Week 1
Lecture 1

Anamika

Biodiversity

Bio = Life
Diversity = Variety and Variability
It means the **Variety and Variability in the life form** is known as Biodiversity.

The term biodiversity coined by **Walter G. Rosen in 1985**. The **term** '**Biodiversity**', **coined** by Walter G. Rosen in the year 1985 (Wilson, 1988) is a relatively new compound **word** of the longer version '**Biological Diversity**', which was introduced by Lovejoy (1980) to express the number of species present in the community.

According to the Convention of Biological Diversity (CBD-1992) biodiversity has been defined as the variability among living organisms from all sources including *inter alia,* terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part.

Biodiversity encompasses all life forms, ecosystems, and ecological processes, and acknowledges the hierarchy at **genetic, species and ecosystem levels** (**UNEP**).

So, in simple words "**the variability between genes, species and ecosystems**" is known as biodiversity.

Biodiversity is the vast array of all the species of plants, animals, insects and the microorganisms inhabiting the earth either in the aquatic or the terrestrial habitats. The human civilization depends directly or indirectly upon this biodiversity for their very basic needs of survival–food, fodder, fuel, fertilizer, timber, liquor, rubber, leather, medicines and several raw materials. This diversity's the condition for the long-term sustainability of the environment, continuity of life on earth and the maintenance of its integrity.

Although our understanding of the earth's organisms–its biological resources- is still imperfect, there is no doubt that the abundance and diversity of living organisms provide many benefits and make our world a beautiful and interesting place to live. Biodiversity is generally described in terms of its 3 fundamental and hierarchically related levels of biological organisms.

Levels of Biodiversity:

The biological diversity includes three hierarchical levels:

- Genetic diversity
- Species diversity

- Ecosystem diversity

Genetic diversity

It includes the genetic variations within species, both among geographically separated populations and among individuals within single population.

When the **genes** within the same species show different versions due to **varied combinations**, it is known as Genetic Diversity.

Genetic diversity refers as the variation of genes within the same species.

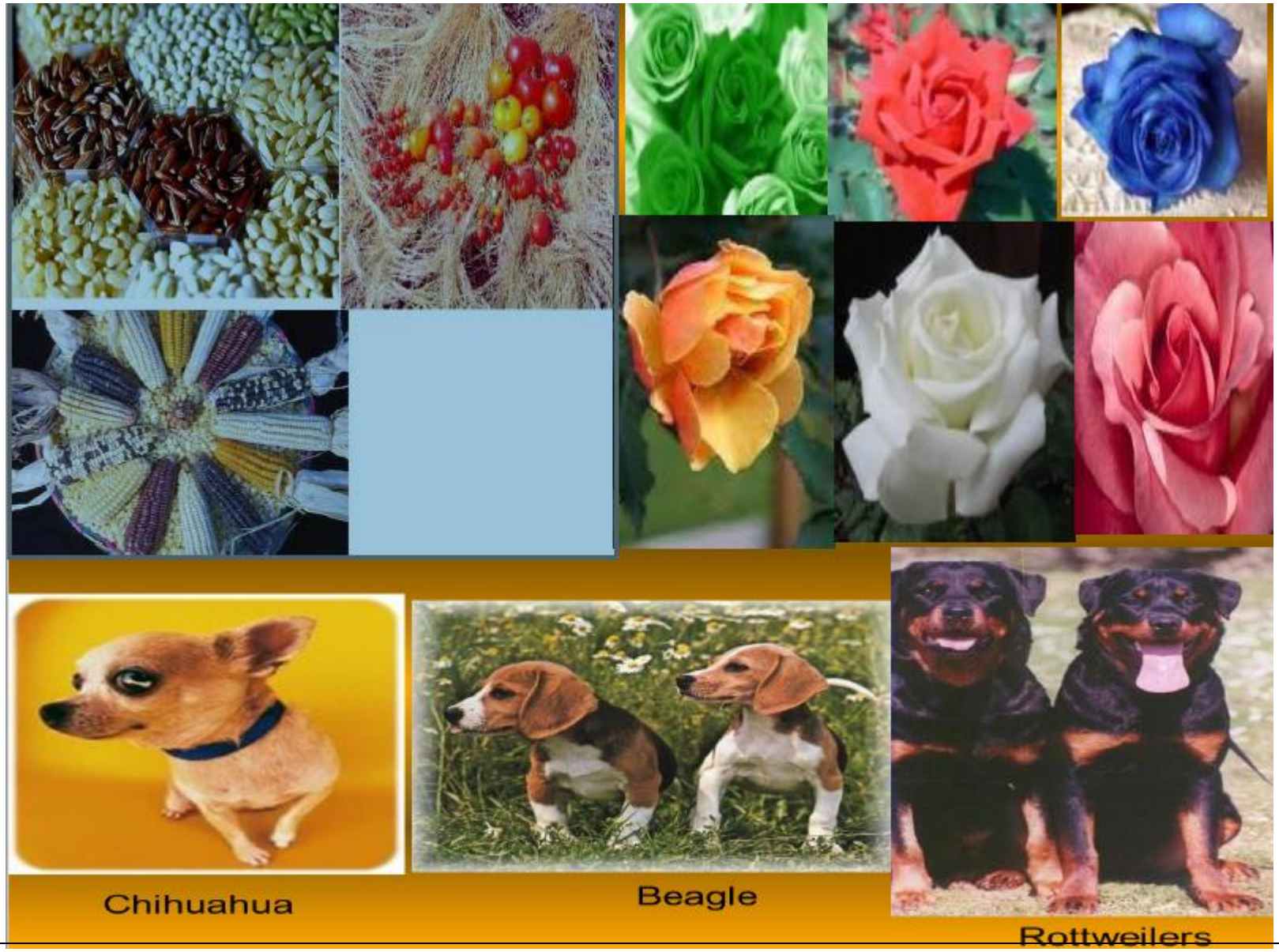
Genes are the **basic units of hereditary information** transmitted from one generation to other. The population of a species of plant or animal cannot be genetically similar, that's why it is the **basic source of biodiversity**.

Generally, no two organisms of a species are genetically identical.

Eg. Variety of rice, tomato, rose species and various breeds of dog species etc.

Likewise, there are many wild or cultivated varieties of rice (*Oryza sativa*) which show variation in their colour, size, shape, aroma and nutrient content of the grain.

Sp. Note: With the help of **Biotechnology,** the genes of species can be **manipulated** and which in turn produces many desirable and new varieties of species.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Species Diversity

This is the variability found between different species of a community. The **number of species of plants and animals** present in a region or community constitute its species diversity.

The easiest way to quantify the species diversity is to count the number of species in the particular area i.e. **species richness**.

There are two important indices to understand species richness and their abundance in a community:
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Diversity in the species at **ecosystem level** known as ecosystem diversity.

Every ecosystem on the earth have their own and **distinctive species-community** which is based on the variation in their physical environment including temperature, precipitation and altitude.

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Rain Forest

Mangrove

Estuary

Coral reef

Week 1
Lecture 2

Anamika

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They are quantified in many different ways.

