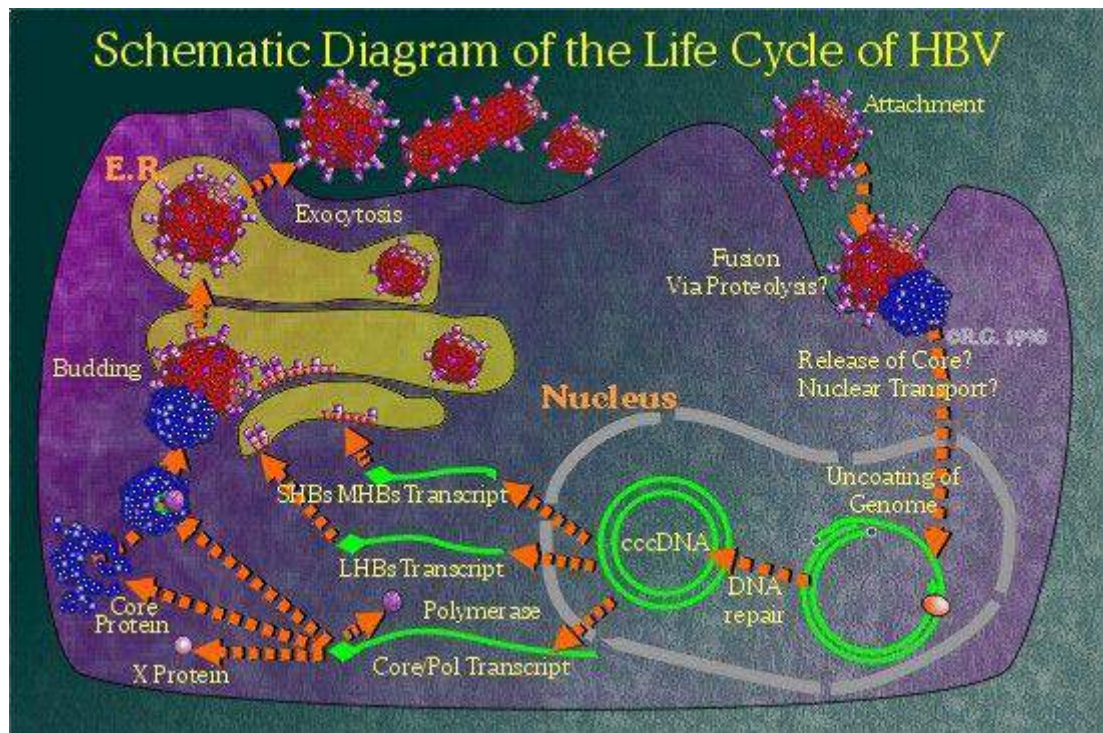


**Fig.8.5. simplified schematic of the HBV replicative cycle (hepatitisbviruspage.com)**

The hepatitis B virus, as in the case of all other viruses, must first attach specifically onto a cell capable of supporting its replication. Though the liver is the most effective cell type for replicating HBV, other extra hepatic sites have been found to be able to support replication to a lesser degree. HBV replicative intermediates and/or viral transcripts have been found in mononuclear cells, bile duct epithelial, endothelial, pancreatic acinar cells, and smooth muscle tissue, as well as in adrenal glands, gonads, cultured bone marrow, kidneys, lymph nodes, spleen, and thyroid glands of acute hepatitis B infected patients. Viral attachment often determines host and tissue specificity of a virus. However, for HBV, there are no cell-lines available that are able to support viral replication. Only primary duck hepatocytes, which are freshly explanted from the liver, can support DHBV infection. Consequently, the initial steps of HBV entry is poorly understood. However, several differentiated and immortalized cell lines are capable of supporting viral replication if transfected with viral DNA. The availability of these cell systems has allowed for the elucidation of much of the hepatitis B lifecycle. Many proteins have been found associated with the various hepatitis B surface proteins. Attempts to define the receptor for HBV have yielded a plethora of candidates such

as Apo lipoprotein H(Apo-H) an altered form of Apo lipoprotein H (alt.Apo-H), poly-human serum albumin (pHSA), fibronectin, and interleukin-6 (IL-6). More recently, a protein (gp180) has been identified to interact with the preS1 domain in DHBV. Also, an 80kd protein has been found to bind onto human HBV which has yet to be identified. Despite these findings, the proteins and mechanism of HBV entry into cells has yet to be well characterized.

Hepatitis can be dangerous and difficult to treat, so people are advised to take ample precautions to stay safe from its infection. To prevent hepatitis A, proper hand washing, consuming freshly prepared food, taking bottled or boiled water, consuming peelable fruits and getting vaccinated before are some of the effective measures to be taken. To minimize the risk of transmission of hepatitis B, use of clean needles, practicing safe sex, not sharing razors and toothbrushes are highly effective. As hepatitis C is often transmitted through sharing body fluids, so not sharing needles, using sterilised equipment for skin piercing, reducing alcohol consumption and avoiding injecting illegal drugs could be some steps effective in preventing its transmission. The treatment of hepatitis varies, depending upon the type, severity and the cause of the disease. Treatment is usually supportive that includes taking intravenous hydration, medication, liver transplant and maintaining healthy nutrition. Many patients have been treated with antiviral therapy. Injectable interferon alpha is the first therapy approved for chronic hepatitis while as pegylated interferon is given as subcutaneous injection once a week which is more effective than standard interferon. Lamivudine being first approved oral nucleoside analogue for first line therapy.

## **8.4 Soil Borne Diseases:-**

Soil borne diseases are transmitted from soil to humans

**8.4.2 Botulism:-**The term “Botulism” is commonly used to describe poisoning with Clostridium botulinum toxin. Clostridium botulinum bacteria are normally found in soils and aquatic sediments. To thrive, the bacteria need:

- Temperatures between 40-120°F/ 5-49°C
- Anaerobic conditions (Oxygen below 2%)
- Neutral pH
- Moist conditions (Water activity level greater than 0.85)

A sealed jar of moist, low acid food provides excellent conditions for the growth of botulism bacteria. If food is not processed correctly, it's possible for the toxins to build to dangerous levels within 3-4 days.

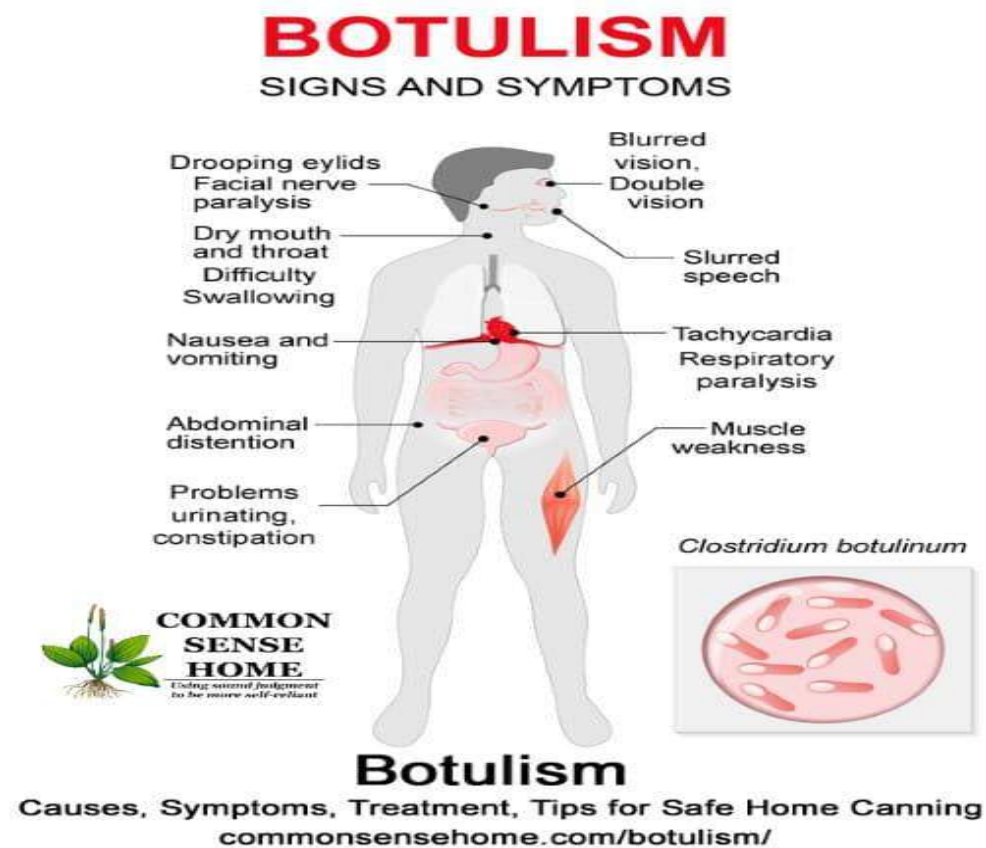


**Fig.8.6. Botulism signs and Symptoms** Source (commonsensehome.com)

The CDC monitors four different categories of botulism causes (transmission categories):

- Food borne botulism is caused by the consumption of foods containing pre-formed botulinum toxin.
- Wound botulism is caused by toxin produced in a wound infected with *Clostridium botulinum*.
- Infant botulism by definition occurs in persons less than one year of age and is caused by consumption of spores of *C. botulinum*, which then grow and release toxins in the intestines.
- “Other” botulism, Consistent with the Council of State and Territorial Epidemiologists (CSTE) position statements, the “other” category includes botulism in which the route of transmission is unknown. Cases are classified as “other” if the patient with confirmed botulism is not an infant, has no history of ingesting a suspect food, and has no wounds. The “other” category also includes iatrogenic botulism, which is caused by an accidental overdose of botulinum toxin (that is, a therapeutic or cosmetic injection) and

- Adult intestinal colonization (adult intestinal toxemia) botulism, a rare kind of botulism that occurs among adults by the same route as infant botulism.

### 8.4.1 Tetanus:

Also known as Lockjaw, Tetanus is caused by a neurotoxin produced by the bacterium *Clostridium tetani*. The disease is characterised by muscle contractions of the jaw and neck, including generalised muscle spasms. Although it is now rare in the developed world, tetanus can be fatal without appropriate and timely access to medical care.

#### Causes and transmission

*C. tetani* is a Gram-positive, spore-forming bacillus commonly found in soil and the faeces of animals, such as horses and cows. Human infection occurs through direct contamination of a wound with these spores; tetanus is not spread from person to person. Common ways in which tetanus is acquired include:

- Burns with systemic sepsis;
- Certain animal bites and scratches (if the animal lives in an agricultural setting);
- Compound fractures;
- Contaminated surgery (use of non-sterile instruments/material);
- Cuts with/without foreign objects;
- Eye injuries;
- Gunshot wounds;
- Injecting contaminated drugs;
- Piercings;
- Puncture wounds acquired in a contaminated environment (e.g. gardening injuries);
- Splinters and other puncture wound

The average incubation period of the disease is between 3 and 21 days. Under favourable anaerobic conditions, the spores germinate into toxin-producing tetanus bacilli. The potent neurotoxin is transported via the blood and the lymphatic system to the spinal cord and brainstem, where it enters inhibitory interneurons within the host. It then binds to membrane proteins within the neurons and disrupts the release of inhibitory neurotransmitters in the central nervous system that normally modulate anterior horn cells and muscle contraction. This results in increased muscle tone, contractions, painful spasms and autonomic instability.

#### Symptoms

There are three main clinical presentations of tetanus

### ➤ **Generalised tetanus**

This is the most common and severe clinical form of tetanus and is characterised by trismus (lockjaw), muscle rigidity and painful muscle spasms. During generalised tetanic spasms, patients characteristically clench their fists, arch their back, and flex and abduct their arms while extending their legs. Continual spasms and rigidity can lead to breathing difficulties. Other severe symptoms include autonomic instability (i.e. when the autonomic nervous system does not function correctly) resulting in tachycardia, hypertension and sweating (sometimes rapidly alternating with bradycardia and hypotension).

### ➤ **Local tetanus**

Presents with tonic and spastic muscle contractions in one extremity or body region, usually in the same area as the injury site. Local tetanus often, but not invariably, progresses to generalised tetanus.

### ➤ **Cephalic tetanus**

This is a rare form of the disease. Patients with injuries to the head or neck may present with cephalic tetanus, which initially involves only cranial nerves. The facial nerve is most commonly affected, but involvement of other cranial nerves may also occur. Patients may manifest confusing clinical findings including dysphagia, trismus and focal cranial neuropathies that can lead to a misdiagnosis of stroke. Like other forms of local tetanus, patients with cephalic tetanus can progress to generalised tetanus.

## **Diagnosis**

The diagnosis of tetanus includes the presence of clinical symptoms, a history of recent events (e.g. recent cut or wound that may have introduced tetanus spores) and differential diagnosis. Tetanus is more likely if there is dirt or something inside the wound and if the patient has not been fully vaccinated.

## **Treatment**

Tetanus-containing vaccine and/or immunoglobulin should be administered if necessary.

## **8.5 Occupational and work-related diseases**

### **Definitions of occupational diseases**

According to the Protocol of 2002 to the Occupational Safety and Health Convention, 1981 (No. 155), the term “occupational disease” covers any disease contracted as a result of an exposure to risk factors arising from work activity.

### ***The Wake-up Calls: Environmental Catastrophes***

- *Minamata disease (1953–1961) –Methyl mercury poisoning*
- *Seveso, Italy (1976) –Leak of toxic gas (TCDD) „*
- *Bhopal (1984) –16.5 tons of toxic pesticide released*
- *Chernobyl (1986) –Nuclear reactor accident „*
- *Milwaukee incident (1993) –Cryptosporidium in drinking water*

The ILO Employment Injury Benefits Recommendation, 1964 (No. 121), Paragraph 6(1), defines occupational diseases in the following terms: “Each Member should, under prescribed conditions, regard diseases known to arise out of the exposure to substances and dangerous conditions in processes, trades or occupations as occupational diseases.”

An “occupational disease” is any disease contracted primarily because of an exposure to risk factors arising from work activity. An occupational disease is not characterised merely by the disease itself, but by a combination of a disease and an exposure, as well as an association between these two. Classifications of occupational diseases have been developed mainly for two purposes:

1. Surveillance and notification for labour inspection purposes
2. Social security (compensation) purposes.

Most of the classification systems have the following hierarchy:

1. Diseases caused by agents
  - 1.1 Diseases caused by chemical agents
  - 1.2 Diseases caused by physical agents
  - 1.3 Diseases caused by biological agents
2. Diseases by target organ
  - 2.1 Occupational respiratory diseases
  - 2.2 Occupational skin diseases
  - 2.3 Occupational musculoskeletal diseases
3. Occupational cancer
4. Others

Different occupational diseases include lung diseases (Silicosis, Asbestosis, Byssinosis, and Pneumoconiosis) and skin diseases (sun burn, Eczema, Skin cancer, dermatitis, urticaria).

### 8. 5.1 Silicosis:-

It is caused by exposure to crystalline silica that comes from chipping, cutting, drilling or grinding soil sand granite or other minerals. An occupation where earth's crust is disturbed can cause silicosis. It is also known as miner's phthisis, grinder's asthma or potter's rot. Various occupations known to expose workers to silicosis are; tunnel work, masonry, sand blasting, hard rock mining, ceramic and glass manufacturing and steel work. It is a lung disease caused by the inhalation of crystalline silica dust which causes inflammation and scarring in the form of nodular lesions in the upper lobes of lungs that harm the ability to breathe. The inhaled silica dust causes fluid build-up and scar tissue in the lungs and damages the lining of the air sacs that reduces the breathing capacity. It is of following types;

- Acute silicosis: where lungs become very inflamed filled with fluid causing severe shortness of breath and reduced oxygen levels.
- Chronic silicosis: it appears 10 to 30 years after exposure where the silica dust causes the swelling of the lungs and chest lymph nodes making breathing more difficult.
- Accelerated silicosis: appears within 10 years of high level exposure characterised by swelling in the lungs and symptoms are faster than chronic silicosis.

People with acute silicosis experience chest pain, weight loss, tiredness and cough while as those with chronic silicosis face shortness of breath and extensive scarring. However some later symptoms include trouble breathing, swollen legs, blue lips, sudden fever etc. Silicosis can increase the chances of getting some serious lung diseases like chronic bronchitis, lung cancer and TB. Chest x-ray, biopsy, sputum test and bronchoscopy are the tests required to diagnose the silicosis disease. Although there is no treatment for silicosis however, medications like inhaled steroids can reduce lung mucus, bronchodilators can relax breathing passage while as oxygen therapy reduces fatigue and lung transplant surgery is needed in advanced lung damage. The disease can be prevented by reducing the exposure to silica and wearing a mask or protective cloths. Other ways to prevent silicosis include proper ventilation, use of respirators, and use of wet methods for grinding materials and not drinking or eating near silica dust.

### 8.5.2 Asbestosis:-

It is a chronic lung disease or a type of pulmonary fibrosis caused by inhalation of asbestos fibres at work places which leads to long term breathing complications. Asbestos is a natural mineral resistant to heat and corrosion and used extensively in products like cement,

insulation and floor tiles. Prolonged exposure can cause scarring of lung tissues and shortness of breath. On exposure to high levels of asbestos over prolonged periods of time, the air borne fibres become lodged within the alveoli of the lungs irritating and scarring lung tissue and making breathing difficult. Pleural thickening of the lung lining is caused by the long term presence of asbestos fibres or pleural effusion which means build up of fluid between chest walls and lungs. As asbestos progresses, more and more lung tissues become scarred and eventually whole lung becomes so stiff that it can't expand and contract normally. People like miners, aircraft mechanics, boiler operators, electricians, shipyard workers etc who work in mining, milling, manufacturing, installation and removal of asbestos and its products are at greater risk of getting asbestos. Asbestos could increase the chances of lung cancer if a patient has a history of smoking.

The symptoms can range from mild to severe which usually don't appear until many years after exposure. Long term exposure to asbestos doesn't show effects up for 10 to 40 years after initial exposure. Some major symptoms include dry cough, shortness of breath, loss of appetite, chest pain, fatigue, loss of weight and appetite, cracking sound while breathing and advanced symptoms like wider and rounder finger and toes than normal, pulmonary hypertension. Its diagnoses require thorough medical and occupational histories besides medical testing. Chest x-ray, lung function test and CT scan are some of the tests recommended for its diagnosis.

Reducing exposure to asbestos is the best way to prevent asbestosis besides quitting smoking, following pulmonary rehabilitation programme, healthy nutrition and getting vaccines against Flu and pneumonia. Although it is an incurable disease, once developed it is not possible to reverse the damage to lungs but treatment can alleviate symptoms. Except lung transplant, all other treatment options only address the symptoms of asbestosis to improve the life quality of patient. Some medications are available to help with coughing and pain like use of inhalers, pain relievers, supplementary oxygen and antibiotics. To alleviate some symptoms, patients may change lifestyle by quitting smoking or reducing daily physical activity besides adjustments in diet schedule.

## **8.6 Sexually Transmitted Diseases**

Sexually transmitted diseases (STDs) or sexually transmitted infections (STIs) can be caused by: Bacteria (gonorrhea, syphilis, chlamydia) Parasites (trichomoniasis) Viruses (human papillomavirus, genital herpes, HIV).



**8.6.1 AIDS:-**The Acquired Immune Deficiency Syndrome sometimes called slim disease is a fatal disease caused by retro virus known as the human immune deficiency virus which breaks down the bodie's immune system living the victim vulnerable to a host of life threatening infections.

HIV has infected 46million people where 36million deaths have been recorded as of 2012.

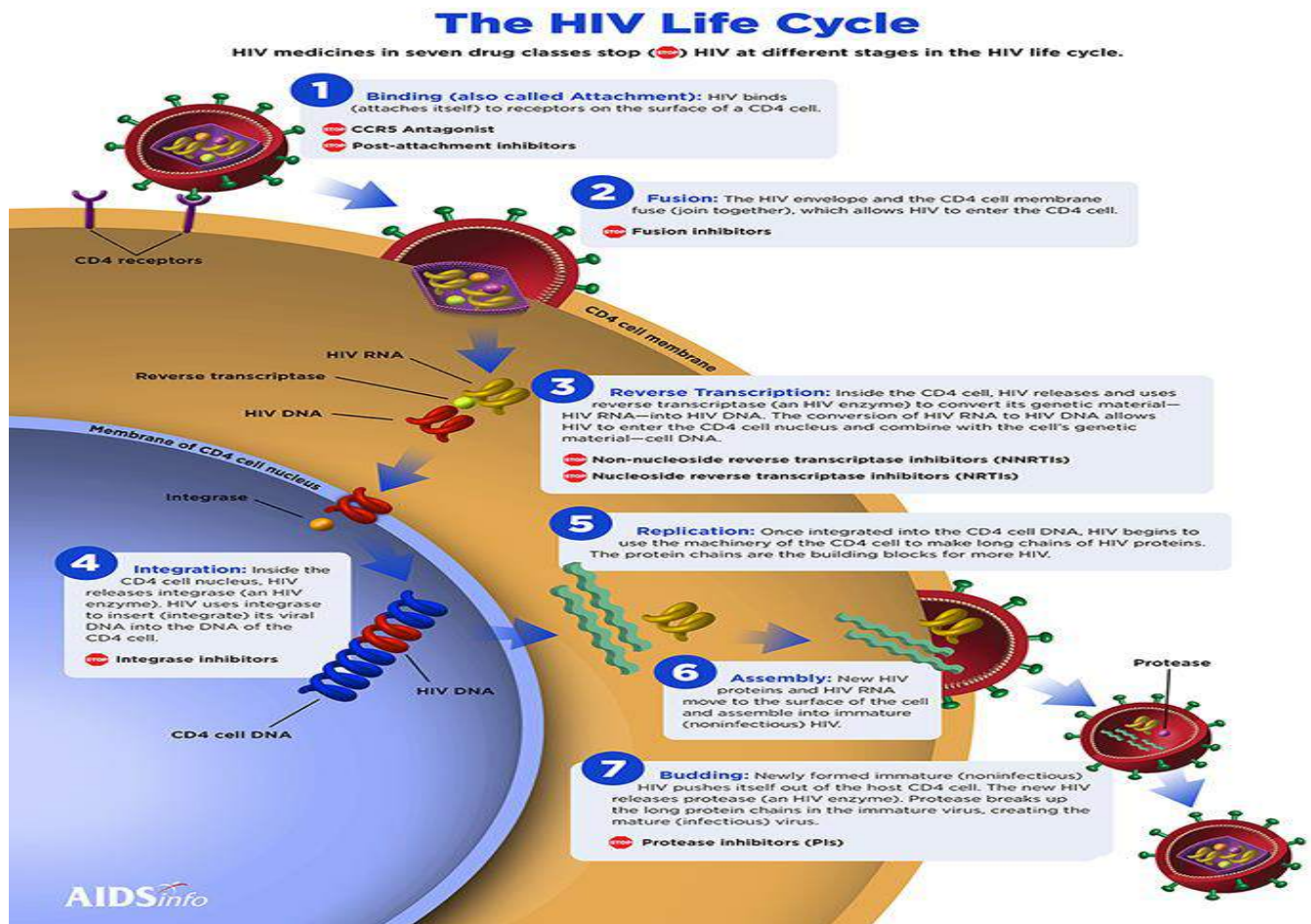
**Epidemiological Features:-**

Agent factors:-In May1986 the international community on the taxonomy named the AIDS causing virus as human immune deficiency virus. It is1/10000mm in diameter. It is a protein capsule containing two short strengths of genetic material RNA &a few enzymes. These viruses use human cells to perpetual itself. The virus replicates inactively dividing into T<sub>4</sub> lymphocytes & like other retro virus state in lymphoid cells that can be activated. The virus has unique ability to destroy human T<sub>4</sub> cells & can spread throughout whole body. The virus can pass through blood brain barrier& can destroy brain cells.HIV mutates rapidly & can affect any part of the body. There are two types of HIVs, HIV1 & HIV2.

**HIV life cycle:**

HIV attacks and destroys the CD4 cells of the immune system. CD4 cells are a type of white blood cell that plays a major role in protecting the body from infection. HIV uses the machinery of the CD4 cells to multiply and spread throughout the body. This process, which is carried out in seven steps or stages, is called the HIV life cycle.The seven stages of the HIV life cycle are:

- |                       |                       |                                 |
|-----------------------|-----------------------|---------------------------------|
| <b>1) Binding</b>     | <b>2) Fusion</b>      | <b>3) Reverse Transcription</b> |
| <b>4) Integration</b> | <b>5) Replication</b> | <b>6) Assembly 7) Budding</b>   |



Source : (From the National Institute of Allergy and Infectious Diseases:)

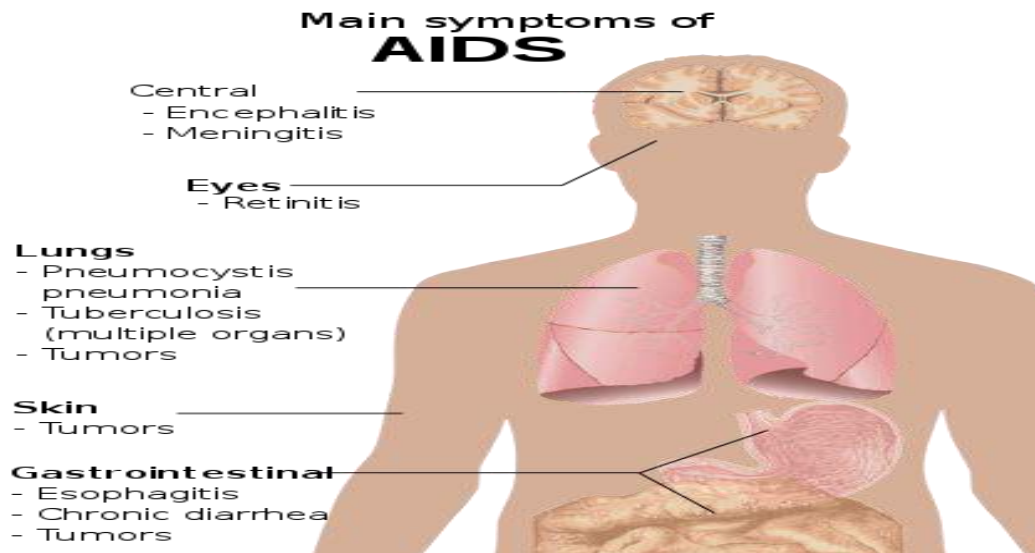
### Host Factors:-

Age, Sex & Immunological status of the host are important factors of host. Most cases of infection occur in sexual active person.

### Signs and symptoms:

There are three main stages of HIV infection:

- Acute infection
- Clinical latency
- AIDS.



Main symptoms of acute HIV infection, Source: (Häggström, Mikael, 2014).

### **Acute infection**

The initial period following the contraction of HIV is called acute HIV, primary HIV or acute retroviral syndrome. Many individuals develop an influenza-like illness or a mononucleosis-like illness 2–4 weeks after exposure while others have no significant symptoms. Symptoms occur in 40–90% of cases and most commonly include fever, large tender lymph nodes, throat inflammation, a rash, headache, tiredness, and/or sores of the mouth and genitals. The rash, which occurs in 20–50% of cases, presents itself on the trunk and is maculopapular, classically. Some people also develop opportunistic infections at this stage. Gastrointestinal symptoms, such as vomiting or diarrhoea may occur. Neurological symptoms of peripheral neuropathy or Guillain–Barre syndrome also occurs. The duration of the symptoms varies, but is usually one or two weeks.

### **Clinical latency**

The initial symptoms are followed by a stage called clinical latency, asymptomatic HIV, or chronic HIV. Without treatment, this second stage of the natural history of HIV infection can last from about three years to over 20 years (on average, about eight years). While typically there are few or no symptoms at first, near the end of this stage many people experience fever, weight loss, gastrointestinal problems and muscle pains. Between 50% and 70% of people also develop persistent generalized lymphadenopathy, characterized by unexplained, non-painful enlargement of more than one group of lymph nodes (other than in the groin) for over three to six months.

Although most HIV-1 infected individuals have a detectable viral load and in the absence of treatment will eventually progress to AIDS, a small proportion (about 5%) retain high levels of CD4<sup>+</sup> T cells (T helper cells) without antiretroviral therapy for more than five years. These individuals are classified as "HIV controllers" or long-term nonprogressors (LTNP). Another group consists of those who maintain a low or undetectable viral load without antiretroviral treatment, known as "elite controllers" or "elite suppressors". They represent approximately 1 in 300 infected persons.

### **Acquired immunodeficiency syndrome**

Acquired immunodeficiency syndrome (AIDS) is defined as an HIV infection with either a CD4<sup>+</sup> T cell count below 200 cells per  $\mu\text{L}$  or the occurrence of specific diseases associated with HIV infection. In the absence of specific treatment, around half of people infected with HIV develop AIDS within ten years. The most common initial conditions that alert to the presence of AIDS are pneumocystis pneumonia (40%), cachexia in the form of HIV wasting syndrome (20%), and esophageal candidiasis. Other common signs include recurrent respiratory tract infections. Opportunistic infections may be caused by bacteria, viruses, fungi, and parasites that are normally controlled by the immune system. Which infections occur depends partly on what organisms are common in the person's environment. These infections may affect nearly every organ system.

### **Mode of Transmission:**

The causative virus is transmitted from person to person most frequently through sexual activity or blood transfusion. The most common methods are:

1. Sexual transmission;-Oral sex & Oval sex.
2. Blood content:-By infected blood transfusion.
3. Congenital transmission.
4. Maternal foetus transmission.

### **Treatment for HIV**

The treatment for HIV is called antiretroviral therapy (ART). ART involves taking a combination of HIV medicines (called an HIV treatment regimen) every day. ART is recommended for everyone who has HIV. ART can't cure HIV, but HIV medicines help people with HIV live longer, healthier lives. ART also reduces the risk of HIV transmission.

### **Control of AIDS:**

There are three basic approaches to control of AIDS:

**Education:** Until a vaccine or cure of AIDS is found the only means at present available is health education on avoiding indiscriminate sex & using Condoms.

**Prevention of blood borne HIV Transmission:-**People in high risk groups should be asked to refrain from donating blood, body organs, sperm or other tissues. Blood should be screened for HIV1&HIV2 before transmission.

**Specific prophylaxis:-**Anti-viral chemotherapy with the chemical compound Zidovudine while notin prolonging the life of severely ill patients.

**Primary health care:-**AIDS touches all aspects of primary health care; including mother child health, family planning & education, it is important therefore that AIDS Control Programme should be launched at international level. The WHO has launched global programme on AID on 1 February 1987 to provide global leadership & support the development of national AIDS programme. First December. is being celebrated as world AIDS day in order to aware, prevent & control the transmission of AIDS.

### 8.6.1 Environmental factors influencing the spread of communicable diseases

A number of environmental factors influence the spread of communicable diseases that are prone to cause epidemics. The most important of these are:

- Water supply
- Sanitation facilities
- Food
- Climate.

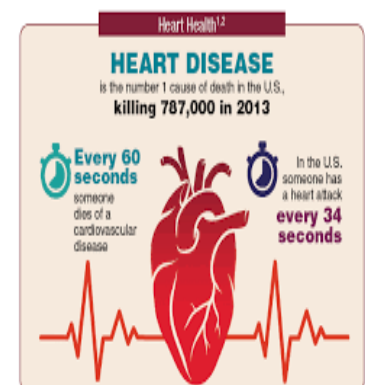
A lack of safe water, inadequate excreta disposal facilities, poor hygiene, poor living conditions and unsafe food can all cause diarrhoeal diseases. These diseases are a major cause of suffering and death in an emergency situation.

Climate can affect disease transmission in a variety of ways. The distribution and population size of disease vectors can be heavily affected by local climate. Flooding after heavy rains can result in sewage overflow and widespread water contamination. In addition, there is some evidence to suggest that pathogens spread from one region to another along air streams or by wind.

## 8.7 Non-communicable diseases

These diseases affect the individuals and cannot be passed into others. They are caused by reduced physical activity, bad eating habits, alcohol and smoking.

### 8.7.1 Cardiovascular Diseases:-



These are a group of diseases of heart and vascular system. These are more prevalent in the urban areas than in rural areas. Cardiovascular Disease (CVD) includes dysfunctional conditions of the heart, arteries and veins that support oxygen to vital life-sustaining areas of the body like the brain, the heart itself. Without oxygen tissue or organ would die.

High blood pressure (hypertension) often results from excess fat in the blood. It blocks the supply of blood to all areas of body.

### **Heart disease**

Heart and blood vessel disease (also called heart disease) includes numerous problems, many of which are related to a process called atherosclerosis.

Atherosclerosis is a condition that develops when a substance called plaque builds up in the walls of the arteries. This build-up narrows the arteries, making it harder for blood to flow through. If a blood clot forms, it can block the blood flow. This can cause a heart attack or stroke.

### **Heart attack**

A heart attack occurs when the blood flow to a part of the heart is blocked by a blood clot. If this clot cuts off the blood flow completely, the part of the heart muscle supplied by that artery begins to die. Most people survive their first heart attack and return to their normal lives, enjoying many more years of productive activity. But experiencing a heart attack does mean that you need to make some changes.

The medications and lifestyle changes that your doctor recommends may vary according to how badly your heart was damaged, and to what degree of heart disease caused the heart attack.

### **Stroke**

An ischemic stroke (the most common type of stroke) occurs when a blood vessel that feeds the brain gets blocked, usually from a blood clot.

When the blood supply to a part of the brain is cut off, some brain cells will begin to die. This can result in the loss of functions controlled by that part of the brain, such as walking or talking. A haemorrhagic stroke occurs when a blood vessel within the brain bursts. This is most often caused by uncontrolled hypertension (high blood pressure).

Some effects of stroke are permanent if too many brain cells die after being starved of oxygen. These cells are never replaced.

The good news is that sometimes brain cells don't die during stroke — instead, the damage is temporary. Over time, as injured cells repair themselves, previously impaired function

improves. (In other cases, undamaged brain cells nearby may take over for the areas of the brain that were injured.)

Either way, strength may return, speech may get better and memory may improve. This recovery process is what stroke rehabilitation is all about.

### **Heart failure**

Heart failure, sometimes called congestive heart failure, means the heart isn't pumping blood as well as it should. Heart failure does not mean that the heart stops beating that's a common misperception. Instead, the heart keeps working, but the body's need for blood and oxygen isn't being met.

Heart failure can get worse if left untreated. If your loved one has heart failure, it's very important to follow the doctor's orders.

### **Arrhythmia**

Arrhythmia refers to an abnormal heart rhythm. There are various types of arrhythmias. The heart can beat too slow or too fast or irregularly.

Bradycardia, or a heart rate that's too slow, is when the heart rate is less than 60 beats per minute. Tachycardia, or a heart rate that's too fast, refers to a heart rate of more than 100 beats per minute. An arrhythmia can affect how well your heart works. With an irregular heartbeat, your heart may not be able to pump enough blood to meet your body's needs.

### **8.7.2 Diabetes Mellitus**

It is a chronic disease and is a serious health problem in Asia. Diabetes is a disease in which body either fails to produce insulin or the insulin produced is unable to adequately trigger the conversion of food into energy.

The symptoms are:-

1. Excessive thirst.
2. Frequent urination.
3. Weight Loss.
4. Blurred Vision.
5. Increased hunger.
6. Urinability.
7. Slow to healing of wounds
8. Extreme unexplained fatigue.

## **8.8 Traditional and Local system of Medicine.**

Traditional medicines refers to health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, exercises to treat diagnose and prevent illness.

Countries in Africa, Asia and Latin America use traditional medicine to help meet some of their primary health care needs. In Africa about 80% of population uses traditional medicine for primary health-care.

## **8.9 Incident of disease as an indicator of the health of environment (Minamata disease)**

Minmata disease sometimes referred as ChissoMinamata disease is a neurological Syndrome caused by severe Hg poisoning. Symptoms include ataxia in the hands & feet, narrowing the vision, coma & congenital disease can also affect foetus in the woman.

Minmata disease was first discovered in Minamata city in Japan in 1956. It was caused by the waste water from the Chisso co-operation chemical factory. This highly toxic chemical bio-accumulation in shellfish & in Minmata way, which when eaten by local people resulted in mercury poisoning causing deaths in humans, cats, dogs, pigs which continued for 36 yrs. A second outbreak occurring 1965 in Niihara Japan & effecting almost 30 thousand people living in the catchment areas.

## **ADDITIONAL INFORMATION**

### **10 facts of disease prevention through healthy environments**

An estimated 12.6 million people died as a result of living or working in an unhealthy environment in 2012 nearly 1 in 4 global deaths. Environmental risk factors such as air, water and soil pollution, chemical exposures, climate change, and ultraviolet radiation contribute to more than 100 diseases and injuries.

In March 2016, WHO published the second edition of the report, *“Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks”*, which cites proven strategies for preventing disease and deaths through healthy environments.

#### **Fact 1: Nearly 1 in 4 deaths across the globe are due to environmental factors**

Every year an estimated 12.6 million people die as a result of living or working in an unhealthy environment.

#### **Fact 2: Non-communicable diseases cause 65% of environmental-related deaths**

Some 8.2 million out of the 12.6 million deaths caused by the environment each year are due to non-communicable diseases, primarily linked to air pollution. Stroke, heart disease, unintentional injuries, cancers and chronic respiratory infections are the top five causes of environmental-related deaths.

#### **Fact 3: Deaths from infectious diseases have declined**

In the past decade, deaths due to infectious diseases, such as diarrhoea and malaria, often related to poor water, sanitation and waste management have declined. Increases in access to safe water and sanitation and decreases in households using solid fuels for cooking have been key contributors to this decline, alongside better access to immunization, insecticide-treated mosquito nets and essential medicines.

#### **Fact 4: Children under 5 years of age are most affected by the environment**

Yearly, 1.7 million deaths in children less than 5 years of age are due to the environment. The most prominent causes of death are lower respiratory infections, such as pneumonia, and diarrhoeal diseases.

#### **Fact 5: Older adults are the second age group most impacted by the environment**

Yearly, 4.9 million deaths in adults between 50 and 75 years of age are due to the environment. Unlike children under 5, older adults are most affected by non-communicable diseases.

**Fact 6: Low and middle-income countries bear the greatest share of environmental disease**

Regionally, low and middle-income countries in the WHO South-East Asia and Western Pacific Regions had the largest environment related disease burden in 2012, with a total of 7.3 million deaths, most attributable to indoor and outdoor air pollution.

**Fact 7: Environmental impacts are uneven across different social groups**

Exposure to environmental risk factors is unequally distributed across populations. This unequal distribution is often related to social characteristics such as income, social status, employment and education, but also non-economic aspects such as gender, age and ethnicity.

**Fact 8: Environmental disease burden is preventable**

Health and other sectors need to work together to reduce the environmental disease burden. For example, traffic congestion and public transport networks are important determinants of air pollution, and usually require cooperation with the transport sector and city planners.