Two main factors taken into account by ecologists are:

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Biogeography = Phytogeography + Zoogeography

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On the basis of variation in **geography, climate, pattern of vegetation and various communities of mammals, birds, reptiles, amphibians, insects and other invertebrates**, India is classified into 10 major biogeographic zones.

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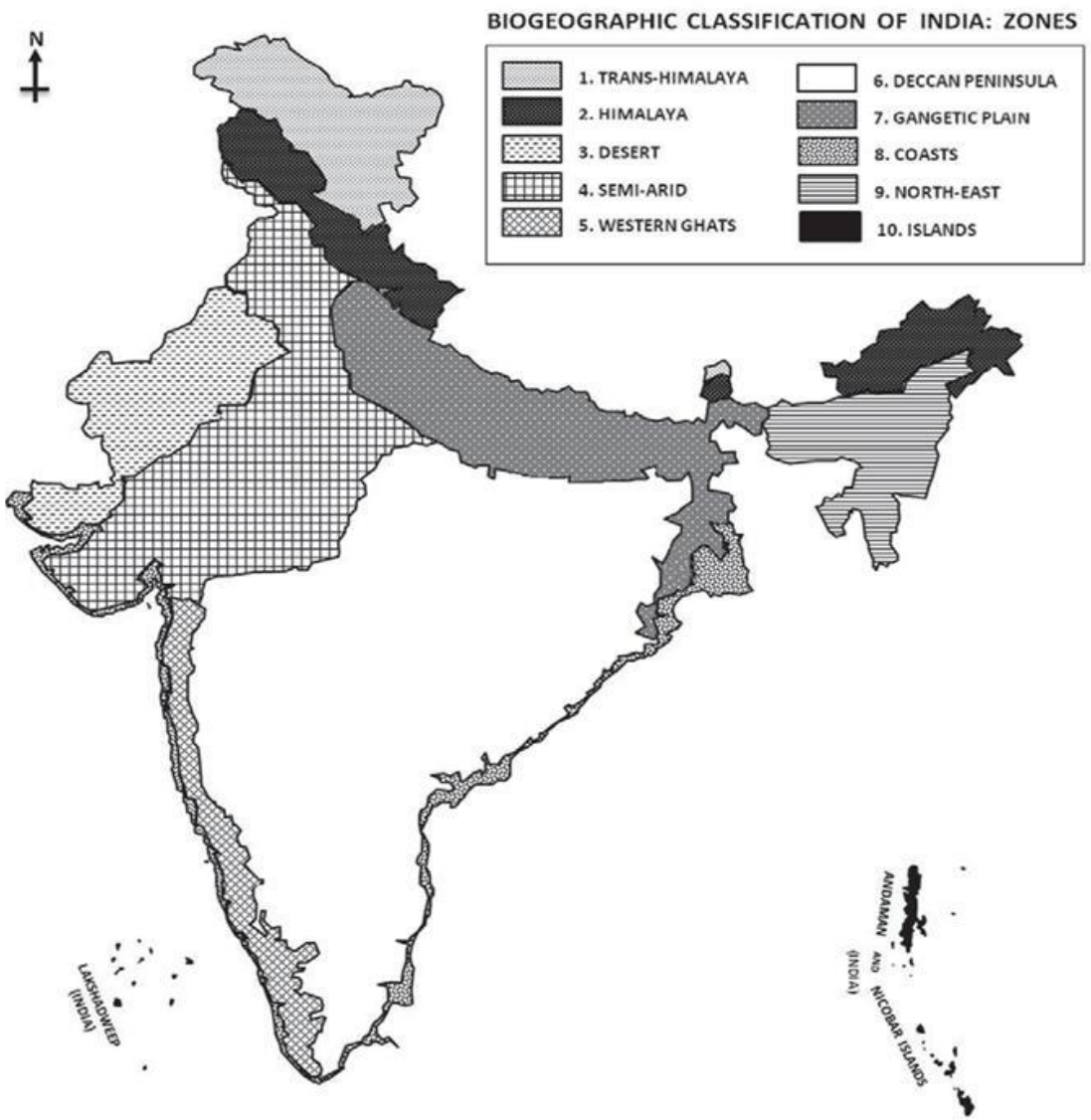
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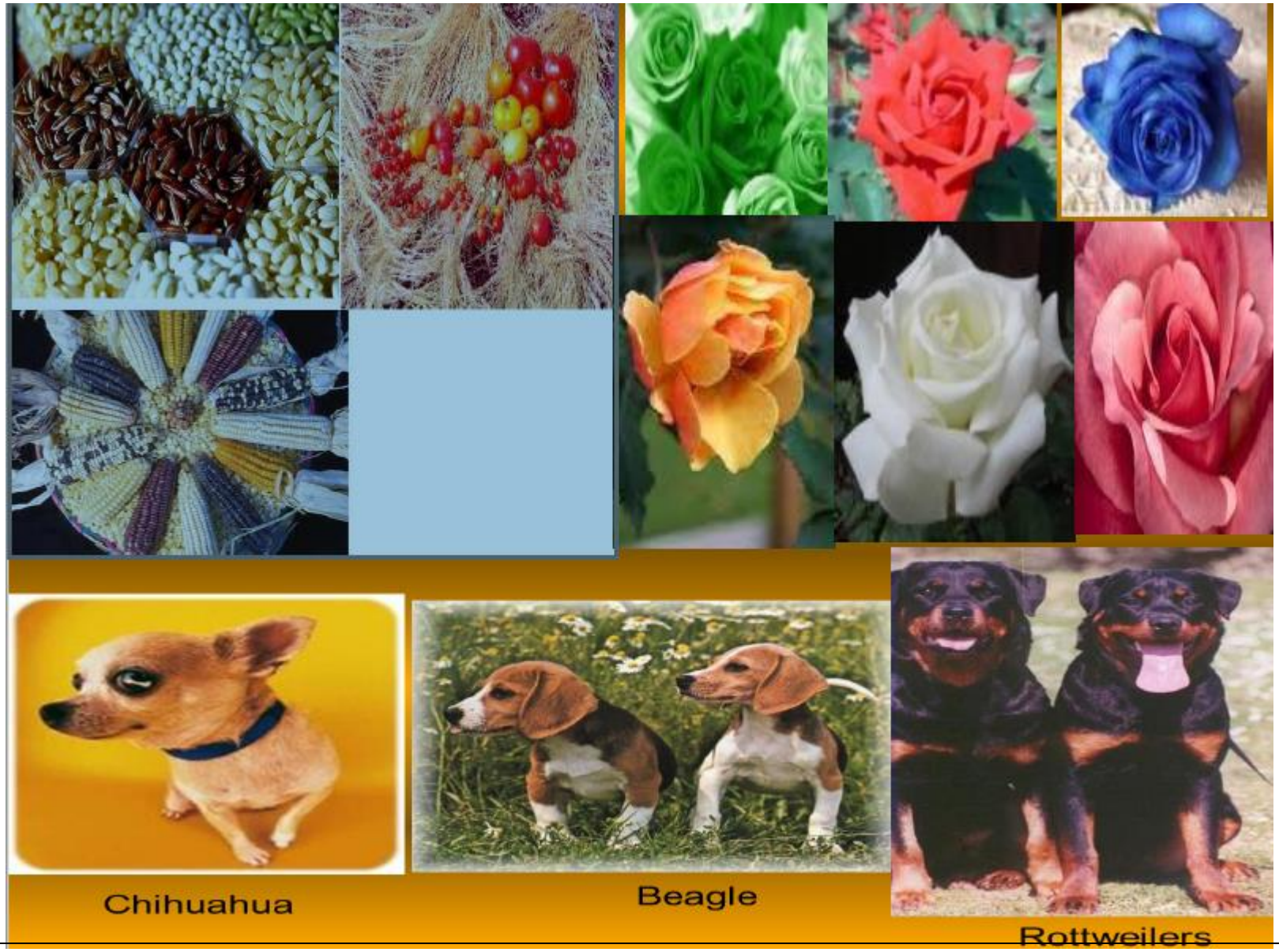
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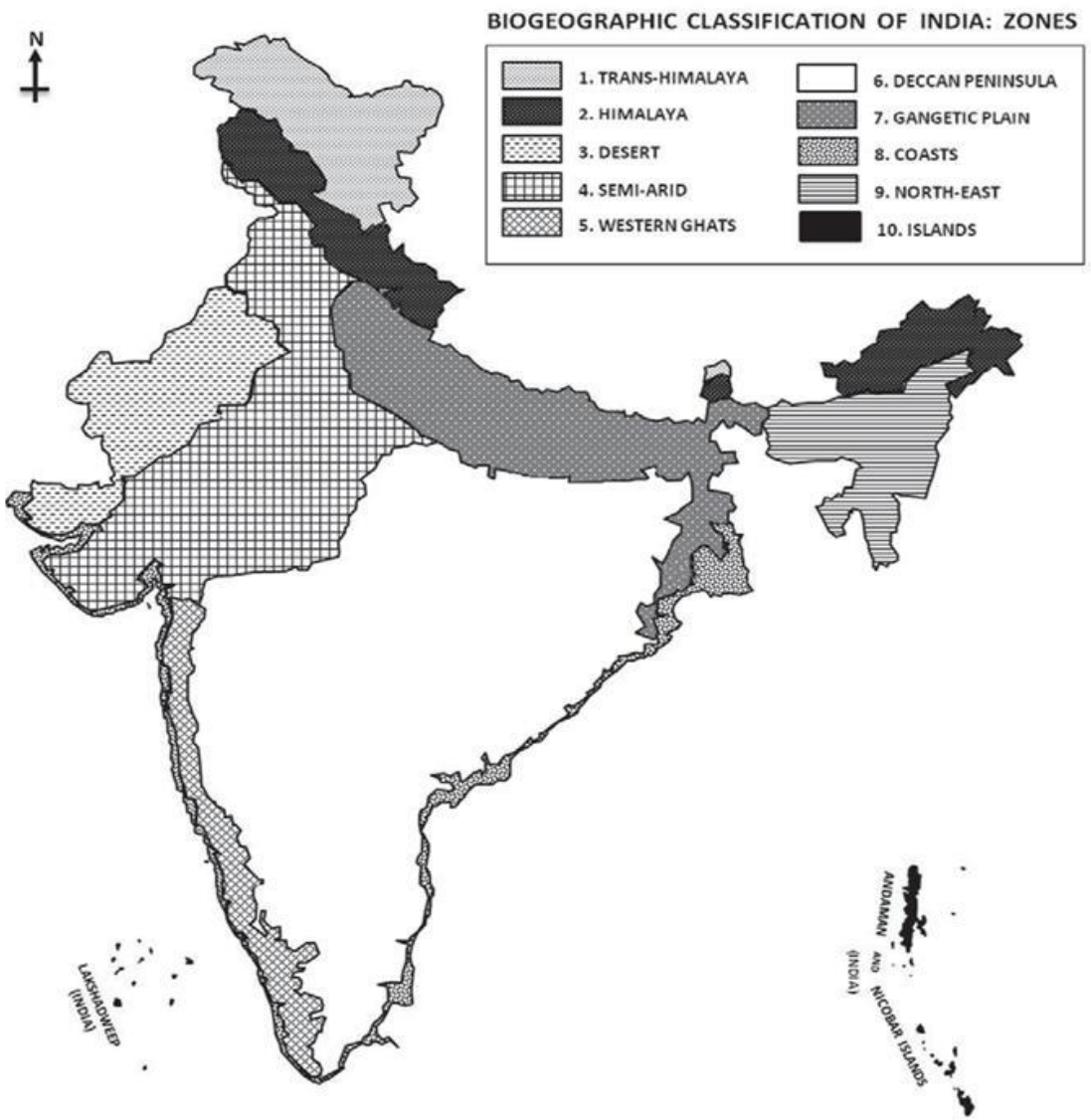
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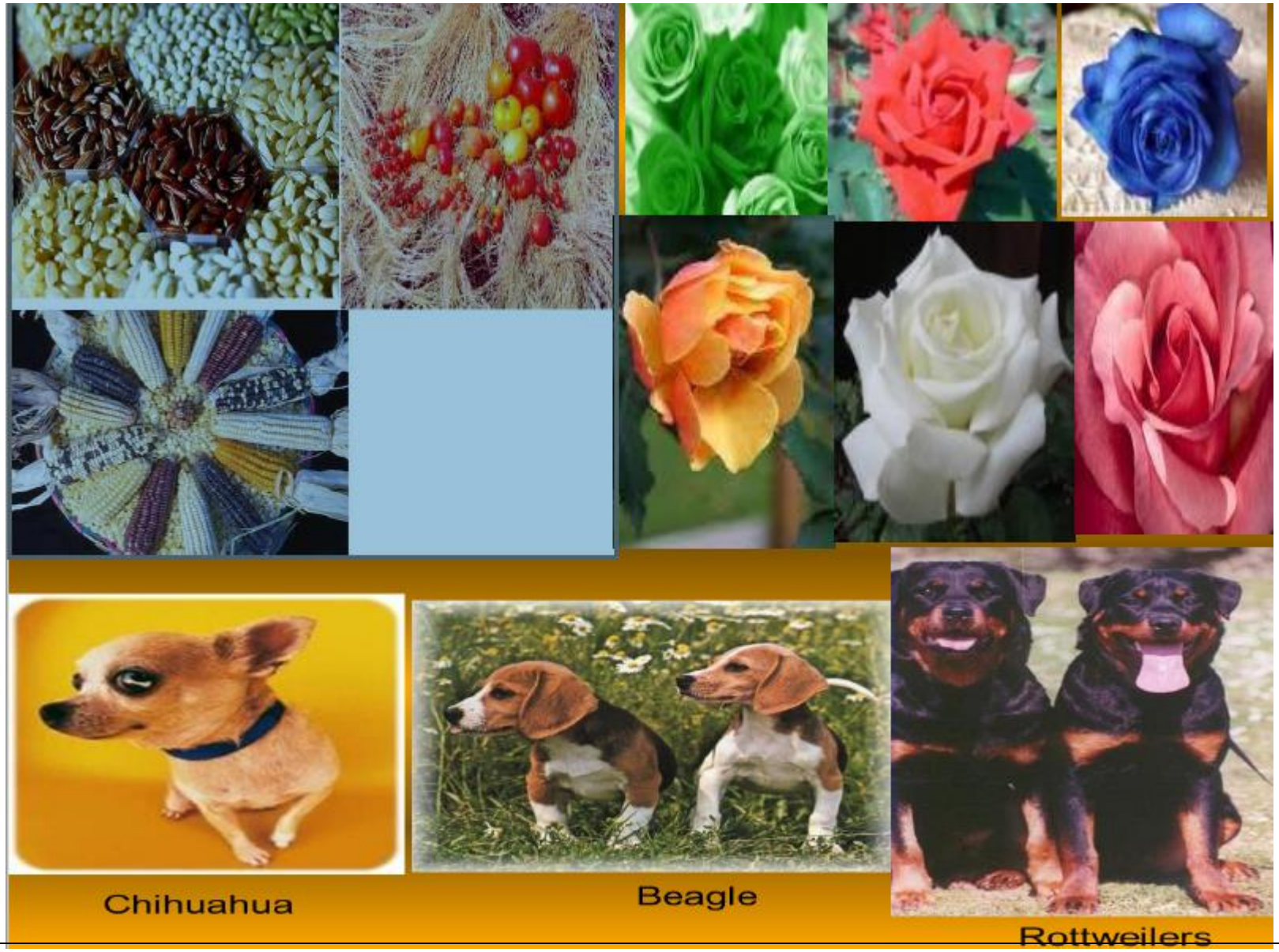
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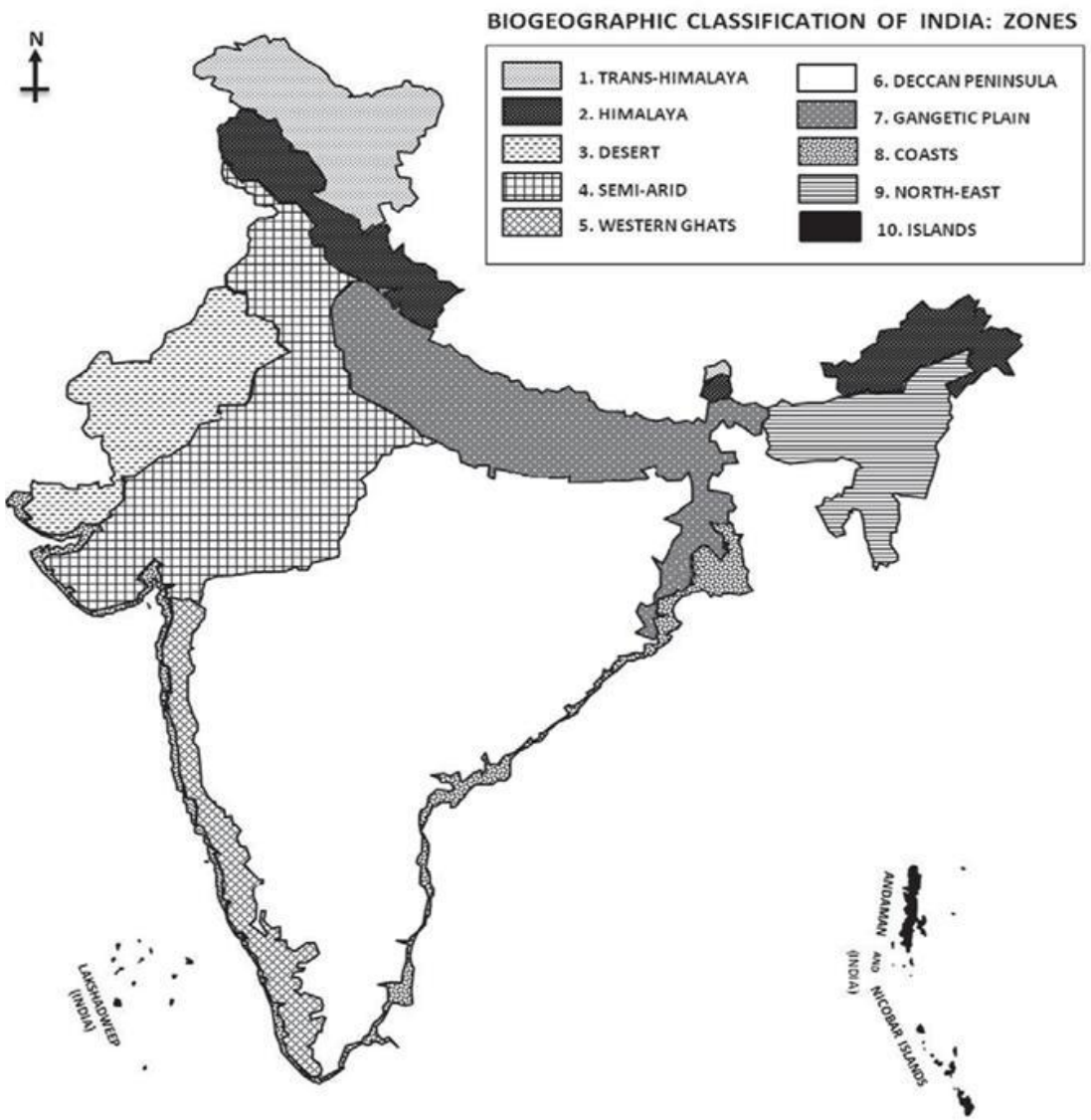
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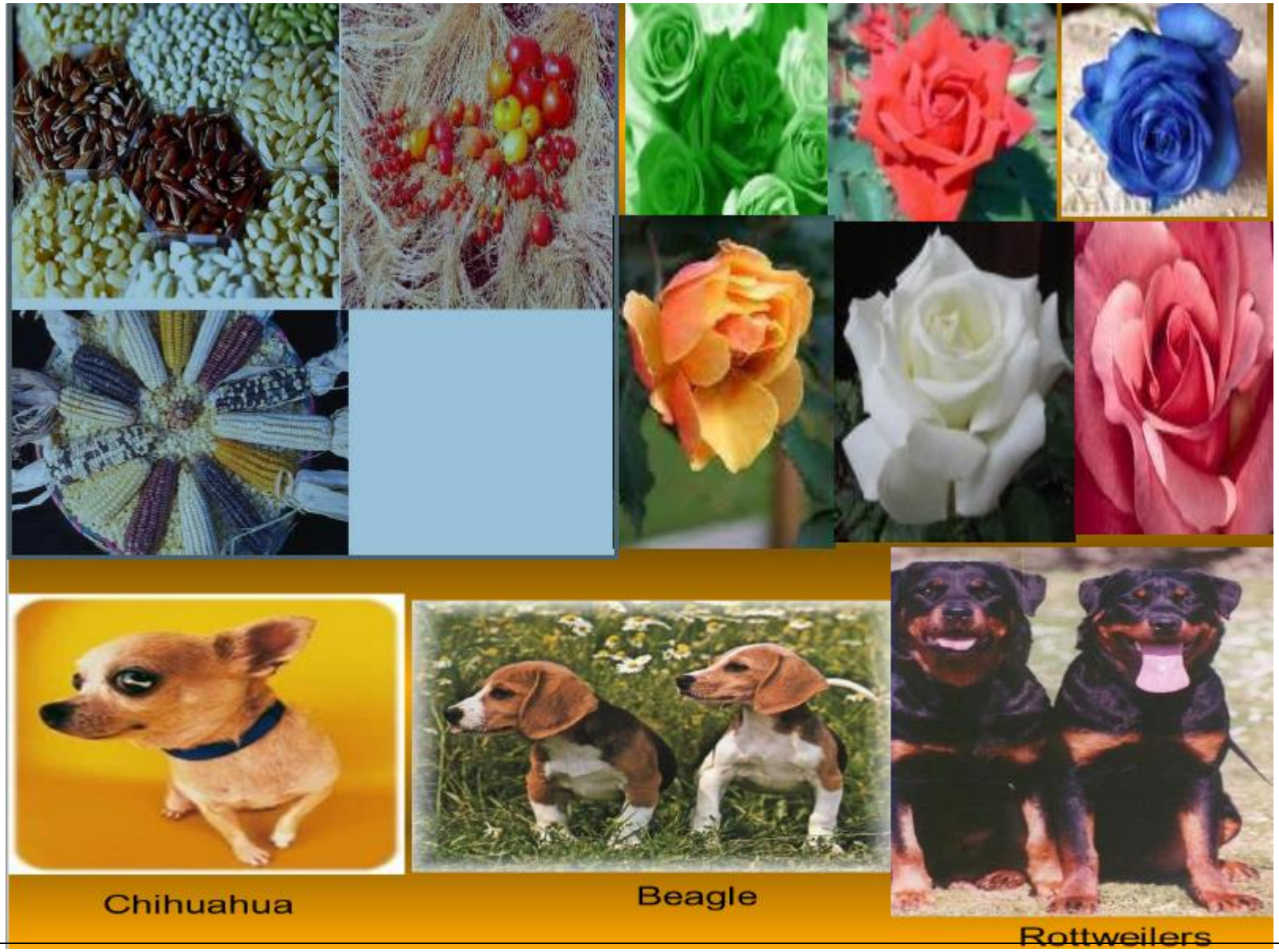
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This **distinction in the ecosystem** can be due to the landscape like forest, grasslands, deserts and mountain as well as aquatic ecosystem like river, lakes and seas.