**Fact 9: Local governance must address environmental health planning**

Municipalities are natural leaders of the local environment and health planning. They are often involved in developing the local economy, including transport, tourism, and industry, and can play an important role in healthy planning if they are aware of the potential risks and benefits at stake, and are provided with the tools and support they need.

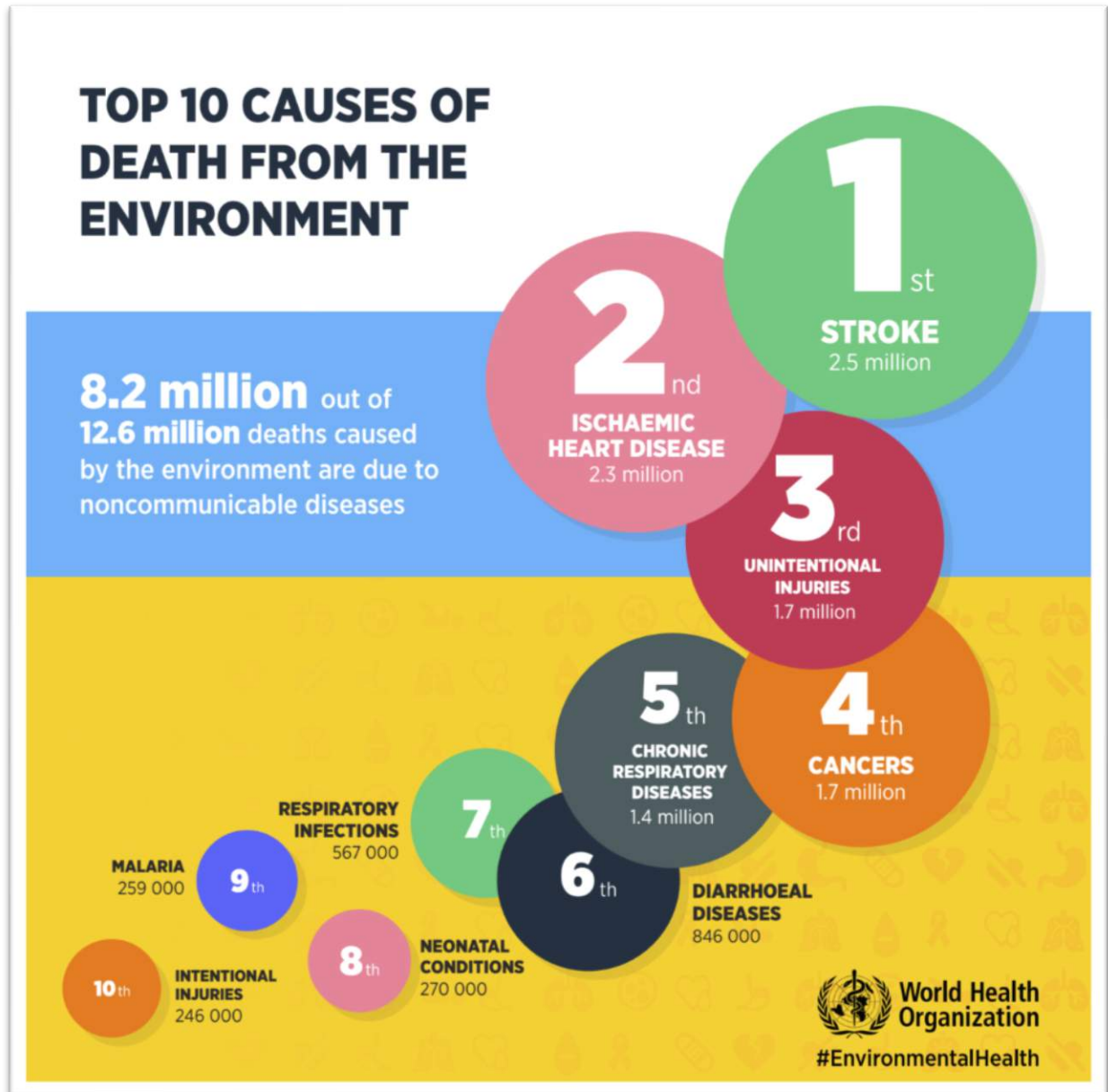
**Fact 10: Healthy environments greatly contribute to the Sustainable Development Goals**

All of the seventeen UN Sustainable Development Goals are related to the environment and to health. Environmental health interventions can make a valuable and sustainable contribution towards reducing the global disease burden and improving the well-being of people everywhere.

Let's understand ....

If we will play with nature what is going to be our fate .....?

## TOP 10 CAUSES OF DEATH FROM THE ENVIRONMENT



## What we can do .....



- 1.** Apply low **carbon strategies** in energy generation, housing and the industry.



- 2.** Use more active and **public transportation**.



- 3.** Introduce **clean fuels** for cooking, heating and lighting and clean technologies.



- 4.** Reduce **occupational exposures** and improve working conditions.



- 5.** Increase **access to safe water** and adequate sanitation and promote hand washing.



- 6.** Change **consumption patterns** to lower the use of harmful chemicals, minimize waste production and save energy.



- 7.** Implement interventions that can increase **sun protective behaviour**.



- 8.** Pass **smoking bans** to reduce exposure to second-hand tobacco smoke.



- 9.** Always use a **health in all policies** approach to create healthier environments and prevent disease.

## valuation

### **B) Long answer type**

Q.NO1. what do you mean by health. Explain factors responsible for keeping good health.

Q.NO.2. What ARE water borne diseases. Elaborate on any one disease .

Q.NO.3. What are occupational diseases. How is asbestosis caused and what are its possible remedies..

### **B) Short answer type**

Q.NO.1. Wht are different modes of transmission of communicable diseases..

Q.NO.2. briefly explain the role of hygiene in preventing water borne diseases.

Q.NO.3. Write a short note on silicosis.

### **C). Very Short answer type.**

Q.NO.1.how is AIDS transmitted.

Q.NO.2. Write some symptoms of cholera.

Q.4: What is influenza?

## References

1. Smith KR, Corvalán C, Kjellstrom T. 1999. How much global ill health is attributable to environmental factors? Epidemiology. 10 (5): 573-84.
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3. The World Health Report 2002: reducing risks, promoting healthy life. Geneva, World Health Organization.
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5. Boston, Health Effects Institute. 2004. Health effects of outdoor air pollution in developing countries of Asia: a literature review.

6. World Health Organization Physical activity. 2004. Environmental issues, <http://www.who.int/hpr/physactiv/environment.shtml>, 25

### **Further Readings**

There is no formal textbook for the course; for students interested in broad coverage, the following basic texts are recommended as additional resources:

- Blumenthal, D. S., and Ruttenber, A. J. (1995). Introduction to environmental health. Second Edition. New York: Springer.
- Lippmann, M. (Ed.). (1992). Environmental toxicants: Human exposures and their health effects. New York: Van Nostrand Reinhold.
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- Philp, R. B. (1995). Environmental hazards and human health. Boca Raton: Lewis Publishers.
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## Unit9- Natural Resources

### ❖ Learning Outcomes

- Develop the concept of a resource and its types.
- to develop conceptual understanding of renewable and non-renewable resources .
- Understand the significance of the non-violent environmental movements
- To acquaint the students about uses of different resources such as forests, water, minerals and animals.
- To develop understanding about medicinal plants and their uses in treatment of different diseases.

### 9.0. Introduction

The word resource is derived from old French “ Re” means again and “Sourdre” means spring up i.e. something that lies ready for use or can be drawn up for use. A resource is any substance which is useful or can be made useful to meet the needs of living organisms. The substance that is available for use from nature is called natural resource like fresh air, water, soil, forests, grasslands, minerals, land, fossil fuels, and others. Hence, natural resources are the goods and services produced and supplied by our environment to fulfill the demands of everyone.

Thus any substance from which valuable items can be drawn or which can be transformed in a way that it becomes more useful. Therefore, resources are said to satisfy human wants both individual as well as social wants.

### 9.1. Classification of Resources:

Resources are mainly classified into two groups viz;

- **Renewable resources:-** These are those resources which are continuously produced in nature .e.g. sunlight, air, forests, soil, etc.
- **Non- renewable resources:-** These are those resources which are produced in nature once and are in limited quantity. These resources will definitely come to an end one day e.g. coal, petroleum etc.

Earth as a planet provides such resources in abundance to the mankind for its survival and maintenance. These resources are briefly explained as follows:

#### 9.1.1. Forest Resources

A forest is a large natural area dominated by trees. The word forest has been derived from ancient French “Foris” which means outside. A forest is a biome with enough annual precipitation (at least 76 cms) to support growth of various species of trees and smaller forms of vegetation. It may be also defined as a biotic community predominantly consisting of trees, shrubs or any other woody vegetation usually with a closed canopy. Forests usually vary in species composition and density from region to region. Forests are considered to be the life lines of nation because these contribute substantially to the economic development of the country besides checking air pollution, noise pollution and soil erosion.

Our country as per state forest report 1999 has a total forest cover of 637,293 km<sup>2</sup> which is equal to about 19% of the total geographical area. But India should ideally have 33% of its land under forests as per national forest policy, 1952; so there is a need not only to protect our existing forests but also to increase our forest cover by means of practices like afforestation and reforestation.

### 9.1.2. Uses

Forest are vast natural resources that have been providing a broad array of commodities, amenities and other environmental services to mankind from the dawn of civilizations. Forests have been used from thousands of years by mankind especially by the people who live in or near a forest and others derive the benefits indirectly which are necessary for existence of life. Hence, it is impossible to think of life on this planet without forests. Broadly the uses of forests can be categorized into two major groups viz.

**Direct uses:-** Forests provide us;

- Fuel wood for cooking and warming.
- Food in the form of fruits leaves roots and meat of forest animals.
- Timber for construction and furniture.
- Shelter to wildlife (Mammals birds, insects, reptiles).
- Paper from bamboo pulp and from other trees.
- Forest products like drugs, gums, insecticides, waxes, honey, etc.
- Fodder for cattle and many more.

**Indirect uses:-** Forests also help us in;

- Soil conservation by preventing soil erosion.
- Soil improvement by adding organic matter and humans.
- Reduction of atmosphere pollutants (CO<sub>2</sub>, Noise) etc.
- Recharging of ground water.
- Control of climate (transpiration, humidity etc)

- Refreshing of atmosphere by adding O<sub>2</sub>.

### 9.1.3. Deforestation

Removal or cutting down of forest vegetation by natural or anthropogenic means is termed as deforestation. Mass scale destruction of forest is causal by man for economic gains leading to the long term irreversible effects on mankind. Earlier in our country, deforestation was only done by the Britishers, but after Independence the same trend was chosen by the people of India. Since the main driving force behind forest destruction is population explosion however, some important factors which are responsible for the deforestation are briefly discussed as:

- **Forest Fires and Diseases:-** The people residing in or around forests may be responsible for setting large areas of forests on fire. Sometimes the tourists may intentionally or unintentionally do so. Thus, resulting in destruction of forests. The pest attack is a natural process, where a range of forest or a patch of forests gets diseased and ultimately results in killing of the plant species of that particular area.
- **Shifting or Jhum Cultivation:-** This method is practical by indigenous landless people or the tribal's (who live in or around forests) who cut down large areas of forests to grow crops over there. After few years of cultivation the same areas is left as such and the farms move to another areas and continue the same process.
- **Agricultural expansion:-** This is another factor responsible for forest destruction where large areas of forest land have been/ are converted to agricultural fields in order to meet the demands of growing population especially in tropical and sub-tropical regions.
- **Lastly deforestation is also caused by:**
  - Construction of roads, dams and other developmental project.
  - Increased demand of wood for commercial /domestic purpose.
  - Mining, quarrying, forest, industries, fuel wood gathering, overgrazing and conversion of forests to pastures.

**9.1.4. Consequences :** Deforestation has both long term as well as short term adverse effects on the well being of humans. It give rise to several environmental problems, like soil erosion, increased siltation of water bodies, increases in the frequency of floods, change in precipitation patterns etc. However, the main specific effects of deforestation could be briefly summarized as:-

1. Disturbance of ecological balance i.e., increase in CO<sub>2</sub> concentration and reduction of O<sub>2</sub> in atmosphere.

2. Destruction of wild life and their habitats.
3. Lowering of water table.
4. Melting of ice caps.
5. Sacrifice of fuel wood giving rise to decreased economy of tribals.
6. Decrease in supply of forest products and raw material.
7. Increase in soil erosion and expansion of desert areas.
8. Loss of flora and fauna.

#### 9.1.4. Control Measures:-

The conservation, protection and control of forest destruction is not only the need of the hour but also necessary for economic development of the nation and maintenance of ecological balance. There is a need to protect the existing forest cover from further destruction besides increasing the forest cover upto the target level (i.e. 33% of the geographical area).

Some important methods evolved in conservation as well as protection of forests are as follows.

- (i) **Afforestation and Re-forestation:-** In order to reduce the pressure of demand on forests, massive forestation programmes should be launched to increase the forest cover of the nation. The top priority should be given to afforestation in the open wastelands and reforestation of already degraded forest areas which are not fit for cultivation.
- (ii) **Social forestry:-** This type of forest programme is done on private lands (Public and common land) where general public as well as school children are involved to raise plants in a decentralized way to produce the fuel wood, fodder, small timber for local poor people so that to reduce the pressure of such demands on existing forests.
- (iii) **Agro- forestry:-** When a land area is used for agriculture, forestry and animal husbandry i.e., using the woody perennial plants on the same land management units as annual agriculture crops either sequentially or simultaneously for obtaining greater outputs in the growth of fire wood, fodder and small timber. Thus, this will also reduce the sole dependence of man on forests and hence will help in conservation of existing forests.
- (iv) **Community forestry (JFM):-** The need to involve local communities activity in protection, conservation action and regulation of forests has become a growing

concern. In this process, an arrangement between local communities and forest department is made to share some economic benefits between the Govt. and local for the development of community from the annual harvest of the forest.

- (v) **Forest Conservation through law:-** The national forest policy adopted in 1952 makes it obligatory that 33% of our country should be under forest cover. However, due to population explosion, there has been a continuous decrease in the forest cover of our nation. Keeping this thing in view, the existing forest resources could be protected by actively implementing the forest conservation Act-1980, where people have to respect and follow each and every provision of this act and anybody found guilty should have to pay penalties for any offence punishable under the act.

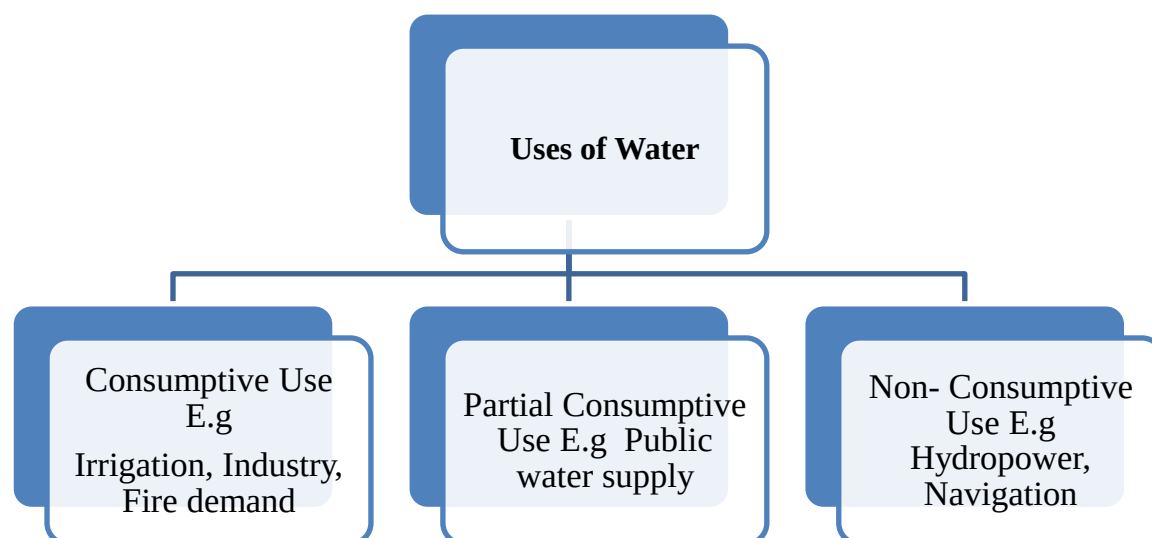
## 9.2. Water Resources

Water resources are natural resources of water that are potentially useful. Earth is called a blue planet, because  $\frac{3}{4}$ <sup>th</sup> of its surface is covered by water. Water is present on this planet in all the three forms i.e. solid, liquid and vapour state. Out of the total water 97% is salt water and only 3% being fresh water of which 2% is locked in glaciers and polar ice caps and only 1% is available for use. At global level most of the water is used for agriculture than for industry and domestic uses. Most of the water that is available to mankind is surface water (such as rivers) stream, lakes, ponds etc. or ground water (aquifers). It is the hydrological cycle that brings H<sub>2</sub>O from oceans and distributes it to the land, but the total stock of salt water and fresh water has remained constant throughout the ecological history.

| Location               | Amount of H <sub>2</sub> O (10 <sup>12</sup> tons)/ % age |
|------------------------|-----------------------------------------------------------|
| 1. Oceans/ seas        | 98                                                        |
| 2. Polar ice/mountains | 10.77                                                     |
| 3. Fresh water         | 0.002                                                     |
| 4. Atmosphere          | 0.001                                                     |
| 5. Ground water        | 0.20                                                      |

**Table.9.1 Distribution of water world-wide (source Cunningham and Cunningham)**

Studies have shown that per capita demand of water is 20-40 liters/day/person. But besides the domestic uses of water there are several other important uses of water which are as follows.



**9.2.1. Overexploitation:-** Water is used in huge amounts as compared to other natural resources. Due to increase in population at an alarming rate and industrial development, there increased consumption of water in every section be it agriculture, industry or domestic. Globally, water is abundant but the actual problem of water crisis arises when water is not available in right place at right time. This unavailability of water or unequal distribution of water is caused by various reasons which are briefly discussed as;

- Over use or increased use of water.
- Wastage of water.
- Water pollution.
- Disturbance of hydrological cycle (irregularity in the duration and intensity of precipitation).

It is quite clear that most of the water i.e. more than 97% is unavailable for human use and only 1% of the fresh water is there for animals plants and humans to live. So, when there is already a shortage of freshwater and on the other hand the global population goes on increasing day by day giving rise to increased demand of water for industry, agriculture and other areas; as a result the fresh water resources deplete day by day too.

### 9.2.2. Water pollution

Any undesirable change in the chemical, physical and biological properties of water that render it unfit for a specific use is known as water pollution. A large number of pollutants are introduced daily into our water resources directly or indirectly. There is a regular flow of pollutants through regular channels like sewerage systems, industrial effluents and domestic sewage, besides the pollutants scattered on the ground ultimately reach the water sources and cause water pollution (e.g. pesticides, fertilizers, mining, construction etc). Since, there is

already scarcity of fresh water and as such pollution of water further worsens the condition making the fresh water more and more scarce leading to water crises.

### **9.2.3. Disturbance of Hydrological cycles**

Fresh water is not equally distributed on the globe because firstly there is no homogenous rainfall throughout the seasons or from year to year and secondly due to Global Climate Changes, the hydrological cycle is somewhat disturbed. Thus, both these conditions further worsen the condition of water scarcity.

In addition there is a change of water runoff and infiltration patterns by deforestation, concrete constructions on the soil surface and soil erosion leading to poor recharging of ground water. Ground water being extracted (for irrigation and domestic uses) at rates higher than its recharging leading to reduced levels of ground water. Hence this also leads to over exploitation of water resources.