Rain Forest

Mangrove

Estuary

Coral reef

Week 1
Lecture 2

Anamika

Measuring Biodiversity

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Hence, biodiversity refers to the species richness of an area.

They are quantified in many different ways.

Two main factors taken into account by ecologists are:

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2. *Beta Diversity*- It indicates the degree to which species composition changes along an environmental gradient.

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BIOGEOGRAPHIC CLASSIFICATION OF INDIA

Rio-geographic Classification of India

India has been classified into ten bio geographic zones by the Wildlife Institute of India under the Government's Bio-geographic Project

Biogeography = Phytogeography + Zoogeography

Biogeography deals with region wise distribution of plants and animals.

On the basis of variation in **geography, climate, pattern of vegetation and various communities of mammals, birds, reptiles, amphibians, insects and other invertebrates**, India is classified into 10 major biogeographic zones.

Each of these regions comprises of **variety of ecosystems** such as forest, lakes, grasslands, rivers, wetlands, mountains and hills, which is characterized by specific plant and animal species.

Table of Bio-geographic Zones of India

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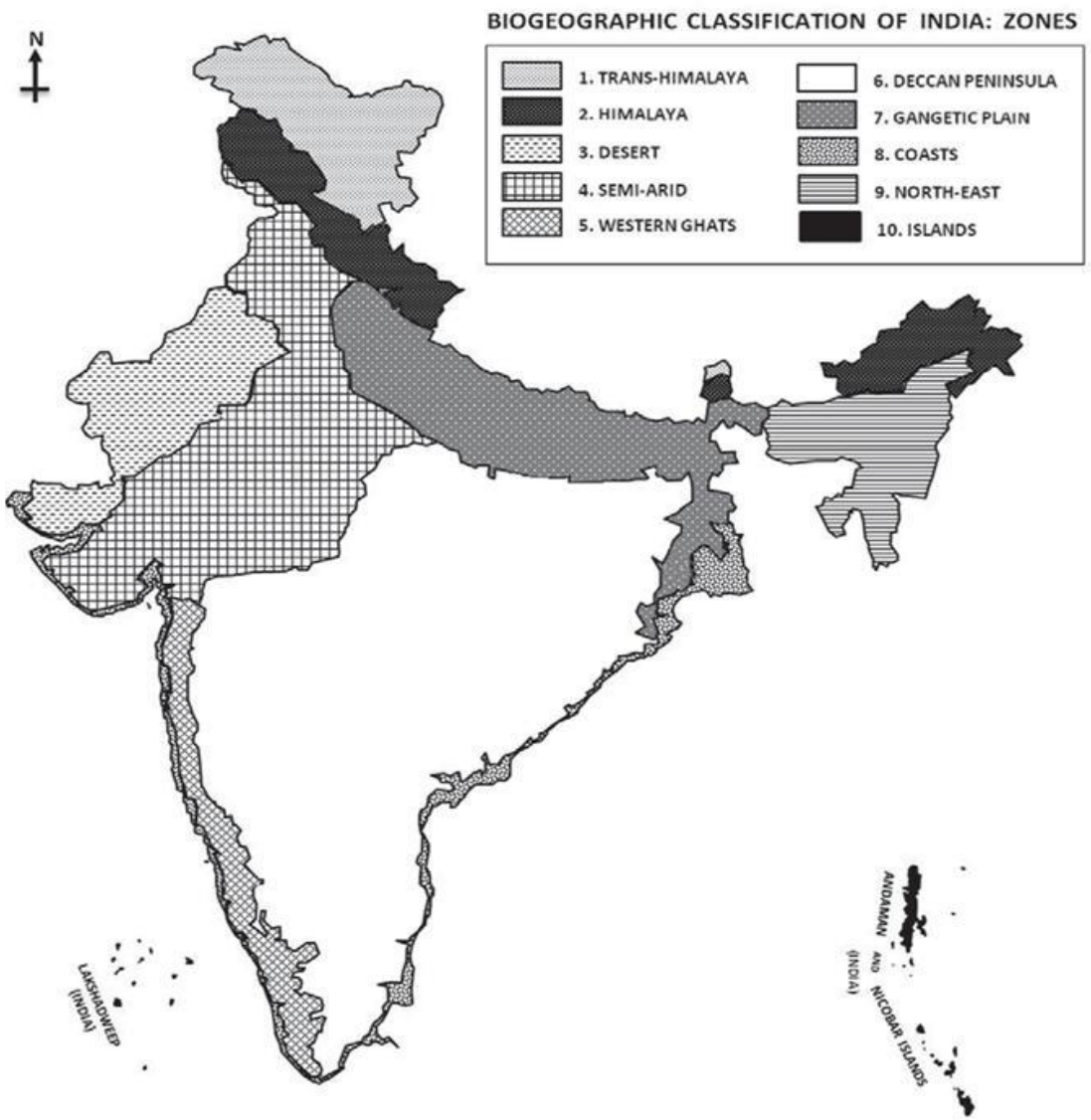
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300
Kilometer

Week 1
Lecture 1

Anamika

Biodiversity

Bio = Life
Diversity = Variety and Variability
It means the **Variety and Variability in the life form** is known as Biodiversity.