### **9.2.4. Water Harvesting**

Water harvesting means capturing the rain water that falls, capturing the surface runoff from catchments and streams. The available water resources are under tremendous pressure due to natural limit and increased demand from over population, industrialization and urbanization. It is necessary to make use of water in a proper way. Hence, water conservation may be defined “as arrangement for proper organizing the hydrosphere in order to prevent a major water crisis in the years to come”. Some of the important means of water conservation are;

- Management of watershed and proper adoption of irrigation technology like drip irrigation.
- Industries having high consumption of water should use new technology to reduce their water consumption.
- No discharge of sewage and other wastes in water bodies.
- Reduction in per capita demand as well as recycling and maintenance of water quality.

**9.2.5. Rainwater Harvesting:-** It is a type of harvest in which rain drops are collected and stored for the future use. At house hold level, in order to conserve water, the rainwater harvesting can be done by:

- Construction of traditional ring wells.
- Percolation tanks, check dams, recharge ponds.
- Roof top rain water harvesting.

Rainwater harvesting is done by collection of rain water (Surface runoff) in rainy season in tanks and reservoir and then using the same water in water scarce season for fulfilling the agricultural and domestic demands. The rain water collected in this manner could be easily used for irrigation or after storage into underground tanks, followed by chlorination and filtration could be used for better domestic water supply. This method could be also used for efficient recycling of ground water through recharge wells, ponds etc.

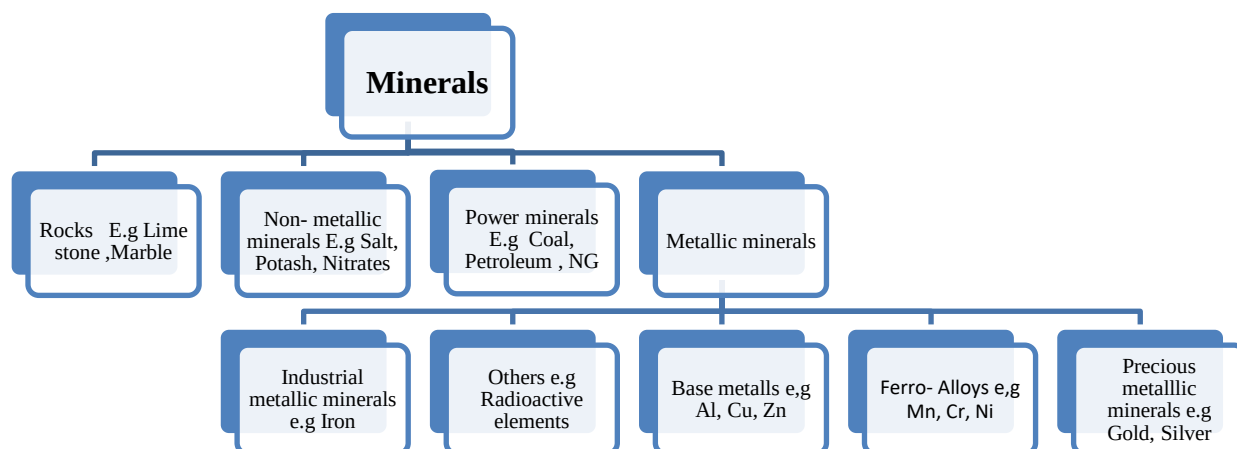
The main objectives of rain water harvesting are:-

- Reducing water crises all over the globe
- Restoring supplies of depleted ground water.
- Reducing surface runoff and preventing soil erosion.
- Reducing the effects of droughts.
- Storing excessive water for use in dry seasons.
- Increasing water availability in wells.

### 9.3. Mineral Resources

A mineral is a pure inorganic substance that occurs naturally in earth's crust. It is an inorganic substance having a definite chemical composition and certain characteristics properties or in ecological terminology a mineral is any substance which involve ecological process in their formation and in searching them. Most of these mineral occur in the earth's crust and about 2000 mineral have been extracted from earth till date. There has been a close relationship between man and minerals right from the beginning such as food cloths or even the human body is made of a variety of minerals. Thus, earth's mineral wealth has been trapped for thousands of years by mining not only for sustenance of mankind but also for economic and industrial developed.

**9.3.1.Classification:-** Minerals are classified by key chemical constituents. The wide variety of minerals of explored by man for general and commercial purposes are classified as;



Metallic minerals are mostly used in automobile industry (7% Cu, 10% Al, 13% Ni, 35% Zn, 50% Pb) and for construction and development. Minerals are non renewable but can be recycled. Some of the mineral occur in elemental form (e.g; gold) but most of them occur in mixtures like ( $\text{CuSO}_4$ ). Although there are large number of minerals present in earth's crust but only a small number of these are extracted economically. Some minerals are called ores because metals are economically extracted from them by metallurgical operations. But before extracting a mineral from earth's crust or oceanic beds, some specific conditions are given priority (i.e profitability of mining operations thus depends on):

- Mining costs
- Size of the ore deposits
- Grade of the ore
- Methods of mining
- Transport costs and labour.

Ores may be classified as high grade or low grade depending on their mineral concentration. For instance copper ore containing 3% copper is considered to be high grade ore while as copper ore with only 0.3% Cu is a low grade ore.

### **9.3.2. Use and exploitation**

Minerals are used almost in all walks of life. Minerals are used right from the stone age but their large scale utilization started with the advent of industrial revolution for social cultural and economic growth of the society. There is an exponential change in the economic conditions of a region, following the exploitation of minerals e.g, Saudi Arabia which was a barren land before World War II but emerged as a rich nation after exploration of oil in this country started.

Minerals are formed in the earth's crust over a period of millions of years and right from the beginning are an important source of raw materials for multiple industry. Minerals in the form of coal, oil and gas are used as fuel while as important non-metallic minerals resources including salt, clay, and silica are used in other spheres of life. Similarly building materials such as granite, marble, limestone, cement etc. are another categories of minerals used for welfare of mankind. Thus in all spheres of human advancement, man is exploiting the minerals for sustenance, decoration, growth and development from cradle to grave leading to over exploitation these limited resources. Where once humans mined earth's surface with primitive tools to extract valuable minerals, today huge mining machines extract mineral

resources to support a society so dependent on minerals that a shortage of any one of a few dozen would bring it to its knees.

If the current rate of exploitation continues and if there is no further new exploitation of deposits then our mining activity might be a short episode in the life of human beings.

### **9.3.3.Environmental Impacts**

Extraction of minerals and mineral processing are two of the most environmentally damaging activities of humankind. Right from the stage of mineral extraction adverse impact on land water air, biological resources social impact degradation of land resources continues as the mineral is beneficiated and processed further. Some of the impacts of mining and mineral processing could be listed as:

- Noise pollution from mining and allied industrial activities.
- Surface mining is destructive because it quickly transforms a scenic area into an ugly landscape.
- Waste piles from both types of mining causes additional environmental problems if not vegetated and stabilized as heavy rains wash the instable soils into stream and lakes.
- Deforestation/ removal of vegetation from the area where mining is to be carried out.
- Mining in wilderness areas leads to distribution and loss of wildlife.
- Certain minerals such as salt and potash which are water soluble can be easily removed by solution mining polluting ground water resources.
- Many ores are heated to high temperatures for separating metals from ores leading to the release of a large no of toxic materials into the atmosphere.
- Increase in SPM concentration in mining areas.
- Lung diseases caused to miners during mining operations.
- Water pollution by discharging of acid mine water effluents and toxic substances like Selenium, Nickel, Fluorine and radioactive elements to water bodies.
- Ultimately the abandoned land after mining gives an unaesthetic picture devoid of vegetation laced with stagnant pools of waste water or covered with mine tailings or stags.

### **9.3.5. Mineral Conservation**

There are two views about the minerals viz. the optimist believe that our mineral future is secure and there is no need to worry about the mineral supplies as new discoveries new

mining technologies, substitutes and sea floor deposits will come to the rescue. But the pessimists argue that the deposits are limited and there is a need to look for additional ways to meet the needs. However, some important means of conservation of minerals are;

1. **Reduction in demand:-** Reducing our demand for minerals can be achieved by reducing population growth, cutting back per capita consumption, decreasing the size of products and increasing product durability. Per capita demand can be achieved by reducing unnecessary purchases, avoiding discardable items etc. Manufactures can contribute by reducing wasteful packaging, eliminating throw away item, increasing product durability i.e, to make products that last longer, and finally reducing the size of the products.
2. **Recycling:-** There is an urgent need of recycling the materials made up of minerals because there is;
  - increase on price of minerals.
  - Depletion of minerals
  - Shortage of landfills
  - Concern about environment and economy
 Thus, the recycling method will reduce the presence on new mineral supplies as already consumed minerals are used again and again.
3. **Individual efforts:-** Resource conscious individuals can play a significant role in reducing mineral consumption by several means such as;
  - By recycling the products made of metals
  - By purchasing products made of recyclable material
  - By reducing the per capita demand
  - By avoiding throwaway practices
  - By choosing goods which are made from renewable resources.

#### 9.4. Animal Resources

Animals are vital natural resources. These act as a productive resource for humans as these supply a wide variety of goods and services to mankind. Throughout history, humans have been using animals and their derivatives especially for food, clothing, tools, medical, magic and religious purposes. Animals have been companions of humans since the times immemorial. They are also crucial in scientific research, military, agriculture, sporting, crime and drug fighting activities. Animals are used for both practical such as production of food and clothing and symbolic uses like art, literature, mythology and religion. Human

civilizations have been dependent on animals for different aspects because these provide means of survival like meat, eggs, cheese, fur, butter and fibre. Different animals like cattle, sheep, buffalo goats, Pigs and poultry birds are an important means of getting valuable food items for the mankind. Some organisms like oysters and corals provide pearls to produce jewels and handicraft. The hide of some animals like reindeers, tigers, leopards etc is used as a mean of clothing. In many parts of the world animals act as important means of transport like camels in deserts and horses in other places. Animal husbandry, dairying and fisheries sector provide large employment opportunities in rural areas that supplement family incomes particularly among landless farmers and women besides providing cheap nutrition to millions. Fishery and aquaculture provide income to 500 million people world wide where raising and farming fish is done to obtain diet rich in protein fatty acids. Many marine species of fish such as cod, herring, tuna, mackerel etc are caught commercially forming important part of diet. Invertebrates like lobsters, octopus, prawns and crabs are also hunted or cultured for food. Most utilitarian to luxurious textiles are made from animal fibres such as wool, camel hair, angora, cashmere etc. Leather from cattle have been widely used to make leather goods like shoes, bags, and other items. Animals are tamed and hunted for fur used to make hats and coats ranging from simple warming to most expensive.

Many domestic animals are used as work animals including cattle, horses, camels, yaks, elephants and these are used for transport and still account for 80% of the power of small farms in third world and 20 % of the world transport especially in mountainous regions. Animals mostly insects and mammals provide a handy help in science experiments including biological research such as genetics and in the development and testing of new medicines. Vaccines for viral diseases like polio and mumps have been developed using animal cells. Some birds and animals like dogs, cats and parrots are kept as pets to ensure safety and recreation at our homes. Animal dung and bird droppings are used as efficient manures in agriculture as a substitute to chemical fertilizers. Animals including many insects and mammals feature in mythology and religion. Every day animals help man and join him in most diverse activities. Because of their sensory superiority and greater adaptability to the external environment, they can carry out tasks that man normally cannot.

### 9.5. Medicinal Plants

Medicinal plants also called as medicinal herbs have been discovered and used in traditional medicine since prehistoric times. A plant that is used to maintain health or to treat different common ailments by administering through a specific mode of preparation in modern or

traditional medicine is known as a medicinal plant. Plants synthesise hundreds of chemical compounds for various functions such as defence against pathogens and predators and herbivore animals and because of these properties such plants known as medicinal herbs or medicinal plants have been used in traditional medicine since times immemorial to treat different human and livestock ailments. Plant medicines are in wide use around the world especially in rural areas of developing nations where it is the lone source of health care for the people. Traditional medicinal systems continue to be practised world wide because of main reason such as population rise, shortage of drugs, side effect of synthetic drugs etc.

Almost all plants produce certain chemicals or hormones that help them defensive mechanism against herbivores. These chemicals are known as phytochemicals which are used as drugs when their concentration and pharmacological action is known and scientifically approved. These chemicals may be in the form of alkaloids, glycosides, polyphenols or terpenes which are produced in different parts of a plant having different modes of action. Alkaloids are bitter in taste, toxic and widely found in nature in different medicinal plants. Different traditional medicines include berberine, caffeine, nicotine, quinine, vincamine, morphine, codine, vincristine etc. derived from different plant species like berberis, coffee, opium, tobacco etc. Glycosides are also produced by various plants like rhubarb, cascara, foxglove etc which produce plant based laxatives like senna, rhubarb and aloe. Foxglove produces a cardiac glycoside known as digoxin which supports heart beating and acts as diuretic. Polyphenols are having diverse roles in defence against plant diseases and predators. They include phytoestrogens which mimic certain female hormones and have been used for centuries to treat gynaecological disorders like fertility, menstrual and menopause problems. Many polyphenolic extracts derived from grape seeds or olives are sold as dietary supplements and cosmetics. Terpenes and terpenoids are also found in resinous plants such as conifers. They are strongly aromatic in nature and act as repellents to herbivores. Their scent makes them chief components of perfumes used in aromatherapy. The essential oil of thymus Thymol which is used as a strong antiseptic and antifungal medicine.

Medicinal plants are often fibrous which require some sort of preparation to make them easy to administer. There are various methods of preparation for herbal medicines including powdering, decoction, paste and extraction. The most frequently used plant part in the preparation of the herbal remedies include leaves, roots, rhizomes, fruits, seeds, whole plant, flowers and bark.

Kashmir is unique with richest repositories of medicinal and aromatic plants of promising health and economic benefits owing to its characteristic climate, altitudinal variations and conducive growing environment. Some of the conspicuous medicinal plants of the valley are briefly describes as under:

- ***Podophyllum hexandrum* :-** Also known as *Banwangun* It is a succulent erect herb that grows upto a height of 30 cms with white to pinkish flowers. It is native to Himalayas. Its rhizome is used for typhoid fever. Jaundice, chronic hepatitis, skin diseases, kidney and bladder diseases and is also used to treat vaginal warts. Its main derivatives podophyllotoxin are elopside and teniposide which are employed for treatment of cancers. The paste made from its roots is applied to treat cuts and wounds.
- ***Aconitum heterophyllum*:-**It is an annual erect herb found in grassy slopes of alpine Himalayas with its flowers white to violet. Its tubers are used as expectorant having also anthelmenthic, anti-inflammatory and antidiarrhoeal properties. Leaf paste is used against snake bites.
- ***Saussurea lappa*:-** Also known as Kuth, it is a potent perennial plant with its medicinal uses such as antiulcers, anticancer and antiarthritic. It is used to treat toothache and to improve fertility. It is a good appetizer and its extracts are used in perfumes from ancient times. It cleans body from toxins and is also used to treat acne and heart diseases.
- ***Dioscorea deltoidea*:-** It is a perennial climbing herb producing annual stems with antibacterial, antioxidant and hyperglycaemia properties. It produces a medically active compound known as diosgene. It is helpful to treat chronic liver pain, piles and ophthalmic infections. Root juice is used to treat roundworms in humans.
- ***Taraxicum officinale*:-** Also known as *Hund* It is a common flowering herb used in terms of medical and food preparations. Its leaves are rich in beta carotenoids, vitamin C, calcium and iron. It is used as a leafy vegetable that improves digestion. It is having anti-inflammatory, antioxidative and anticarcinogenic properties. It is also used to treat bile and liver problems.
- ***Arnebia benthamii*:-** It is a distinctive hairy perennial plant growing upto a height of 60cm with red purple flowers. It is an important ingredient of an important drug under the name as Gaozaban having antibacterial, antifungal, anti-inflammatory and wound healing properties. It is used to treat the diseases of tongue and throat.

- ***Artemesia absinthum***:- Also known as *tethwen* it is a herbaceous perennial plant with strong sage smell. It is used for various digestion problems such as loss of appetite, upset stomach, gallbladder diseases and intestinal spasms. It is also used to treat depression, muscle pain, worm infection, liver diseases and to increase sexual desire.
- ***Datura stramonium***:- Also known as thorn apple it is an erect, much branched, annual to short lived perennial herb that can grow upto 2 meters tall. It is a bitter narcotic plant that relieves pain and encourages healing. It is well known for treatment of chest pain, asthma, cough, TB, ulcers, IBS, Parkinson's disease and bronchitis as more than 70 alkaloids have been identified from its various parts.
- ***Rheum emodi***:- Commonly known as *Pambhaakh* it is a stout herb found in temperate Himalayas. It has a strong stem and roots with radical leaves and small dark purple or pale red flowers. It can act as antispasmodic, antiseptic, antidiabetic, antitumor, astringent and diuretic. It is also used as a leaf vegetable with considerable amounts of minerals and vitamins present in it. Its root is used to treat cough, jaundice, blood infection, constipation and to combat diarrhoea.
- ***Viola odorata***:- Locally known as *Banafsha* it is a herbaceous flowering perennial plant with aromatic dark violet or white flowers. It has been used for a variety of respiratory ailments like asthma and bronchitis, insomnia and skin disorders. Its syrup is recommended as a laxative for children and its leaves are used as anti-inflammatory agents in fever and rheumatism. Besides it is also used for treating mouth ulcers, relieving mouth cancer pain.

## Evaluation

### Long Answer Type Questions

Q.1. Define forest resources. What are their uses?

Q.2: Explain deforestation, causes, effects and control measures.

Q.3: Animal resources are beneficial to mankind. Explain.

Q.4: Define animal products. Explain how these are used as a source of food for mankind?

Q.5: Explain water resources in detail.

### Short Answer Type Questions

1: Write short notes on:        a) Fresh water resources b) Water table

Q.2: What are Minerals? Give their classification.

Q.3: How does mineral extraction affect our environment?

Q.4: Describe briefly the conservation of mineral resources.

### Very Short Answer Type Questions

Q.1: What is water conservation?

Q.2: Name some important medicinal plants of J & K.

Q.3: What are renewable resources? Give two examples.

Q.4: What do you mean by JFM?

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## Unit 10- Managing Agriculture

### ❖ Learning Outcome

- The student should be able to know about the history of agriculture, how it evolved over a period of time
- The student should be able to know the need of agricultural revolution
- The student should be able to understand the modern trends, techniques, methods of modern agriculture
- To developing the understanding about the concept of agriculture its primitive ways , its modern techniques and effects of it on environment
- To develop the understanding about the concept of sustainable agriculture its importance and may understand the value of food and food security

### 10. Concept of Agriculture:-

Agriculture helps to meet the basic needs of human and their civilization by providing food, clothing, shelters, medicine and recreation. Hence, agriculture is the most important enterprise in the world. It is a productive unit where the free gifts of nature namely land, light, air, temperature and rain water etc., are integrated into single **primary unit** indispensable for human beings. **Secondary productive units** namely animals including livestock, birds and insects, feed on these primary units and provide concentrated products such as meat, milk, wool, eggs, honey, silk and lac.

Agriculture provides food, feed, fibre, fuel, furniture, raw materials and materials for and from factories; provides a free fare and fresh environment, abundant food for driving out famine; favours friendship by eliminating fights. Satisfactory agricultural production brings peace, prosperity, harmony, health and wealth to individuals of a nation by driving away distrust, discord and anarchy. It helps to elevate the community consisting of different castes and classes, thus it leads to a better social, cultural, political and economic life. Agricultural development is multidirectional having galloping speed and rapid spread with respect to time and space. After green revolution, farmers started using improved cultural practices and agricultural inputs in intensive cropping systems with labourer intensive programmes to enhance the production potential per unit land, time and input. It provided suitable environment to all these improved genotypes to foster and manifest their yield potential in newer areas and seasons. Agriculture consists of growing plants and rearing animals in order to yield produce and thus it helps to maintain a biological equilibrium in nature.

## 10.1 AN INTRODUCTION TO AGRICULTURE

### Terminology

Agriculture is derived from Latin words **Ager** and **Cultura**. **Ager** means land or field and **Cultura** means cultivation. Therefore the term agriculture means cultivation of land. *i.e.* the science and art of producing crops and livestock for economic purposes. It is also referred as the science of producing crops and livestock from the natural resources of the earth. The primary aim of agriculture is to cause the land to produce more abundantly, and at the same time, to protect it from deterioration and misuse. It is synonymous with farming—the production of food, fodder and other industrial materials.

### Definitions

Agriculture is defined in the Agriculture Act 1947, as including ‘horticulture, fruit growing, seedgrowing, dairy farming and livestock breeding and keeping, the use of land as grazing land, meadowland, osier land, market gardens and nursery grounds, and the use of land for woodlands where that use ancillary to the farming of land for Agricultural purposes’. It is also defined as ‘purposeful work through which elements in nature are harnessed to produce plants and animals to meet the human needs. It is a biological production process, which depends on the growth and development of selected plants and animals within the local environment.

**As a science :** It utilizes all modern technologies developed on scientific principles such as crop improvement/breeding, crop production, crop protection, economics etc., to maximize the yield and profit. For example, new crops and varieties developed by hybridization, transgenic crop varieties resistant to pests and diseases, hybrids in each crop, high fertilizer responsive varieties, water management, herbicides to control weeds, use of bio-control agents to combat pest and diseases etc.

**As the business:** As long as agriculture is the way of life of the rural population, production is ultimately bound to consumption. But agriculture as a business aims at maximum net return through the management of land, labour, water and capital, employing the knowledge of various sciences for production of food, feed, fibre and fuel. In recent years, agriculture is commercialized to run as a business through mechanization.

## 10.2 SCOPE OF AGRICULTURE IN INDIA

In India, population pressure is increasing while area under cultivation is static (as shown in the land utilization statistics given below) or even shrinking, which demand intensification of cropping and allied activities in two dimensions *i.e.*, time and space dimension. India is

endowed with tropical climate with abundant solar energy throughout the year, which favours growing crops round the year.

There is a vast scope to increase irrigation potential by river projects and minor irrigation projects. In addition to the above, India is blessed with more labourer availability. Since agriculture is the primary sector, other sectors are dependent on agriculture.

**Table.10.1. Land use pattern showing area under cultivation**

|    |                                             |                              |
|----|---------------------------------------------|------------------------------|
| In | <b>Total Geographical area</b>              | <b>: 328.848 million ha.</b> |
|    | <b>Total reporting area :</b>               | 304.300 million ha.          |
|    | <b>Area under cultivation :</b>             | 143.000 million ha.          |
|    | <b>Total cropped area :</b>                 | 179.750 million ha.          |
|    | <b>Area sown more than once :</b>           | 36.750 million ha.           |
|    | <b>Area not available for cultivation :</b> | 161.300 million ha.          |
|    | <b>Area under forest</b>                    | <b>: 66.400 million ha.</b>  |

India, major allocation has been done in each five-year plan to agriculture. In 8th five-year plan, nearly 23% of the national budget allocation goes to agriculture and allied agro-based cottage industries run on small scales. More than 60% of the Indian population (60 million/1.05 billion) depends or involved in agriculture and allied activities. Nearly 40% of the net national product is from agricultural sector. Approximately 35% employment is generated from agriculture, out of which 75% is found in rural areas either directly or indirectly. In India, food grain production increased almost four folds from about 50 million tonnes at independence to more than 220 million tonnes in 2005 through **green revolution**. Despite variation in the performance of individual crops and regions, total food grain production maintained a growth of 2.7% per annum, which kept ahead of population growth at about 2.2% per annum. Through **white revolution**, milk production increased from 17 million tonnes at independence to 69 million tonnes (1997–98). Through **blue revolution**, fish production rose from 0.75 million tonnes to nearly 5.0 million tonnes during the last five decades. Through **yellow revolution**, oil seed production increased 5 times (from 5 million tonnes to 25 million tonnes) since independence. Similarly, the egg production increased from 2 billion at independence to 28 billion, sugarcane production from 57 million tonnes to 276 million tonnes, cotton production from 3 million bales to 14 million bales which shows

our sign of progress. India is the largest producer of fruits in the world. India is the second largest producer of milk and vegetables. In future, agriculture development in India would be guided not only by the compulsion of improving food and nutritional security, but also by the concerns for environmental protection, sustainability and profitability. By following the General Agreement on Trade and Tariff (GATT) and the liberalization process, globalization of markets would call for competitiveness and efficiency of agricultural production. Agriculture will face challenging situations on the ecological, global climate, economic equity, energy and employment fronts in the years to come.

### 10.3. Branches of Agriculture

Agriculture has 3 main spheres viz., Geoponic (Cultivation in earth-soil), Aeroponic (cultivation in air) and Hydroponic (cultivation in water). Agriculture is the branch of science encompassing the applied aspects of basic sciences. The applied aspect of agricultural science consists of study of field crops and their management (Arviculture) including soil management.

**Crop production** - It deals with the production of various crops, which includes food crops, foddercrops, fibre crops, sugar, oil seeds, etc. It includes agronomy, soil science, entomology, pathology, microbiology, etc. The aim is to have better food production and how to control the diseases.

**Horticulture** - Branch of agriculture deals with the production of flowers, fruits, vegetables, ornamental plants, spices, condiments (includes narcotic crops-opium, etc., which has medicinal value) and beverages.

**Agricultural Engineering** - It is an important component for crop production and horticulture particularly to provide tools and implements. It is aiming to produce modified tools to facilitate proper animal husbandry and crop production tools, implements and machinery in animal production.

**Forestry** - It deals with production of large scale cultivation of perennial trees for supplying wood, timber, rubber, etc. and also raw materials for industries.

**Animal Husbandry** - The animals being produced, maintained, etc. Maintenance of various types of livestock for direct energy (work energy). Husbandry is common for both crop and animals.

The objective is to get maximum output by feeding, rearing, etc. The arrangement of crops is done to get minimum requirement of light or air. This arrangement is called geometry. Husbandry is for direct and indirect energy.

**Fishery Science** - It is for marine fish and inland fishes including shrimps and prawns.

**Home Science** - Application and utilization of agricultural produces in a better manner. When utilization is enhanced production is also enhanced. e.g., a crop once in use in south was found that it had many uses now

## 10.4 Crop Production Practices

Crop production practices are of utmost importance for successful and economic cultivation of field crops and national food security at large. Current agriculture direly needs scientific and rational crop production practices to enhance farm productivity with long-term sustainability. Crop production practices can be divided into various categories that farmers make to produce food, fodder and fibre, etc. The major ones are:

**Soil and crop management:** It deals with deciding what crops and varieties to grow and in what sequence to utilize the soil's productive capacity, and what tillage, cultivation, and soil conservation measures to undertake to physically till and preserve the soil and conserve moisture in a particular agro-ecology.

**Nutrient management:** It deals with determining the additional nutrients the soil needs for crop growth, and applying agricultural resources, animal manure, compost, or commercial fertilizers in appropriate forms, amounts, and ways that foster crop yields and farm profitability, while reducing nutrient loss to the environment.

**Water management:** It deals with determining the water needed for crop growth and applying that water efficiently, considering water availability, drainage, and offsite water quantity/quality impacts.

**Weed management:** It deals with determining the weed threats to crop growth, yield, and quality and the management practices to control them in field crops.

**Pest management:** It deals with determining insect-pest and disease threats to crop growth, yield, and quality and the preventive or remedial measures to control them besides keeping the food and environmental safety.

## 10.5 Crop Production Seasons

Primarily, there are three crop production seasons in India viz. Kharif, Rabi and Zaid.

**Kharif season crops:** The Kharif crop is the summer crop or monsoon crop in India. Kharif crops are usually sown with the beginning of the first rains in June-July, during the south-west monsoon season. Major Kharif crops of India include: rice, maize, sorghum, mungbean, groundnut, cotton, soybean, etc.

**Rabi season crops:** The Rabi crop is the winter season crop in India. It is sown in October-November and harvested in March-April every year. Major Rabi crops in India include: wheat, barley, oats, mustard, peas, etc. **Zaid season crops:** This crop is grown in some parts of the country during March to June. Major Zaid crops in India include: French bean, muskmelon, watermelon, bitter gourd, pumpkin, ridge gourd, etc.

## 10.6 Classification of Agricultural Crops

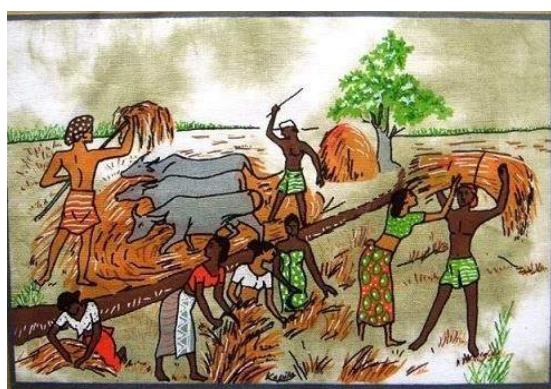
The broader classification of the agricultural crops on the basis of their economical use is described as under:

- **Cereal crops:** Rice, wheat, maize, sorghum.
- **Pulse crops:** Pigeon pea, urdbean, moonbeam, kidney bean, cowpea, chickpea, lentil, pea, etc.
- **Oilseed crops:** Soybean, rapeseed & mustard, groundnut, sunflower, sesame, safflower, etc.
- **Fodder crops:** Berseem, red clover, lucerne, etc.
- **Fibre crops:** Cotton, jute, Mesta, etc.
- **Commercial crops:** Sugarcane, tea, coffee, etc.

## 10.7 Traditional Agriculture and its impact on the environment

Human has sacrificed their natural resources for economic development from the dawn of Human civilisation to the modern world. In the evolutionary period of agriculture, people used the practice of slash and burn cultivation or shifting cultivation, which is still prevalent in the tribal region of northeast India.

**Traditional Agriculture:** Traditional Agriculture can be defined as a primitive style



of farming that involves the intensive use of indigenous knowledge, traditional tools, natural resources, organic fertilizer and cultural beliefs of the farmers. It is noteworthy that it is still used by about 50% of the world population.

Fig. (Traditional Agriculture and its impact on the environment)

Image source: (ceylonbatiks.com)

### Characteristics of traditional agriculture

1. Extensive farming with indigenous knowledge and tools

2. Indigenous tools like axe, hoe, and stick
3. Method: Slash & Burn, and Shifting Cultivation
4. Cattle raising helps to create fallow land
5. Absence of accountability and responsibility to the Environment
6. Lacked by surplus production

### **Impact of traditional agriculture on Environment**

The impacts of traditional agriculture on Environment are discussed below

#### **a. Depletion of Nutrients**

The primitive style of farming like slash and burn decreases the organic matter from the soil and within the short period of time the nutrient content of the soil taken up by the crops. This makes the farmers to move to another place for farming.

#### **b. Deforestation:** It is the process of the removal of a forest or stand of trees where the land for the conversion of forestland to farms, ranches, or urban use. The most concentrated deforestation occurs in tropical rainforests. The slash & burn, and shifting cultivation required massive cutting down of the forest which leads to the situation of deforestation.

#### **c. Soil Erosion:** It is a process of the removal of topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage. The roots of the plant and trees firmly hold the soil, but the deforestation exposed the soil to get eroded by the weathering forces like rain, wind and storms which causes the loss of top fertile soil.

## **10. 8 Traditional Farming Methods**

Traditional farming is characterized by

- The use of fire for clearing a new farm plot (slash-and-burn agriculture),
- Superficial tillage by hand,
- Often planting on mounds or ridges,
- Mixed cropping using a number of carefully composed crop associations,
- The lack of any inputs for fertilizing and crop protection.

## **Methods**

### **1. Clearing**

Especially clearing by fire has been heavily attacked for destroying the soil. Here, in less technical terms, are the advantages and disadvantages of burning: Burning of the bush

- Clearing in the Forest Zone
- Clearing in the Grassland Area

## **2. Tilling**

In the overwhelming majority of cases tilling is done by hand. A hoe with a large blade is the universal tool for tilling. So far, only in some areas are ox-drawn ploughs used. There are several traditional methods of tilling. The simplest one, practiced on fertile, well-drained soil, is the simple scratching of the surface with a cutlass, planting maize seeds and covering them at once with soil. Tilling and planting are done at the same time.

## **3. Timing - The Crop Calendar**

The correct timing of farm operations is part of good farm management. Timing is particularly important with respect to planting, weeding, and, for some crops, harvesting. The right planting time is a matter of great concern in traditional agriculture. The effect of weeding on plant development also depends on good timing. In traditional agriculture, weeding may be done later than in modern agriculture, due to the effect of fire on weeds:

## **4. Reading the Crop Calendar**

For easy comparison, all farm work has been grouped into four main operations: soil preparation, planting, farm maintenance, and harvesting

**5. Planting and Sowing** Work connected with planting and sowing differs very much according to the crops grown. Selection and preparation of seed material Selection of seeds, tubers, corms, suckers or cuttings as planting material always involves a lot of skill and careful observation. Each farming community has its set of rules in order to find out what will make the best planting material.

## **6. Weeding**

Weeding is a feature of nearly all farming. Weeding is usually done with a hoe. Weeds are left on the farm to wither - except those that could immediately start to grow again.

## **8. Manuring**

Farms are usually not manured. As was mentioned above, soil fertility is restored by

- the fallow period,
- burning at the beginning of a new farming period.

The cultivated areas directly surrounding the houses are manured with all sorts of suitable materials, e.g.

- Kitchen and household refuse,
- Ashes,

- Animal dung,
- Waste from the processing of crops, e.g. coffee berry pulp.

**10.9 Modern Agriculture** Modern agriculture is an evolving approach to agricultural innovations and farming practices that help farmers increase efficiency and reduce the



Image source: (ceylonhatiks.com)

number of natural resources like water, land, and energy necessary to meet the world's food, fuel, and fibre needs. The agribusiness, intensive farming, organic farming, and sustainable agriculture are other names of modern agriculture.

## 10. 10 Characteristics of Modern Agricultural Techniques

The new technology adopted in the Indian agriculture during mid-1960s is consisted of several ingredients like HYV seeds, chemical fertilizers, pesticides, irrigation and improved machines and tools like tractors pump sets etc. All these together are termed as 'package programme. If any one of these elements is missing, there will be no significant remarkable impact on productivity per hectare of land.

**The basic features of modern agricultural techniques are:**

**(i) HYV seeds:** Under the new agricultural strategy special emphasis has been placed on the development and widespread adoption of high yielding varieties of seeds. Production of improved seeds (HYV seeds) was encouraged by both the Central and State Governments. As a result the use of HYV seeds had increased from 25 lakhs quintals in 1980-81 to 105 lakhs quintals in 2003-04. The use of these seeds leads to multiple cropping.



Fig. (High Yeilding Variety Seeds of Wheat)

**(ii) Chemical Fertilizers:**

Indian soil is deficient in nitrogen and phosphorous and this deficiency can be reduced by increasing the use of chemical fertilizers. Thus, traditional fertilizers are replaced by chemical fertilizers. Multiple cropping is possible only by using the chemical fertilizers in a large extent.

**(iii) Irrigation:** Increase in agricultural production and productivity depends on the availability of water. Moreover, the use of HYV seeds and chemical fertilizers required

adequate supply of water. Hence, irrigation (i.e., artificial ways of supplying water in the cultivatable lands) is the basic requirement for the successful implementation of Green Revolution. In India, still today 60 percent of grass cropped areas are depended on the gambling of monsoon.

#### **(iv) Pesticides:**

Pesticides are defined as any substance or mixture of several substances which prevented the HYV seeds and plants from the diseases and unwanted pest-attacks. Thus, the use of various types of chemical pesticides (compounds) for controlling pest-attacks is an essential element of modern agricultural techniques.

#### **(v) Multiple Cropping:**

India enjoys tropical and sub-tropical climatic conditions. Therefore, she has huge potentialities to grow crops on a year round basis. However, 80 percent of the annual rainfall is received in less than four months; hence multiple cropping is generally not possible. However, the successful implementation of ‘package programme’ through intensive cultivation can make environment to grow crops more than one time (twice or thrice) during a year in several parts of India.

### **10. 11 Impact of Modern Agriculture on the Environment**

As we know that modern agriculture improved our affordability of food, increases the food supply, ensured the food safety, increases the sustainability and also produces more biofuels. But with the same time, it also leads to environmental problems because it is based on high input–high output technique using hybrid seeds of high-yielding variety and abundant irrigation water, fertilizers and pesticides. The impacts of modern agriculture on Environment are discussed below:

- a. Soil Erosion:** The top fertile soil of the farmland is removed due to the excessive water supply. This leads to the loss of nutrient rich soil that hampered the productivity. It also causes the global warming because the silt of water bodies induces the release of soil carbon from the particulate organic material.
- b. Contamination of ground water:** The ground water is one of the important sources of water for irrigation. From agricultural fields nitrogenous fertilizers leach into the soil and finally contaminate groundwater. When the nitrate level of groundwater exceeds 25 mg/l, they can cause a serious health hazard known as “Blue Baby Syndrome”, which affects mostly infants even leading to their death.

- c. Water-logging and salinity:** The salinity of the soil is one of the reasons of low productivity just because of the improper management of farm drainage. In this situation, the roots of plants do not get enough air to respiration then it leads to low crop yield as well as low mechanical strength.
- d. Eutrophication** It refers to the addition of artificial or non-artificial substances such as nitrates and phosphate, through fertilizers or sewage, to a fresh water system. It leads to increase in the primary productivity of the water body or 'bloom' of phytoplankton. Excessive use of fertilizers that consists of nitrogen and phosphorus leads to over nourishment of the lakes/waterbodies and gives rise to the phenomenon of eutrophication (eu = more, trophication = nutrition).
- e. Excessive use of Pesticide:** There are many pesticides are used for destroying pests and boosting crop production. Earlier arsenic, sulphur, lead and mercury was used to kill pests. For Example- DichloroDiphenylTrichloroethane (DDT) content pesticides were used, but unfortunately, it also targeted the beneficial pests. Most importantly, many pesticides are non-biodegradable, which also linked to the food chains which are harmful to human being.

### 10.12 Difference between traditional and modern methods of farming

| Traditional agriculture                              | Modern agriculture                                                         |
|------------------------------------------------------|----------------------------------------------------------------------------|
| Uses manure & compost                                | Uses chemical fertilizers                                                  |
| More farm labours & no machines                      | Less farm labours & more machines                                          |
| Depended on seasonal rainfall                        | Well occupied irrigation system and so not dependent on seasonal rainfall. |
| Animals are used to plough the field                 | Tractors used for ploughing the field                                      |
| Production is less but the crops are of high quality | Production is more but the crops are of less quality.                      |

### 10.13 Sustainable Agriculture

Many different expressions have come to be used to imply greater sustainability in some agricultural systems over prevailing ones (both pre-industrial and industrialized). These include biodynamic, community based, Eco agriculture, ecological, environmentally sensitive, extensive, farm fresh, free range, low input, organic, permaculture, sustainable and wise use. There is continuing and intense debate about whether agricultural systems using some of these terms can qualify as sustainable. Systems high in sustainability can be taken as

those that aim to make the best use of environmental goods and services while not damaging these assets. The key principles for sustainability are to:

1. Integrate biological and ecological processes such as nutrient cycling, nitrogen fixation, soil regeneration, allelopathy, competition, predation and parasitism into food production processes,
2. Minimize the use of those non-renewable inputs that cause harm to the environment or to the health of farmers and consumers,
3. Make productive use of the knowledge and skills of farmers, thus improving their self-reliance and substituting human capital for costly external inputs, and
4. Make productive use of people's collective capacities to work together to solve common agricultural and natural resource problems, such as for pest, watershed, irrigation, forest and credit management.