The term biodiversity coined by **Walter G. Rosen in 1985**. The **term** '**Biodiversity**', **coined** by Walter G. Rosen in the year 1985 (Wilson, 1988) is a relatively new compound **word** of the longer version '**Biological Diversity**', which was introduced by Lovejoy (1980) to express the number of species present in the community.

According to the Convention of Biological Diversity (CBD-1992) biodiversity has been defined as the variability among living organisms from all sources including *inter alia,* terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part.

Biodiversity encompasses all life forms, ecosystems, and ecological processes, and acknowledges the hierarchy at **genetic, species and ecosystem levels** (**UNEP**).

So, in simple words "**the variability between genes, species and ecosystems**" is known as biodiversity.

Biodiversity is the vast array of all the species of plants, animals, insects and the microorganisms inhabiting the earth either in the aquatic or the terrestrial habitats. The human civilization depends directly or indirectly upon this biodiversity for their very basic needs of survival–food, fodder, fuel, fertilizer, timber, liquor, rubber, leather, medicines and several raw materials. This diversity's the condition for the long-term sustainability of the environment, continuity of life on earth and the maintenance of its integrity.

Although our understanding of the earth's organisms–its biological resources- is still imperfect, there is no doubt that the abundance and diversity of living organisms provide many benefits and make our world a beautiful and interesting place to live. Biodiversity is generally described in terms of its 3 fundamental and hierarchically related levels of biological organisms.

Levels of Biodiversity:

The biological diversity includes three hierarchical levels:

- Genetic diversity
- Species diversity

- Ecosystem diversity

Genetic diversity

It includes the genetic variations within species, both among geographically separated populations and among individuals within single population.

When the **genes** within the same species show different versions due to **varied combinations**, it is known as Genetic Diversity.

Genetic diversity refers as the variation of genes within the same species.

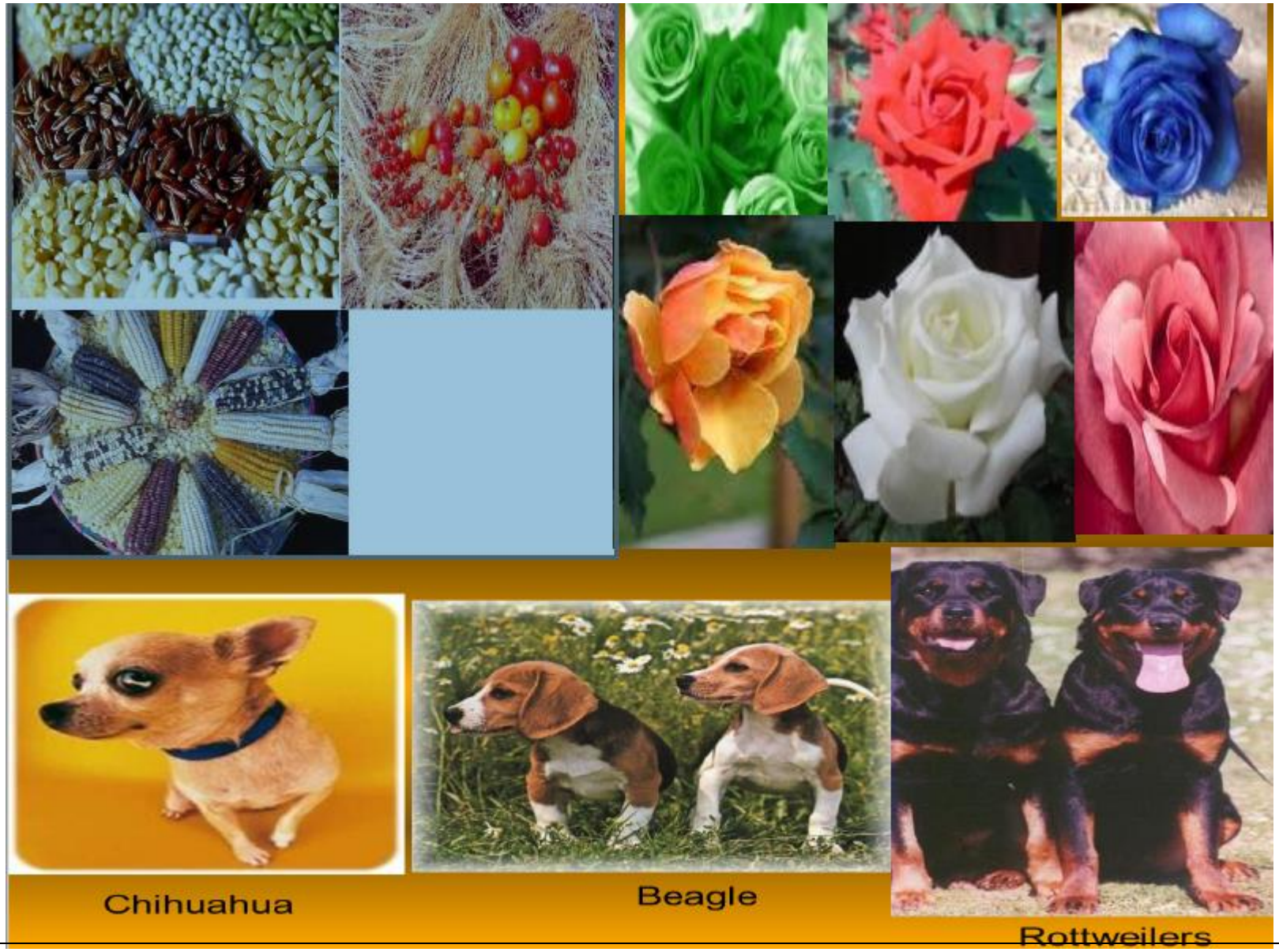
Genes are the **basic units of hereditary information** transmitted from one generation to other. The population of a species of plant or animal cannot be genetically similar, that's why it is the **basic source of biodiversity**.

Generally, no two organisms of a species are genetically identical.

Eg. Variety of rice, tomato, rose species and various breeds of dog species etc.

Likewise, there are many wild or cultivated varieties of rice (*Oryza sativa*) which show variation in their colour, size, shape, aroma and nutrient content of the grain.

Sp. Note: With the help of **Biotechnology,** the genes of species can be **manipulated** and which in turn produces many desirable and new varieties of species.


Chihuahua
Beagle
Rottweilers

Species Diversity

This is the variability found between different species of a community. The **number of species of plants and animals** present in a region or community constitute its species diversity.

The easiest way to quantify the species diversity is to count the number of species in the particular area i.e. **species richness**.

There are two important indices to understand species richness and their abundance in a community:
1. *Shannon-Wiener Index*
2. *Simpson Index*

Eg: For example, monkeys, dragonflies, and meadow beauties are all different species in the same community.

Monkey


Golden Skimmer


Meadow Beauty


Purple loosestrife
Asian longhorn beetle
Round goby
Kudzu vine
Multiflora rose
Eurasian milfoil
Zebra mussel
Grass carp
Leafy spurge
Gypsy moth
Mongoose
Asian tiger mosquito
Scotch broom
Glossy buckthorn
Cheat grass
Sea lamprey
Water hyacinth
Boll weevil
Nutria
Caulerpa taxifolia alga
European green crab
Canadian thistle
Russian thistle

Ecosystem Diversity

This is the diversity of ecological complexity showing variation in physical character, ecological niches, trophic structure, food web and nutrient cycling etc.

Diversity in the species at **ecosystem level** known as ecosystem diversity.

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Lecture 2

Anamika

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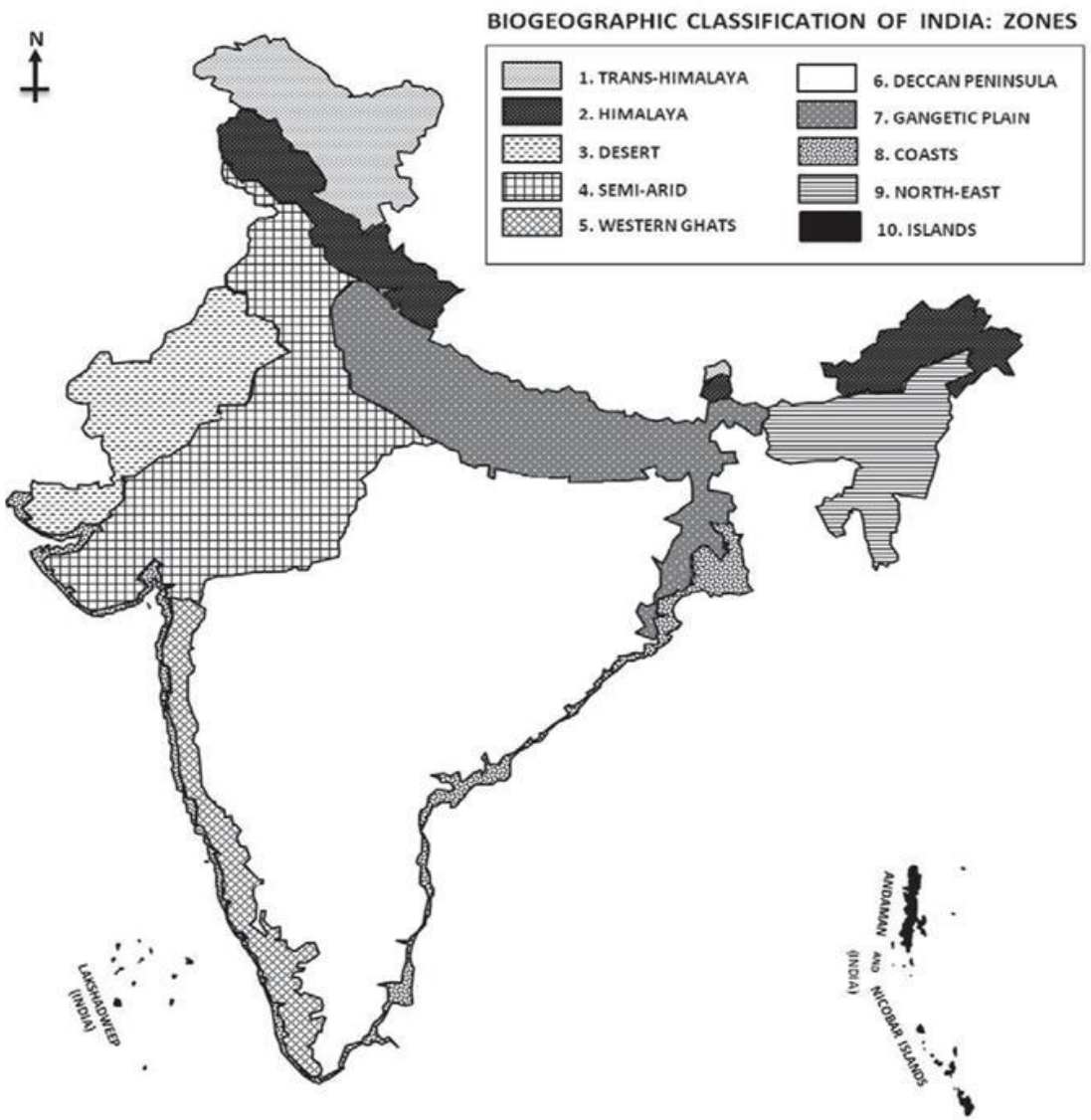
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Week 1
Lecture 1

Anamika

Environmental Pollution

INTRODUCTION

Pollution may be defined as an undesirable change in the physical, chemical or biological characteristics of air, water and land that may be harmful to human life and other animals, living conditions, industrial processes and cultural assets. Pollution can be natural or man- made. The agents that pollute are called pollutants.

Paracelsus (1493-1541)

"All substances are poisons ; there is none which is not a poison. The right dose differentiates a poison from a remedy"

Pollutants

Pollutants are by-products of man's action. The important pollutants are summarized below:

- **Deposited matter**—Soot, smoke, tar or dust and domestic wastes.
- **Gases**—CO, nitrogen oxides, sulphur oxides, halogens (chlorine, bromine and iodine).
- **Metals**—Lead, zinc, iron and chromium.
- **Industrial pollutants**—Benzene, ether, acetic acid etc., and cyanide compounds.
- **Agriculture pollutants**—Pesticides, herbicides, fungicides and

fertilizers.

- **Photochemical pollutants—**Ozone, oxides of nitrogen, aldehydes, ethylene, photochemical smog and proxy acetyl nitrate.
- **Radiation pollutants—**Radioactive substances and radioactive fall-outs of the nuclear test.

Classification of Pollutants

On the basis of natural disposal, pollutants are of two types:

(i) Non-degradable pollutants

These are the pollutants, which degrade at a very slow pace by the natural biological processes. These are inorganic compounds such as salts (chlorides), metallic oxides waste producing materials and materials like, aluminum cans, mercuric salts and even DDT. These continue to accumulate in the environment.

(ii) Biodegradable pollutants

These include domestic sewage that easily decomposes under natural processes and can be rapidly decomposed by natural/ artificial methods. These cause serious problems when accumulated in large amounts as the pace of deposition exceeds the pace of decomposition of disposal.

On the basis of the form in which they persist after their release into the environment, pollutants can be categorized under two types:

(i) **Primary pollutants:** These include those substances, which are emitted directly from some identifiable sources. This include-

(a) Sulphur compounds: SO_2, SO_3, H_2S produced by the oxidation of fuel.

(b) Carbon compounds: Oxides of carbon ($CO+CO_2$) and hydrocarbons.

(c) Nitrogen compounds: NO_2 and NH_3.

(d) Halogen compounds: Hydrogen fluoride (HF) and hydrochloric acid (HCl).