The idea of agricultural sustainability, though, does not mean ruling out any technologies or practices on ideological grounds. If a technology works to improve productivity for farmers and does not cause undue harm to the environment, then it is likely to have some sustainability benefits.

### 10.14 The Green Revolution

The world's worst recorded food disaster occurred in 1943 in British-ruled India. Known as the Bengal Famine, an estimated 4 million people died of hunger that year in eastern India (which included today's Bangladesh). Initially, this catastrophe was attributed to an acute shortfall in food production in the area. However, Indian economist Amartya Sen (recipient of the Nobel Prize for Economics, 1998) has established that while food shortage was a contributor to the problem, a more potent factor was the result of hysteria related to World War II, which made food supply a low priority for the British rulers.



When the British left India in 1947, India continued to be haunted by memories of the Bengal Famine. It was therefore natural that food security was one of the main items on free India's agenda. This awareness led, on one hand, to the Green Revolution in India and, on the other, legislative measures to ensure that businessmen would never again be able to hoard food for reasons of profit.

The Green Revolution, spreading over the period from 1967/68 to 1977/78, changed India's status from a food-deficient country to one of the world's leading agricultural nations. Until 1967 the government largely concentrated on expanding the farming areas. But the population was growing at a much faster rate than food production.

This called for an immediate and drastic action to increase yield. The action came in the form of the Green Revolution. The term 'Green Revolution' is a general one that is applied to successful agricultural experiments in many developing countries. India is one of the countries where it was most successful.

There were three basic elements in the method of the Green Revolution

- Continuing expansion of farming areas
- Double-cropping in the existing farmland
- Using seeds with improved genetics.

The area of land under cultivation was being increased from 1947 itself. But this was not enough to meet the rising demand. Though

other methods were required, the expansion of cultivable land also had to continue. So, the Green Revolution continued with this quantitative expansion of farmlands.

Double cropping was a primary feature of the Green Revolution. Instead of one crop season per year, the decision was made to have two crop seasons per year. The one-season-per-year practice was based on the fact that there is only one rainy season annually. Water for the second phase now came from huge irrigation projects. Dams were built and other simple irrigation techniques were also adopted.

Using seeds with superior genetics was the scientific aspect of the Green Revolution. The Indian Council for Agricultural Research (which was established by the British in 1929) was reorganized in 1965 and then again in 1973. It developed new strains of high yield variety seeds, mainly wheat and rice and also millet and corn.

The Green Revolution was a technology package comprising material components of improved high yielding varieties of two staple cereals (rice and wheat), irrigation or controlled water supply and improved moisture utilization, fertilizers, and pesticides, and associated management skills.

### **Advantages of Green revolution:**

- It solved the food crisis of India by making the farmers to grow crops with high yielding varieties.
- To provide sufficient nourishment and nutrients to the crop, high quality of fertilizers were provided to the framers.
- In order to protect the plant from the attack of pests and insects, pesticides and insecticides were used.



- The areas with irrigation facilities were made to grow more crops; and by doing all these measures, it leads to high crop yield and in turn food scarcity problem was eradicated in India.

### **Disadvantages of Green revolution:**

- The usage of a high quantity of pesticides and insecticides incorporated toxicity in the plants. In order to protect crops from different types of disease caused by pest as well as the damages caused by insects, the farmers used pesticides and insecticides at a high amount.
- The production of different varieties of one single crop was affected. It is because the green revolution programme concentrated mainly on crop with varieties which were very naturally high yielding and did not consider low yielding crop varieties.
- As the water and soil from farming land are ruined either due to rain or flood, all the toxic content of pesticides and other chemicals present in the soil gets mixed with the nearby water source and it leads to the death of aquatic organisms mostly fish.

## **10. 15 White Revolution**

Milk production in India increased from 17 million tons in 1950-51 to 84.6 million tons in 2001-02. Therefore, from being a recipient of massive material support from the World Food Program and European Community in the 1960s, India has rapidly positioned itself as the world's largest producer of milk. Milk production in the country was stagnant during the 1950s and 1960s, and annual production growth was negative in many years. The annual compound growth rate in milk production during the first decade after independence was about 1.64 percent; during the 1960s, this growth rate declined to 1.15 percent. The disappointing performance of the dairy sector concerned policy makers, and the Government of India undertook a far-reaching policy initiative.

During the late 1960s, the Government of India initiated major policy changes in the dairy sector to achieve self-sufficiency in milk production. Producing milk in rural areas through producer cooperatives and moving processed milk to urban demand centers became the cornerstone of government dairy development policy. This policy initiative gave a boost to dairy development and initiated the process of establishing the much-needed linkages between rural producers and urban consumers.

The Government of India launched a massive dairy development program popularly known as Operation Flood (OF) from 1971 to 1996. The program was initially started with the help of the World Food Program (WFP) and later continued with dairy commodity assistance from the European Economic Community (EEC) and a soft loan/credit from the World Bank.

Under this program, rural producers were organized into cooperatives so they would have an assured market, remunerative prices, and inputs and services for milk production enhancement, such as better feed and fodder, breed improvement through artificial insemination, and disease control measures.

The program was unique in its approach as much as the gift dairy commodities received by India under the program were not consumed by free distribution but were used to manufacture liquid milk, and funds thus generated were reinvested in rural areas in milk production enhancement activities. This coordinated and innovative effort has greatly increased milk production and ushered in a "**White Revolution**," making India the world's largest milk producer.

**Operation Flood or White Revolution** was a rural development program started by India's National Dairy Development Board (NDDB) in 1970. One of the largest of its kind, the program objective was to create a nationwide milk grid. The engine behind the success of Operation Flood was Anand Milk Union Limited (or Amul), which in turn became a mega company based on the cooperative approach. Verghese Kurien (Chairman of NDDB at that time), then 33, gave the professional management skills and necessary thrust to the cooperative, and is considered the architect and father of India's White Revolution.

### ***Mission Milk: White Revolution II***

'Mission Milk' has been launched at the headquarters of National Dairy Development Board (NDDB) in the country's milk capital Anand on 20th April, 2012. It is an ambitious scheme of NDDB to double India's milk production.

The dairy sector at present contributes six per cent to country's GDP and 26 per cent to agriculture GDP and according to NDDB, the demand for milk is projected to be around 200 million tonnes in 2021-22, as against the production of 122.8 million tonnes in 2010-11.

Union agriculture minister Sharad Pawar unveiled this national plan. In the first phase, which is spread across six years and with a financial outlay of Rs. 2,242 crore, NDP is aimed at increasing the productivity of milch animals through a scientifically planned multi-state initiative.

NDP I will be implemented in 14 major milk producing states, including Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal. It is being financed largely with loan from International Development Association (IDA) of World Bank and implemented by NDDB through End Implementing Agencies located in the states.

Total financial outlay for entire NDP spread over 15 years tenure is Rs 17,300 crore, which according to Mr. Sharad Pawar, will be well supported by World Bank if all the states support this project and make the implementation of the first phase successful.

For the total success of this phase, steps will be taken to expand village based procurement systems by strengthening existing cooperatives and facilitating the setting up of producer companies or new generation cooperatives. It is expected about 1.2 million milk producers in 23,800 additional villages will be covered in the project.

### **Achievements of the White Revolution**

- The phenomenal growth of milk production in India – from 20 million MT to 100 million MT in a span of just 40 years – has been made possible only because of the dairy cooperative movement. This has propelled India to emerge as the largest milk producing country in the World today.
- The dairy cooperative movement has also encouraged Indian dairy farmers to keep more animals, which has resulted in the 500 million cattle & buffalo population in the country – the largest in the World.
- The dairy cooperative movement has spread across the length and breadth of the country, covering more than 125,000 villages of 180 Districts in 22 States.
- The movement has been successful because of a well-developed procurement system & supportive federal structures at District & State levels.

## **10. 16 PLANT NUTRIENTS**

Plants, like all other living things need food for their development and growth, and they require 16 essential elements. Hydrogen, carbon and oxygen are derived from the atmosphere and water soil. The remaining 13 essential elements (manganese, nitrogen, calcium, phosphorus, potassium, zinc, magnesium, sulfur, iron, copper, boron, molybdenum, and chlorine) are supplied either from soil minerals and soil organic matter or by inorganic or organic fertilizers. The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of bio-fertilizers, healthy plants can be grown, while enhancing the sustainability and the health of the soil. Since they play several roles, a preferred scientific term for such beneficial bacteria is "plant-growth promoting rhizobacteria" (PGPR). Therefore, they are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements by supplying the organic nutrients through microorganism and their by-products. Hence, bio-fertilizers do not contain any chemicals which are harmful to the living soil.

### **Primary Macronutrients required for Plants**

This is in accordance with Justus von Liebig's law of the minimum. The essential plant nutrients include carbon, oxygen and hydrogen which are absorbed from the air, whereas other nutrients including nitrogen are typically obtained from the soil (exceptions include some parasitic or carnivorous plants).

There are 17 most important nutrients for plants. Plants must obtain the following mineral nutrients from their growing medium:-

The macronutrients:

**Nitrogen(N), Phosphorus (P), Potassium (K), Calcium (Ca), Sulfur (S), Magnesium (Mg), Carbon (C), Oxygen(O), Hydrogen (H)**

The micronutrients (or trace minerals):

Iron(Fe), Boron (B), Chlorine (Cl), Manganese (Mn), Zinc (Zn), Copper (Cu), Molybdenum (Mo), Nickel (Ni)

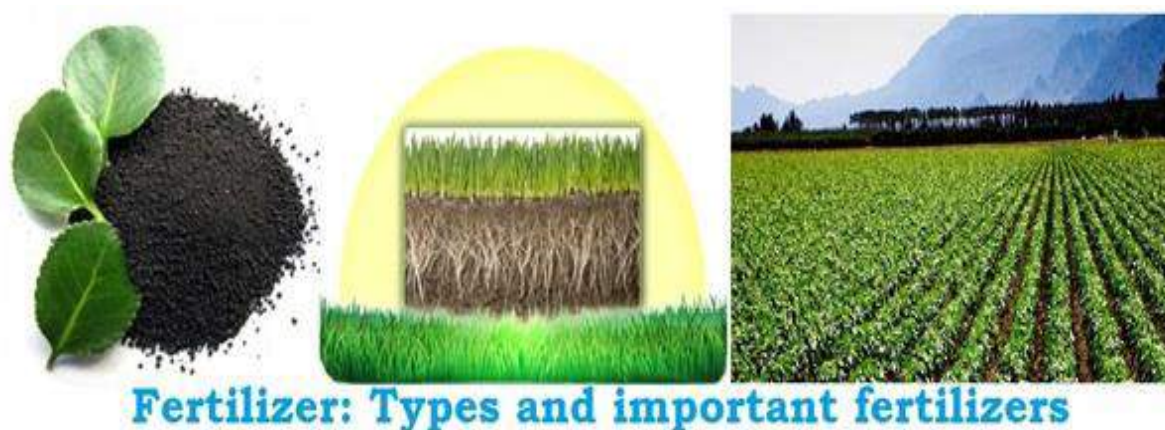
These elements stay beneath soil as salt. So plants consume these elements as ion. The macronutrients are consumed in larger quantities; hydrogen, oxygen, nitrogen and carbon contribute to over 95% of a plants' entire biomass on a dry matter weight basis. Micronutrients are present in plant tissue in quantities measured in parts per million, ranging from 0.1 to 200 ppm, or less than 0.02% dry weight.

## **10.17 Fertilizers**

Fertilizer or fertiliser is that substance which is used to make soil more fertile such as manure or a mixture of nitrates. It is applied to the soils or to plant tissues (usually leaves) to supply one or more plant nutrients essential to the growth of plants. Hence, we can say in other words that the fertilizers are the chemical substances which are directly respondent for the substantial growth of the plants (trees) or crops and being supply the nutrients in the form of nitrogen, phosphorus, potassium etc and keep the soils fertile.

### **• TYPES OF FERTILIZERS**

There are two types of supplies for agriculture, specifically fertilizer and pesticide. It can be said that fertilizer is food, and pesticide is medicine for plants in conventional agriculture. Among the materials used in agriculture, fertilizer is the most widely used. Based on the production process, it can be roughly categorized into three types: chemical, organic and bio fertilizer



### **CHEMICAL FERTILIZERS (Synthetic Fertilizer)**

Fertilizers play an important role in increasing crop production. The main macronutrients present in inorganic fertilizers are nitrogen, phosphorus, and potassium which influence vegetative and reproductive phase of plant growth.

#### **The Advantages of Using Chemical Fertilizers**

Nutrients are soluble and available to the plants, therefore the effect is direct and fast, the price is lower and more competitive than organic fertilizer, which makes it more acceptable and often applied by users. They are quite high in nutrient content; only relatively small amounts are required for crop growth.

#### **Disadvantages of Chemical Fertilizers**

The use of chemical fertilizers alone has not been helpful under intensive agriculture because it aggravates soil degradation. The degradation is brought about by loss of organic matter which consequently results in soil acidity, nutrient imbalance and low crop yields.

Due to its high solubility, up to 70% of inorganic fertilizer can be lost through leaching, denitrification and erosion and reducing their effectiveness.

Over application can result in negative effects such as leaching, pollution of water resources, destruction of microorganisms and friendly insects, crop susceptibility to disease attack, acidification or alkalization of the soil or reduction in soil fertility.

### **ORGANIC FERTILIZERS**

Organic fertilizer refers to materials used as fertilizer that occur regularly in nature, usually as a byproduct or end product of a naturally occurring process. Like any fertilizer, organic fertilizers typically provide the three major macronutrients required by plants: nitrogen, phosphorus, and potassium. Organic fertilizers include naturally occurring organic materials, (e.g. manure, worm castings, compost, seaweed), or naturally occurring mineral deposits.

## Understanding N-P-K

Regardless of its type, any fertilizer you buy will come with information about the nutrients it contains. Prominently featured will be the N-P-K ratio, the percentage the product contains by volume of nitrogen (chemical symbol N), phosphorus (P), and potassium (K). A 16-16-16 fertilizer, for example, contains 16% nitrogen, 16% phosphorus, and 16% potassium. A 25-4-2 formulation contains 25% nitrogen, 4% phosphorus, and 2% potassium.

All fertilizers contain at least one of these components; if any is missing, the ratio will show a zero for that nutrient (a 12-0-0 fertilizer contains nitrogen but no phosphorus or potassium, for instance). Boxed, bagged, and bottled products display the N-P-K ratio on the label. For fertilizers sold in bulk from self-serve bins, the ratio is noted on the bin; for future reference, be sure to write the information on the bags you fill and bring home.

## Types of Organic Fertilizers

### Animal manures:

Animal manures are probably the most commonly available organic material used for their fertilizer value. Animal manure is essentially a complete fertilizer

### Sewage sludge:

It is a recycled product of municipal sewage treatment plants. Forms commonly available are activated, composted and lime-stabilized

### Plant substances

They are often rich in specific nutrients, such as nitrogen.

### Composts

Although making compost from a variety of raw materials is possible, the finished products are remarkably similar in their final concentrations of nitrogen, phosphorus, and potassium.

## Advantages of Organic Fertilizers

- Organic fertilizers are better sources of nutrient in balanced amounts than inorganic fertilizers where soil is deficient in both macro and micronutrients.
- Organic based fertilizer use is beneficial because it supplies micronutrients, and organic components that increase soil moisture retention and reduce leaching of nutrients.
- Organic fertilizers can be used on acid tolerant and those better suited to neutral or alkaline conditions.

- In addition to increasing yield and fertilizing plants directly, organic fertilizers can improve the biodiversity (soil life) and long-term productivity of soil, and may prove a large depository for excess carbon dioxide.
- Organic nutrients increase the abundance of soil organisms by providing organic matter and micronutrients for organisms such as fungal mycorrhiza.

### **Disadvantages of Organic Fertilizers**

- Hard to get, Not sterile, Low nutrient content, Generally costs significantly more than synthetic fertilizer, Organic certification requires documentation and regular inspections, Organic fertilizers still release nutrients into their surroundings; these nutrients can find their way into local streams, rivers, and estuaries just as nutrients from synthetic sources do.

## **10.18 BIOFERTILIZERS**

Biofertilizers are commonly called microbial inoculants which are capable of mobilizing important nutritional elements in the soil from non-usable to usable form through biological processes.

The term 'Biofertilizers' include selective micro-organism like bacteria, fungi and algae which are capable of fixing atmospheric nitrogen or convert soluble phosphate and potash in the soil into forms available to the plants. Soil microorganisms play an important role in soil processes that determine plant productivity. Bacteria living in the soil are called free living and some bacteria support plant growth indirectly, by improving growth restricting conditions either via production of antagonistic substances or by inducing resistance against plant pathogens.

The interactions among the rhizosphere, the roots of higher plants and the soil borne microorganisms have a significant role in plant growth and development. The organic compounds, released by roots and bacteria, play an important role in the uptake of mineral nutrient. The hormones produced by the rhizosphere bacteria have direct effects on higher plants. Biofertilizer is most commonly referred to the use of soil microorganisms to increase the availability and uptake of mineral nutrients for plants

### **Advantages of Biofertilizers**

- Biofertilizers have definite advantage over chemical fertilizers.
- The use of biofertilizers effectively enrich the soil and cost less than chemical fertilizers, which harm the environment and deplete non-renewable energy sources..

- Chemical fertilizers supply over nitrogen whereas biofertilizers provide in addition to nitrogen certain growth promoting substances like hormones, vitamins, amino acids, etc.,.
- On the other hand biofertilizers supply the nitrogen continuously throughout the entire period of crop growth in the field under favourable conditions.
- Continuous use of chemical fertilizers adversely affects the soil structure whereas biofertilizers when applied to soil improve the soil structure.
- The effects of chemical fertilizers are that they are toxic at higher doses. Biofertilizers, however, have no toxic effects.

The utilization of microbial products has several advantages over conventional chemicals for agricultural purposes:

- (1) Microbial products are considered safer than many of the chemicals now in use;
- (2) Neither toxic substances nor microbes themselves will be accumulated in the food chain;
- (3) Self-replication of microbes circumvents the need for repeated application;
- (4) Target organisms seldom develop resistance as is the case when chemical agents are used to eliminate the pests harmful to plant growth; and
- (5) Properly developed bio control agents are not considered harmful to ecological processes or the environment.

### Types of Biofertilizers

The following common types of biofertilizers are available to the farmers in various countries

- Nitrogen fixing biofertilizer** eg. Rhizobium, Bradyrhizobium, Azospirillum and Azotobacter.
- Phosphorous solubilising biofertilizers (PSB)** eg. Bacillus, Pseudomonas and Aspergillus
- Potassium mobilizing biofertilizer** Frateuria aurentia
- Plant growth promoting biofertilizer** eg. Pseudomonas

## 10.19 Pest&Pesticides



Source: Andrei Rybachuk/Shutterstock.com

**Pests** are organisms that occur where they are not wanted or that cause damage to crops or humans or other animals. Thus, the

term “pest” is a highly subjective term.

## **Types of Pests**

**Insect:** These are important and major pests. Insects have three pairs of legs, two pairs of wings, segmented body and characteristic compound eyes and antennae. Insects are tricky and cause damage in different ways viz. sucking sap from plants, biting plant parts, boring in to fruits, twigs and leaves, attacking roots, barks and blossoms etc. The damaging stages of different insect pests are larvae, adults and nymphs.

**Mites:** These are creatures like insect but have soft body and four pairs of legs. These tiny creatures have red or pale yellow colour. They suck the sap from the plant and attack the crops in huge number.

**Rodents** - This group of pest eat away large amount of human food and also damage the crops on large scale. They are also responsible for heavy loss to stored grains on farms, in warehouses and houses.

**Animals:** Animals like Wild Boar, Deer, Elephants, Wild Buffalo, Jackals, Monkeys, Squirrels cause direct damage to crop plants. They eat away the plants and by and large they waste huge amount of crops.

**Birds:** Birds attack the crop plants and eat grains. Crow, Parrots and Sparrows are major among birds that attack the crops.

## **Pest Control Methods**

The types of pest control methods are of two types, preventive and protective.

### **1. Manual Pest Control Methods**

- a. Picking of pests, removing larvae and destroying them.
- b. Remove any plant that is infested.
- c. Set traps.
- d. Catch them with the help of the net.

### **2. Pest Control Spray Methods**

This method is the main pest control method for control of pests. Pest control sprays that kill the pest are used. These pest control sprays are effective and faster as compared to other methods but if not used correctly, can be hazardous to the environment. Improper use of these pest controls sprays leads to the development of resistance among the pests causing heavy out breaks.

### 3. Biological Pest Methods

Most pests are controlled by nature. There are certain predators, micro-organisms parasites, birds, animals that can be used for control of pests.

### 4. Dust Mite Control

These are creatures like an insect but have a soft body and four pairs of legs. These tiny creatures have a red or pale yellow color. They suck the sap from the plant and attack the crops in huge number.

### 5. Rodent Control

These groups of pest eat away a large amount of human food and also damage the crops on a large scale. They are also responsible for the heavy loss to stored grains on farms, in warehouses and houses.

## Pesticides

Pesticides include chemicals which protect crops from insects (insecticides), weeds (herbicides), disease causing microorganisms (fungicides and bactericides), mites (acaricides), nematodes (nematicides), and rodents rodenticides). Pesticides also include chemicals that control pests directly hazardous to animals and human beings, particularly vectors-such as mosquitoes, flies, fleas, ticks and lice that transmit diseases.

Pesticides are chemicals used to control harmful organisms in the everyday life of modern man. More than 1,170 pesticides are registered today with U.S. Environmental Protection Agency out of which 425 are herbicides, 335 are insecticides and 410 are fungicides. They are sold in more than 32,700 products or formulations. In India alone 1/2 kg. of pesticide is used every year by every man, woman and child to feed, clothe and protect them.

A present 10,000 species of insects, 600 weed species, 1500 plant diseases and 1500 species of nematodes are injurious to some degree to men, plants and animals. The use of chemicals to control pests has been in vogue for centuries and these chemicals are called pesticides.

The greatest benefit of the use of pesticides has been that millions of human lives have been saved from yellow fever, encephalitis, malaria and other insect borne diseases. Pesticides have also protected food from pest damage.

The three major problems which limit the continued usefulness of pesticides are:

- (1) Some pest organisms have developed resistance to chemicals.
- (2) Some pesticides are not readily biodegradable and tend to persist for years in the environment (in water and soil both). These chemicals move to other parts of the environment.

(3) The detrimental effects of chemicals on organisms other than the target pests. Soil flora and fauna may be adversely affected. Birds and fish tend to consume these chemicals in their body tissue in some cases to toxic levels.

## **Classification of Pesticides:**

### **Classification based on their origin-**

There are two types – chemical pesticides and bio pesticides.

### **Classification of Chemical pesticides based on their origin-**

**Organophosphate pesticides** - These are the chemical substances which are produced due to reaction between phosphoric acid and alcohols. This affects the nervous system by inhibiting the action of enzyme acetyl cholinesterase (AChE). This causes irreversible blockage leading to accumulation of the enzyme which results in overstimulation of muscles. These mainly include insecticides, nerve gases, herbicides, etc.

**Carbamate** - These are esters of carbamic acids. The mode of action is inhibiting acetyl cholinesterase similar to that of the organophosphates but the bond formed for inhibition is less durable and thus reversible. These also include mainly of insecticides.

**Organ chlorine pesticides**- These are the derived from chlorinated hydrocarbons. These are endocrine disrupting agents which effect on the hormonal systems of the body, act as duplicates of the normal hormones and thus causing adverse health problems. They remain in environment for a long time by breaking down slowly and accumulating in the fat tissues of animals. A well-known example is DDT (dichlorodiphenyltrichloroethane)

**Pyrethroid pesticides**- These are potent neuro poisons, endocrine disruptors and cause paralysis. Pyrethroids are synthetic version of pyrethrin a natural insecticide. They have similar chemical structure and similar mode of action as of pyrethrin which is obtained from chrysanthemum. These are derivatives of ketoalcoholic esters of chrysanthemic and pyrethroic acids and are more stable in sunlight than pyrethrins. These are most popular insecticides as they can easily pass through the exoskeleton of the insect. Few examples are- deltamethrin, cypermethrin, etc.

### **Classification of Biopesticides based on origin:-**

These are naturally occurring materials or derived naturally from living organisms or their metabolites, like bacteria, fungi, plants, etc. These are classified into three major groups-

**Microbial pesticides**- This has microorganisms acting as pest controllers like bacteria, fungi or viruses. Each of it contains specific target. Widely used are strains of *Bacillus Thuringensis* or Bt and its subspecies. The mode of action generally is producing a protein that binds to the larval gut receptor which starves the larvae.

**Biochemical pesticides**- They are naturally occurring, nontoxic pest controllers. These include pheromones, natural plant and insect regulators, enzymes, bio repellents or attractants.

**Plant incorporated protectants (PIPs)**- These substances are produced by plants naturally but the gene necessary for production of pesticide is introduced into the plant through genetic engineering. The substance produced by the plant and the genetic material introduced are together defined as plant incorporated protectants (PIPs).

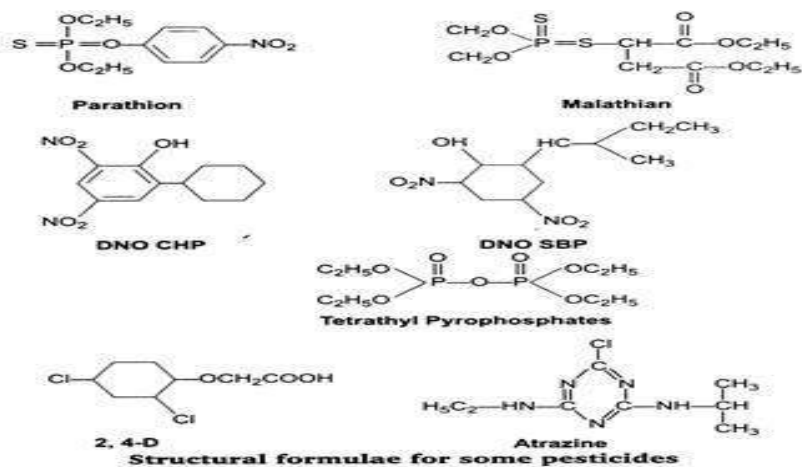
### **Classification of Pesticides based on their pests they control-**

- **Insecticides**- These act especially on insects.
- **Algaecides**- control or kill growth of algae.
- **Herbicides** – controls or kills weeds.
- **Bactericides** - acts against bacteria.
- **Fungicides**- acts against fungi.
- **Rodenticides**- kills or prevents rodents i.e. rats or mice.
- **Larvicides**– inhibits growth of larvae.
- **Repellents** – they tend to repel pests by its taste or smell.
- **Desiccants**- they act on plants by drying their tissues.
- **Ovicides**– they inhibit the growth of eggs of insects and mites.
- **Virucides**- acts against viruses.
- **Molluscicides** – they inhibit or kill mollusc's i. e snail's usually disturbing growth of plants or crops.
- **Acaricides**– they kill arachnids like mites.
- **Nematicides**– they are tend to kill nematodes that act as parasites of plants.
- **Avicides** – these are used to kill birds.
- **Moth balls**- these are used to stop any damage to cloths by moth larvae or molds.
- **Lampricides**– these are designed to target larvae of lampreys which are jawless fish like vertebrates in the river.
- **Piscicides**– they are substances that act against fishes.

### **Magnification of Pesticides:**

When magnification of some of the pesticides takes place biological, the process is known as biological amplification. Several pesticides such as DDT and other chlorinated hydrocarbons have persistent effectiveness of their residual deposits. The biological amplification takes place in sequence of an Eltonian pyramid.

For example, if the concentration of DDT in a water body such as pond is say,  $3.0 \times 10^{-6}$  ppm, it will amplify to  $1.5 \times 10$  when it reaches the top of Eltonian pyramid, represented by large fish. If this fish is consumed by a person, the presence of heavy dose of DDT will disturb the functioning of blood molecules and hence lead to illness.



The **bioamplification** of DDT is about 107 times the original residue. Hence it is called as **ecopoisonous** circulation of DDT.

## 10.20 Integrated Pest Management (IPM)

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. In contrast, *organic* food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

**1) Acceptable Pest level:** - Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will either become an economic threat is critical to guide future pest control decisions.

**2) Monitoring of pest levels:** - Monitoring through inspection and identification is critical in having a full knowledge about pest behaviour and life cycle. Visual inspection, spore collection and insect traps are used for regular monitoring. It will be helpful in knowing the exact time and pattern of outbreak of a particular pest in a particular region which will later help in applying a typical control measure.

**3) Mechanical control:** - In order to prevent a pest from crossing the threshold level, mechanical methods like barriers, traps, hand keeping and tillage are used to disrupt their breeding process.

**4) Biological Control:** - It includes using one species that is a natural enemy of other. These are natural processes that can provide control at low cost often with environmentally acceptable impacts. The beneficial insects are promoted which parasitize target pests. *Bacillus thurengensis* (BT) causes a disease that affects Caterpillars and the larva of other pests. It is environmentally effective and non-polluting. Another group of effective biological agents are small wasps that are parasites of caterpillars or moths. Control of oriental fruit moth is such an example which used to affect so many fruit. In addition, lady bugs are also predators to many pests. Another effective mean being use of sex-pheromones that attract members of opposite sex have been used as bait in the insect traps and to confuse the matching pattern of insect pests.

**5) Pesticide use:** - Synthetic pesticides are used only at specific time periods of pest's life cycle that too in small quantities. Many new pesticides derived from plants are naturally occurring substances such as nicotine, pyrethrum prove to be very promising in IPM. Application of pesticide must reach its specific target and matching the technique, the crop and the pest is very crucial. However, these are used in low volume sprays that reduce overall pesticide usage and farmers costs.

## 10.21 World Food Problems:

Food is the basic necessity of human life without which one cannot survive. Our food mainly comes from agriculture, animal husbandry and fishing.

**16th October is declared as World Food Day.**

### World Food Problems:

1. Production of food is not keeping pace with the growing demand.
2. There are great disparities in the availability of nutritious food. Some tribes still face serious food problems leading to malnutrition especially among women and children.
3. Our fertile soils are being exploited faster than they can recuperate.

4. Forests, grasslands and wetlands have been converted to agricultural use, which has led to serious ecological problems.
5. Our fish resources, both marine and inland, show evidence of exhaustion.
6. Global food production has increased by using more soil, water, plant, animal and energy resources and causing more pollution and environmental damage.
7. More than 100 countries regularly import food from US, Canada, Australia, Argentina, Western Europe, New Zealand and Thailand.
8. With 30-40% of the calories coming from animal products, current world agriculture system would support only 2.5 billion people to have typical diet of a person in any developed country.
9. 40% of people in India suffer from malnutrition because they are poor to buy or to grow enough food to meet their basic needs.
10. 2/3rd of India's land is threatened by erosion, water shortages and salinization.
11. Women and children are mostly underfed and malnourished compared to men.

## **10.22 Food Security**

Famines have been frequent in the world history that have killed millions and substantially have diminished the population of many areas. The most common cause of famines has been droughts, wars and faulty economic policies. Besides population explosion, change in land use and global catastrophic risks have increased the food insecurity to a considerable proportion of global population. This has led to unavailability of nutritionally adequate and safe foods to the society in socially acceptable ways. There are evidences from the past when central authorities from china and Egypt used to release food from storage in the times of shortage or famines; this practice is known to be food security. Food security is a measure of the food availability and the accessibility of the individuals to it. As per the world food conference 1947, food security is defined as the availability at all times of adequate, diverse, nourishing, balanced and moderate food supplies of basic food stuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices. As per the latest report of World Food Summit 1996, food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary requirements and food preferences for an active and healthy life. Household food security occurs when all members at all times have access to enough food for an active and healthy life. Individual food security ensures that no one lives hungry or in a fear of starvation. Food security can be measured by calorie intake per person per day available on a household

budget. Food security means something more than getting two square meals. It has the following dimensions:

- Availability: means food produced within the country, food imports and previous year's stocks stored in granaries.
- Accessibility: means food is within reach of everyone.
- Affordability: means an individual has enough money to buy sufficient, safe and nutritious food to meet one's dietary needs.

Thus food security is ensured in a country when enough food is available for all, all have the capacity to buy it and there is no barrier on access to food. Food security depends on the public distribution system and vigil on behalf of the government when security is threatened. PDS is a food security system established by the government under ministry of consumer affairs. Food and public distribution are managed jointly by state governments that distribute subsidised food and non-food items to the Indian poor. The scheme is active from 1947 that distributes food commodities like wheat, rice, sugar and kerosene through a network of fair price shops across the country. PDS is procured and maintained by Food Corporation of India -a government owned corporation. Buffer stocks-another means of food security are food stocks of wheat and rice procured by government through Food Corporation of India. FCI purchases these food grains from the farmers in states of surplus food. The purchased food is stored in government granaries and later on distributed in the deficit areas among the poorest sections of the society at a price lower than the market. This helps in resolving the shortage of food grains during adverse weather conditions and natural calamities.

## Additional Information

### Kashmiri Saffron at Glance (Refresh Your Souls)



#### Saffron Heritage of Kashmir

No one can deny the fact that agriculture has an important role to play in the economy of Jammu and Kashmir. Eighty per cent population of this state lives in villages and depends on agriculture. The state cannot progress unless the economic condition of this vast majority improves and the standard of living of people gets enhanced. Agriculture itself is a vast field. It's like a tree

which has endless branches. One among them is related to saffron cultivation.



Saffron has several names-Zafran, Kesar, Kang, Kang Posh etc. Kang posh, the flowers of Saffron is a symbol of freshness and purity. The vast stretches of saffron fields give the impression of a newly wedded bride draped in a saffron shawl taking a nap. Kashmir is known as the valley of flowers. Among several varieties of flowers grown here, saffron has its own importance and utility.

The Union Territory of Jammu and Kashmir tops the list of the saffron growing states in India. It can be gauged from the fact that out of the total 5,707 hectares of land under its cultivation 4,496 hectares lie exclusively in Jammu and Kashmir.

In Kashmir, Pampore, which is situated at a distance of 15 kilometers from Srinagar, is famous the world over for its high grade saffron. Saffron is also grown, though in a limited scale, in Kishtwar of Jammu. Pampore and its neighboring areas produce an average of 2,128 kilograms of saffron every year.

In Jammu and Kashmir, saffron is normally sown in August and till the 15<sup>th</sup> of September. The flowers are plucked in October and November. During harvesting or plucking of flowers, the atmosphere must not be hot. So, this process is completed early in the morning.

From sunrise to 10 AM is perceived the ideal time for flower plucking. After harvesting, the flowers are kept for drying for 5 days. Afterwards, they are kept in an airy container so that the quality of the produce does not deteriorate. Now-a-days solar drier is also used. It takes only seven, eight hours to dry the produce.

Locally, one kilogram saffron consists of around one lakh sixty thousand to one lakh seventy thousand tiny flowers. It's so tiring a job, and time consuming too.

## **The Apple of Kashmir's Eye**



The apple tree (*Malus pumila*, commonly and erroneously called *Malus domestica*) is a deciduous tree in the rose family best known for its sweet, pomaceous fruit, the apple. Apple Trees are one of the most well-known fruiting trees, with history in religions, mythologies, and cultures from around the world.

Kashmir is referred to as the fruit bowl of India and apples of the region have gained popularity among the people across the globe for its unique yet delicious taste. In India, Kashmir is the prime source of total Apple production of the country. Apart from Kashmir, Apple is also grown in Himachal Pradesh and Uttarakhand.

From such a history, we know that Sultan Zain-ul-Abidin (1420-1470 AD) paid considerable attention towards the valley's agricultural base while constructing many famous water channels. He also imported several fruit grafts from various parts of Central Asia, particularly from Iran. Subsequently, the Moguls also played their part and laid out parks, gardens and orchards in different places across the valley.

***Sir Walter H. Lawrence in his famous book The Valley of Kashmir (1895) has also mentioned that "Kashmir is a fruit producing country."***

Kashmiri apples have a unique look, taste, flavor, size and color. The apple is one of the most important fruit crops, cultivated almost in every part of the valley, and as such a source for

the economy and the local fruit industry. However, the major producers of apples are districts like Shopian, Baramullah, Kulgam, Pulwama, Budgam, Anantnag, Srinagar, Kupwara and Doda.

### **Uses**

Apples are consumed across the world as the fourth most widely purchased fruits after bananas, oranges and grapes. The entire fruit, except the core that may contain toxic seeds, are consumed raw, as parts of salads, as slices, baked in pies and cakes, pressed to produce juice, cooked into sauces, as jams, made into apple butter. Jewish people dip apple slices in honey and eat them during Rosh Hashanah, the Jewish New Year. Interestingly enough, in our valley thin apple slices (*TsunthHach*) are dried and consumed widely in the winter and early spring.

### **Nutritional Value**

A long list of health benefits is attributed to apples. Apple contains essential vitamins (vitamins A, B1, B2, B3, B5, B6, B9, A, C, E and K) and water, energy, calcium, magnesium, phosphorous, manganese, iron, potassium, carbohydrates, zinc, dietary fiber, carotene, lutein, and low traces of fat, sodium, and protein. Being rich in fiber, apples assist digestion and ensure smooth bowel movement, thus preventing constipation while also reducing the chances of breast and colon cancer. Since apples are rich in iron, they help in treating anaemia as well. The potassium found in apples helps in controlling the heart rate and blood pressure and thus reduces the risk of strokes. Apples also improve the functioning of the beneficial bacteria in our large intestine.

The anti-oxidants present in apples help in reducing the risk of Alzheimer's and Parkinson's disease and help in improving memory. Apples have also shown anti-inflammatory powers and thus assist in treating asthma, arthritis and gout while boosting the immune system. Finally, apples are beneficial in bone and teeth health, and they satiate hunger, serving as an ideal food for weight loss. Apple-based pastes and creams increase skin texture and their juices when applied to the scalp prevent dandruff.

Source: (<https://lokchaar.com/2018/10/03/the-apple-of-kashmirs>)

## Evaluation

### Long Answer Type Questions

- Q.1: Define agriculture. Differentiate between traditional and modern agriculture.
- Q.2: Explain Green Revolution. What are its advantages and disadvantages?
- Q.3: What is white revolution? What are its advantages and disadvantages?
- Q.4: Explain the main causes of disappearance of traditional varieties of crops.
- Q.5: What are fertilizers? Explain their different categories.

### Short Answer Type Questions

- Q.1: Briefly explain IPM. What are its different categories?
- Q.2: What down the classification of pesticides.
- Q.3: What are disadvantages of using pesticides?
- Q.4: What are the environmental impacts of using fertilizers?

### Very Short Answer Type Questions

- Q.1: Define pesticide.
- Q.2: What do you mean by Food security?
- Q.3: Name two nitrogenous fertilizers.
- Q.4: Name three hybrid varieties of wheat.

## Selected References

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- Ahlawat I.P.S., Om Prakash and G.S. Saini, 1998. *Scientific Crop Production in India*, Rama Publishing House Meerut.
- Yellamanda Reddy, T. and SankaraReddi, G.H., 1999. *Principles of Agronomy*, Kalyani Publishers, New Delhi.

## Suggested Further Readings

- Handbook of Agriculture, ICAR Publication, New Delhi. •

# GLOSSARY

- **Abiotic:** Non-Living.
- **Absorption:** The process of taking in, as when a sponge takes up water. Chemicals can be absorbed into the bloodstream after breathing or swallowing. Chemicals can also be absorbed through the skin into the bloodstream and then transported to other organs.
- **Acute:** Occurring over a short time, usually a few minutes or hours. An acute exposure can result in short term or long term health effects. An acute effect happens within a short time after exposure.
- **Adaptability:** Ability to change form and/or function in response to changing conditions. In the context of an agroecosystem and food system, it is the ability to change some components of itself and/or how it is structured based on changing conditions, while still maintaining its viability in providing products and services useful to humans over the long run.
- **Adaptation:** process of adjustment of an organism in particular set of habitat conditions.
- **Aforestation:** Process of planting trees in a land devoid of any trees to create a forest.
- **Agroecosystem:** An agricultural system understood as a set of complementary relationships between living organisms (including crops and/or livestock) and non-living components of their environment within a certain physical area.
- **Agribusiness:** Agriculture operated by business and involving all activities in the business of agricultural production.
- **Agro forestry-** Cultivated mixtures of trees, crops and/or livestock.
- **Agriculture:** The occupation of farming animals, plants and fungi needed for human life.
- **Allele:** An alternative form of a gene or any other segment of a chromosome.
- **Ambient:** Surrounding. Ambient air usually means outdoor air (as opposed to indoor air).
- **Ammensalism:** process in which one organism is inhibited by the other but latter remains unaffected.
- **Aquifer:** A highly permeable layer of sediment or rock containing water.
- **Biodiesel:** A liquid biofuel which is made primarily from vegetable oils (such as soybean or palm oil) and to a lesser extent from other sources like animal fats and waste cooking fat from restaurants.

- **Biofuel:** Any liquid or gaseous fuel that is produced from biomass through various processes.
- **Biogas:** A biofuel which is produced by the process of anaerobic digestion in a biogas digester.
- **Bioinformatics:** The analysis of biological information using computers and statistical techniques; the science of developing and utilizing computer databases and algorithms to accelerate and enhance biological research.
- **Biomarker:** A molecular indicator of a specific biological property; a biochemical feature or facet that can be used to measure the progress of disease or the effects of treatment.
- **Biosphere:** Zone of Earth where life Exists.
- **Biotic potential:** The maximum achievable rate of increase of a population in a given area under ideal conditions.
- **Biotic:** Living.
- **Birth rate:** The number of births within a population at a specific point in time.
- **Body burden:** The total amount of a chemical in the body. Some chemicals build up in the body because they are stored in body organs like fat or bone or are eliminated very slowly.
- **Caldera:** Giant volcanic crater produced by violent volcanic eruptions
- **Carrying capacity:** The maximum number of individuals a given environment's resources can support, including the food and water available for that environment.
- **Central nervous system (CNS):** The part of the nervous system that includes the brain and the spinal cord.
- **Chipko Movement:** nonviolent social and ecological movement in 1973 that was aimed at protection and conservation of trees.
- **Chronic:** Occurring over a long period of time, several weeks, months or years.
- **Climax community:** A community of plants and animals that has reached a stable state, occurring when the different species are best adapted to average conditions in a given area.
- **CNG:** Compressed Natural Gas (CNG) is used as an alternative to petrol and diesel for transport of vehicles.
- **Commensalism:** association where one species is benefited and other not harmed (or unaffected)

- **Competition:** Organisms for the same or from different species competing with each other for food, living conditions, reproductive success, or any limited resource.
- **Contaminant:** Any substance that enters a system (the environment, human body, food, etc.) where it is not normally found. Contaminants are usually referred to in a "negative" sense and include substances that spoil food, pollute the environment or cause other adverse effects.
- **Continental Drift:** Movement of continents in response to sea floor spreading.
- **Core:** with respect to the interior of the earth, represents the central part of the earth
- **Conventional farming:** A method of farming practiced by industrial farmers which requires external high energy inputs in order to achieve high yields. Conventional farming often involves the use of fertilizers, pesticides and machinery.
- **Crater:** A depression on top of volcanic cone below the mantle.
- **Crust:** the outermost and thinnest layer of earth
- **Death rate:** The number of deaths within a population at a specific point in time.
- **Deforestation:** Removal or cutting down of forest vegetation is termed as deforestation.
- **Density-dependent regulation:** The regulation of population in which birth and death rates are dependent on population size.
- **Density-independent regulation:** The regulation of population in which the death rate is independent of population size.
- **Desalination:** The process of removing salt from saltwater to make the water drinkable.
- **Developing country:** A lowly-industrialized country usually with a poor performing economy that is usually primarily based on agriculture. The average income for an individual is often less than \$2 a day.
- **Diversity:** Variety and variability of organisms.
- **DNA (deoxyribonucleic acid):** One of two types of molecules that encode genetic information. (The other is RNA. In humans DNA is the genetic material; RNA is transcribed from it. In some other organisms, RNA is the genetic material and, in reverse fashion, the DNA is transcribed from it.)
- **Dose:** The amount of substance to which a person is exposed.
- **Earthquake:** A trembling or shaking of the ground produced by the passage of seismic waves.

- **Ecological pyramids:** The graphical representation of food chain which shows biomass at each trophic level.
- **Ecology:** The scientific study of interactions between living organisms and their environment.
- **Ecosystem:** A biotic unit consisting of living organisms interacting with their environment to form a stable system.
- **Ecozone:** A broad geographic area encompassing a distinctive pattern of climate conditions, type of landscape, and species of plants and animals.
- **Environment:** The conditions surrounding organisms including all biotic, abiotic components and their interactions.
- **Environmental education (EE):** Process that creates awareness and understanding of the relationship between humans and their many environments - natural, man-made, cultural and technology.
- **Epicenter:** the point on the surface of earth directly above the hypocenter of an earthquake.
- **Epidemiology:** the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems
- **Exponential growth:** An accelerating growth pattern seen in populations where resources are not limiting.
- **Exposed (exposed group):** often used to connote a group whose members have been in contact with a supposed cause of a disease state or health state of interest.
- **Exposure:** Contact with a chemical by swallowing, by breathing or by direct contact (such as through the skin or eyes). Exposure may be either short term (acute) or long term (chronic).
- **Fault:** sharp break in the rock with a displacement (slippage) of the block on one side with respect to an adjacent block.
- **Flash flood:** Flood in which heavy rainfall causes a stream or river to rise very rapidly.
- **Flood plain:** Belt of low, flat ground, present on one or both sides of a stream channel, subject to inundation by a flood about once annually.
- **Food chain:** A linear arrangement of organisms where organisms depend on each other in terms of food and shows who eats whom.

- **Food System:** The interconnected "meta-system" (collection of systems) composed of agroecosystems, their economic, social, cultural, and technological support systems, and systems of food distribution and consumption.
- **Food Web:** A network of food chains which shows the feeding habit of organisms.
- **Gasohol:** A biofuel that is a mixture of gasoline and alcohol (ethanol).
- **Food security:** A situation where the continual supply of food to feed a population is stable.
- **Food shortage:** The lack of sufficient food to meet demand.
- **GAP:** Good Agricultural Practices. These are specific farming techniques that help to grow food that is safe and sustainable, whilst caring for the long term health of the land and environment.
- **Gene:** The basic biological unit of heredity; a segment of deoxyribonucleic acid (DNA) needed to contribute to a function.
- **GMO:** Genetically Modified Organism. An organism whose DNA has been genetically engineered for select characteristics deemed favorable.
- **Green Manure:** Organic matter added to the soil when a crop (usually specifically grown for this purpose) is tilled in.
- **Groundwater:** Water held in aquifers below the earth's surface.
- **Hydroelectricity:** Generation of electricity by the use of hydropower.
- **Hypocenter or focus:** The point in earth where an earthquake originates
- **Ingestion:** Swallowing (such as eating or drinking). Chemicals in or on food, drink, utensils, cigarettes, hands, etc. can be ingested. After ingestion, chemicals may be absorbed into the blood and distributed throughout the body.
- **Inhalation:** Breathing. People can take in chemicals by breathing contaminated air.
- **Inter-specific Interaction:** interactions between the members of two different species.
- **Intra-specific Interaction:** interactions that occur among organisms of the same species.
- **J-shaped growth curve:** The shape of an exponential growth curve.
- **k-selected species:** A species that forms a group of strong competitors in a crowded environment and that has fewer but stronger offsprings.
- **Lava:** magma that emerges at the surface of earth

- **Levee:** May be natural or constructed by humans natural levees result from over banked flows of rivers , human constructed levees are earthen embankments along a river channel to protect land adjacent to the river from flooding.
- **Limiting factor:** Any essential resource that is in short supply in a given environment and therefore limits the possibilities for change in other aspects of the same environment.
- **Logistic growth:** The leveling off of exponential growth due to limiting resources.
- **LPG:** Liquefied Petroleum Gas (LPG), widely used as a domestic fuel for cooking.
- **Magma:** High temperature molten state of rock, usually silicate mineral composition and dissolved gases
- **Mantle:** an internal layer of the earth approx. 3000 Km thick between the crust and the core.
- **Mesopause:** Upper limit of Mesosphere
- **Mineral:** A pure inorganic substance that occurs naturally in earth's crust.
- **Mutualism:** an association where both organisms are mutually benefited, unable to survive in isolation
- **Natural Resources:** Goods and services produced and supplied by our environment to fulfill the demands of everyone.
- **Nebula:** A giant cloud of dust and gas in space
- **NGO:** Non-Governmental Organization- any non-profit, voluntary citizens' group created to solve problems related to society, children, poor, environment etc.
- **Normal Lapse Rate:** The rate at which the temperature decreases with altitude in troposphere. The normal lapse rate in troposphere is  $-6.5^{\circ}\text{C}/\text{km}$ .
- **Nuclear Fission:** A nuclear change in which nucleus of certain isotopes with large mass numbers are split into lighter nuclei on bombardment by neutrons releasing a large amount of energy.
- **Nuclear Fusion:** two isotopes of a light element are forced together at extremely high temperatures until they fuse together to form a heavier nucleus.
- **Organic:** Generally considered as originating from plants or animals, and made primarily of carbon and hydrogen. Scientists use the term organic to mean those chemical compounds which are based on carbon.
- **Ozonosphere:** the lower portion of the stratosphere which has the highest concentration of ozone.

- **Pasture-raised:** To raise animals outside in their natural environment (but with access to shelter) where they are able to forage and behave according to their natural instincts.
- **Photovoltaic cells (PV Cells):** Solar cells that convert solar energy into electricity
- **Predation:** one organism eaten by another.
- **Rainwater Harvesting:** A type of harvest in which rain drops are collected and stored for the future use.
- **Resilience:** Ability to rebound or recover from adversity. In the context of an agroecosystem or food system, it is the ability of that system to remain viable when affected by adverse forces, such as pest infestations, environmental degradation, economic downturns, etc.
- **Risk:** Risk is the possibility of injury, disease or death. For example, for a person who has measles, the risk of death is one in one million.
- **r-selected species:** Species suited to changing environments that produce many offsprings and provide little or no parental care.
- **Seismic:** refers to vibrations in the earth produced by earthquakes.
- **Seismograph:** instrument that records earthquakes
- **Seismology:** scientific study of earthquakes.
- **S-shaped growth curve:** The shape of a logistic growth curve.
- **Strain:** change in shape or size of material as a result of applied stress.
- **Stratopause:** Upper limit of Stratosphere.
- **Stress:** force per unit area.
- **Succession;** change in the species composition of a natural community over time
- **Sustainability** from Sustain meaning: To hold up; to bear; to support; to provide for; to maintain; to sanction; to keep going; to keep up; to prolong; to support the life of. (Chambers Concise Dictionary)
- **Syngas or producer gas:** A gas produced by the gasification of biomass. It is a mixture of carbon monoxide, Hydrogen, hydrocarbons like Methane and a little carbon dioxide.
- **Tectonic plates:** pieces of earth's crust and upper most mantle together referred to as the lithosphere. These lithospheric plates are moving relative to each other.
- **Thermal Pollution:** A rise in the temperature of rivers or lakes that is injurious to water-dwelling life and is caused by the disposal of heated industrial waste water or water from the cooling towers of nuclear power plants.

- **Toxicogenomics:** The collection, interpretation, and storage of information about gene and protein activity in order to identify toxic substances in the environment, and to help treat people at the greatest risk of diseases caused by environmental pollutants or toxicants.
- **Toxicology:** The study of the nature, effects and detection of poisons and the treatment of poisoning.
- **Transgenic:** Having genetic material (DNA) from another species. This term can be applied to an organism that has genes from another organism.
- **Tropopause:** Upper limit of Troposphere
- **Volcano:** A conical circular structure built by accumulation of lava flows.
- **Water shed:** land area that contributes water to a particular stream system. Also known as drainage basin.
- **Wind energy:** The kinetic energy associated with movement of large masses of air.

# MODEL PAPERS

## CBSE PATTERN –A

**Likely to be introduced from this year( annual-regular 2020)**

### Environmental Science (Theory)

*Time allowed: 3 hours*

*Maximum Marks : 70*

**General Instructions:**

- (i) *There are a total of 26 questions and five sections in the question paper. All questions are compulsory.*
- (ii) *Section A contains questions number 1 to 5, very short-answer type questions of 1 mark each.*
- (iii) *Section B contains questions number 6 to 10, short-answer type I questions of 2 marks each.*
- (iv) *Section C contains questions number 11 to 22, short-answer type II questions of 3 marks each.*
- (v) *Section D contains question number 23, value based question of 4 marks.*
- (vi) *Section E contains questions number 24 to 26, long-answer type questions of 5 mark each.*
- (vii) *There is no overall choice in the question paper, however, an internal choice is provided in one question of 2 marks, one question of 3 marks and all the three questions of 5 marks. In these questions, an examinee is to attempt any one of the two given alternatives.*

**SECTION-A (Very short answer type)**

**01 marks each**

- Q.1.** The envelope of air covering earth's surface is called \_\_\_\_\_.
- Q.2.** The interaction where organism of the same species compete for the same resource is called \_\_\_\_\_.
- Q.3.** Natural gas is chiefly composed of which gas.
- Q.4.** Chipko movement started in India in the year \_\_\_\_\_.
- Q.5.** The causative organism of cholera.



### SECTION-B ( Short answer type-1)

02 marks each

- Q.6. Distinguish between a food chain and food web.
- Q.7. what is natality? list its types.
- Q.8. Give a brief note on troposphere.
- Q.9. Give two advantages of using pesticides.
- Q.10. what is traditional method of agriculture.

Or

What do you mean by food security.

### SECTION-C ( Short answer type-2)

03 marks each

- Q.11. What is the scope of studying Environmental science.
- Q.12. What are the different resources of water found on planet earth with their percentage ratio.
- Q.13. What is intra specific interactions? Elaborate on symbiosis.
- Q.14. What is adaptation? What are two different plant adaptations in response to light?
- Q.15. What are biofuels? Give its two advantages.
- Q.16. Write short note on tidal energy.

Or.

Write short note on hydro power.

- Q.17. Write a short note on Narmada Bacho Andolan.
- Q.18. What do you mean by formal environmental education?
- Q.19. Give a short account of Tuberculosis.
- Q.20. Define occupational diseases? Name two occupational diseases.
- Q.21. what do you mean by joint forest management.
- Q.22. Write a short note on integrated pest management.

**SECTION-D (Value based)****04 marks**

**Q.23.** Looking at the current rate of resource depletion and its impact on humans and other components of the environment, the citizens are very much worried and concerned about threats to biodiversity and other resources. Ecologists and other stakeholders have shown their concern and stressed on proper planning for resource conservation and sustainable growth. In reference to this answer the below mentioned questions.

- (a) Write down any two causes of deforestation and their effects. **(02)**
- (b) As a captain of your school Eco-club, suggest any two programmes you would plan to organize in the school so as to bring awareness among the students on how to conserve biodiversity and other resources like water, minerals etc for future generations. **(02)**

**SECTION-E (Long answer type)****04 marks**

**Q.24.** How does energy flow through an ecosystem. Describe briefly one of the energy models.

Or

Define ecological pyramids. Describe its different types in detail.

**Q.25.** Define a population. What are the factors that regulate its size?

Or

What do you mean by population growth? Explain logistic growth in detail.

**Q.26.** Elaborate on atmospheric composition and structure in detail.

Or

Define natural disaster. Describe briefly the causes and effects of earthquakes.

Model paper currently adopted by JKBOSE.(ANNUAL REGULAR-2019)

**K-35-X**

Roll No.....

Total No. of Questions : 30]

[Total No. of Printed Pages : 4

**XIKDRO/N19**

**25535-X**

## ENVIRONMENTAL SCIENCE

Time : 3 Hours]

[Maximum Marks : 70

**Section-A**

1 each

To be answered in one word or one sentence :

1. Define Hydrosphere.
2. Process of movement of water-soluble inorganic nutrients into the soil is called ..... (Fill up)
3. What is a life-table ?
4. Name the causative agent of Tetanus.
5. How does influenza spread ?
6. Name a few fresh-water fishes.

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Turn Over

**K-35-X**

( 2 )

7. Name the tree which yields malarial drug, quinine.
8. Name two carbonates.

**Section-B**

2 each

To be answered in 30 words :

9. What are biotic and abiotic components of atmosphere ?
10. What are limitations of non-renewable sources of energy ?
11. Write a short note on Biological Environment.
12. Briefly describe formation of coal and petroleum.
13. What is the significance of biogeochemical cycles ?
14. What are the objectives of Environmental Education ?
15. Expand the terms IUCN and BNHS.
16. What are communicable diseases ? Give examples.
17. What is economic importance of forests ?
18. What are the different means of communication in animals ?

Or

What is the significance of Pheromones ?

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**K-35-X**

( 3 )

**Section-C**

3 each

To be answered in **40** words :

19. What is green revolution ? What are its advantages ?

*Or*

Write a short note on food security.

20. What is the importance of Environmental Science ?
21. Differentiate between *r*-selection and *k*-selection.
22. Describe briefly the various characteristics of a population.
23. Describe briefly the components of nuclear Power-plant.
24. Write a brief note on Chipko Movement.
25. Write a brief note on, *two* soil-borne diseases.
26. What are Minerals ? Name the different types with examples.
27. What are disadvantages of Pesticides ?

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**K-35-X**

Turn Over

( 4 )

**Section-D**

5 each

To be answered in **40** words :

28. Define an Ecological Pyramid. Write a note on *three* types of Ecological Pyramid.

*Or*

What is Ecological Succession ? Describe its various types.

29. Explain the various cooperative interactions among members of a species.

*Or*

Define adaptations. What is the need for adaptations ?

30. Define Volcano. What are the different types of Volcanoes ?

*Or*

Write a note on earthquakes, their characteristics, effects and mitigation measures.

XIKDRO/N19-25535-X

**K-35-X**