(e) Particles of different size and substances: These are found suspended in air. The fine particles below the diameter of 100u

are more abundant and include particles of metals, carbon, tar, pollen, fungi, bacteria, silicates and others.

(ii) **Secondary pollutants.** The secondary pollutants are produced by the combination of primary emitted pollutants. in the atmosphere. In bright sunlight, a photochemical reaction occurs between nitrogen oxides; oxygen and waste hydrocarbons from gasoline that forms peroxyacetyle nitrate (PAN) and ozone (O_3), Both of them are toxic components of smog and cause smarting eyes and lung damage.

Different Types of Pollutions:

1. Air Pollution
2. Water Pollution
3. Land Pollution
4. Noise Pollution
5. Radiation Pollution
6. Thermal Pollution, etc.

AIR POLLUTION

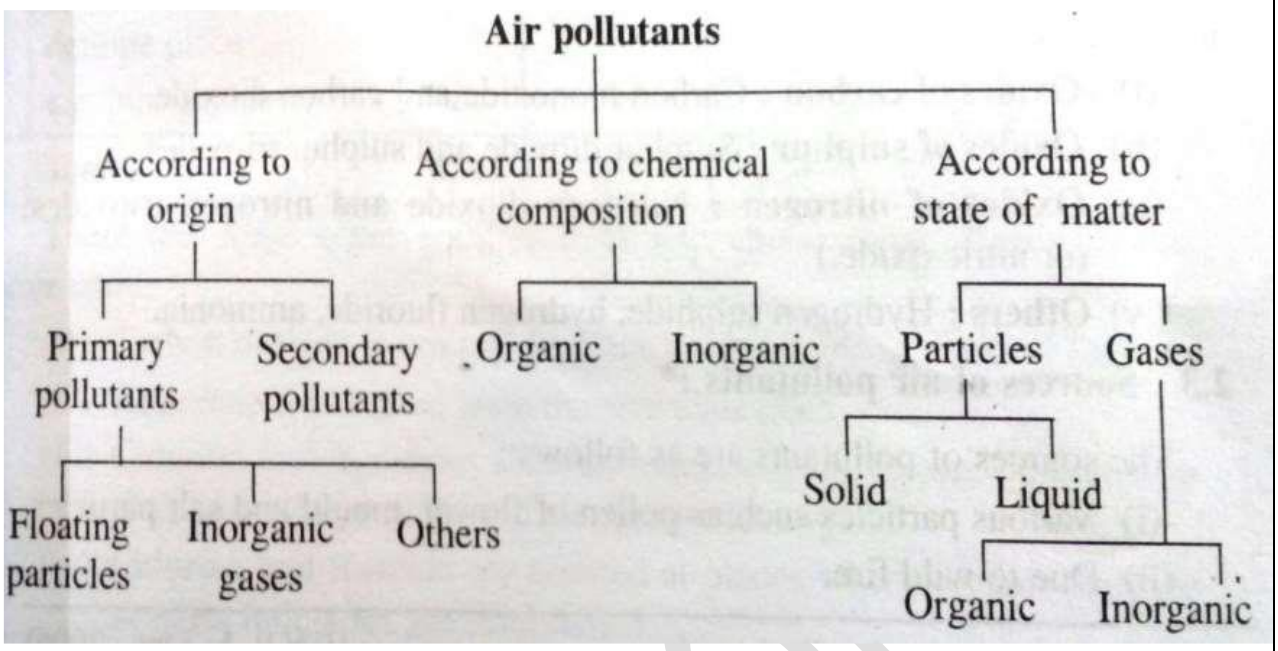
The WHO defines **air pollution** as the presence of materials in the air in such concentration which are harmful to man and his environment. A number of ingredients find their way in the air and these are mostly gases, which rapidly spread over wide areas.

Sources of Air Pollutants:

1. Pollen of flowers, mould and salt particles.
2. Due to wild fire (forest fires)
3. Due to explosion of volcanoes.
4. Emission of carbon monoxide due to decomposition of methane.
5. Emission of hydrocarbons due to decomposition of vegetations.
6. Emission of hydrogen sulphide due to decomposition of organic matters.
7. Due to ignition of fuels.
8. Due to transportation by automobiles.
9. Due to industrialization.
10. Due to ignition of solid wastes from cities and industries.

COMMON AIR POLLUTANTS

Air pollutants are of two main types ~gaseous and particulate. Oxides of carbon. Nitrogen and sulphur are gaseous pollutants. Particulate pollutants may be solid or liquid particles, larger particles settle down quickly viz., sand and water droplets whereas small dust particles remain suspended in air for a long time. These are added into the atmosphere by the processes of blasting, drilling, crushing, grinding and mixing.



(i) Carbon Dioxide

CO_2 content of air has increased by 20% during the last century. CO_2 causes nausea and headache. It's increase in the air may cause green house effect, rise in the atmospheric temperature.

(ii) Carbon Monoxide

It is a very poisonous gas and is produced by incomplete combustion of fuel. If inhaled. it combines with hemoglobin and reduces its oxygen-carrying capacity. This leads to laziness, reduced vision and death.

(iii) Oxides of Nitrogen

These include NO and NO_2, which are released by automobiles and chemical industries as waste gases and also by burning of materials. These are harmful and lower the oxygen carrying capacity of blood.

(iv) Oxides of Sulphur

SO_2 and SO_3 are produced by burning of coal and petroleum and are harmful to buildings, clothing, plants and animals. High concentration of SO_2 causes chlorosis (yellowing of leaves), plasmolysis, damage to mucous membrane and metabolic inhibition. SO_2 and SO_3 react with water to form Sulphuric and sulphurous acids. These may precipitate as rain or snow producing acid rain or acid precipitation.

(v) Photochemical Oxidants

Formed by the photochemical reactions between primary pollutants, viz. oxides of nitrogen and hydrocarbons. Nitrogen oxides in the presence of

sunlight react with unburnt hydrocarbons to form peroxyacyl nitrate (PAN), Ozone, aldehydes and some other complex organic compounds in the air.

(vi) Hydrocarbons

These are unburnt discharges from incomplete combustion of fuel in automobiles. These form PAN with nitrogen oxides, which is highly toxic.

(vii) Particulate Matter

Industries and automobiles release fine solid and liquid particles into the air. Fly ash and soot from burning of coal, metal dust containing lead, chromium, nickel, cadmium, zinc and mercury from metallurgical processes; cotton dust from textile mills; and pesticides sprayed on crops are examples of particulate pollutants in the air. These are injurious to respiratory tract.

(viii) Aerosols

Aerosols are chemicals released in the air in vapour form. These include fluorocarbon (carbon compound having fluorine) present in emissions from the Jet aeroplanes. Aerosols deplete the ozone layer. Thinning of ozone layer results in more harmful ultraviolet rays reaching the earth, which are harmful to skin, and can lead to skin cancer also.

(ix) Radioactive Substances

These are released by nuclear explosions and explosives. These are extremely harmful for health.

(x) Fluorides

Rocks, soils and. minerals containing fluorides release an extremely toxic gas called hydrogen fluoride on heating. This gas is highly injurious to livestock and cattle.

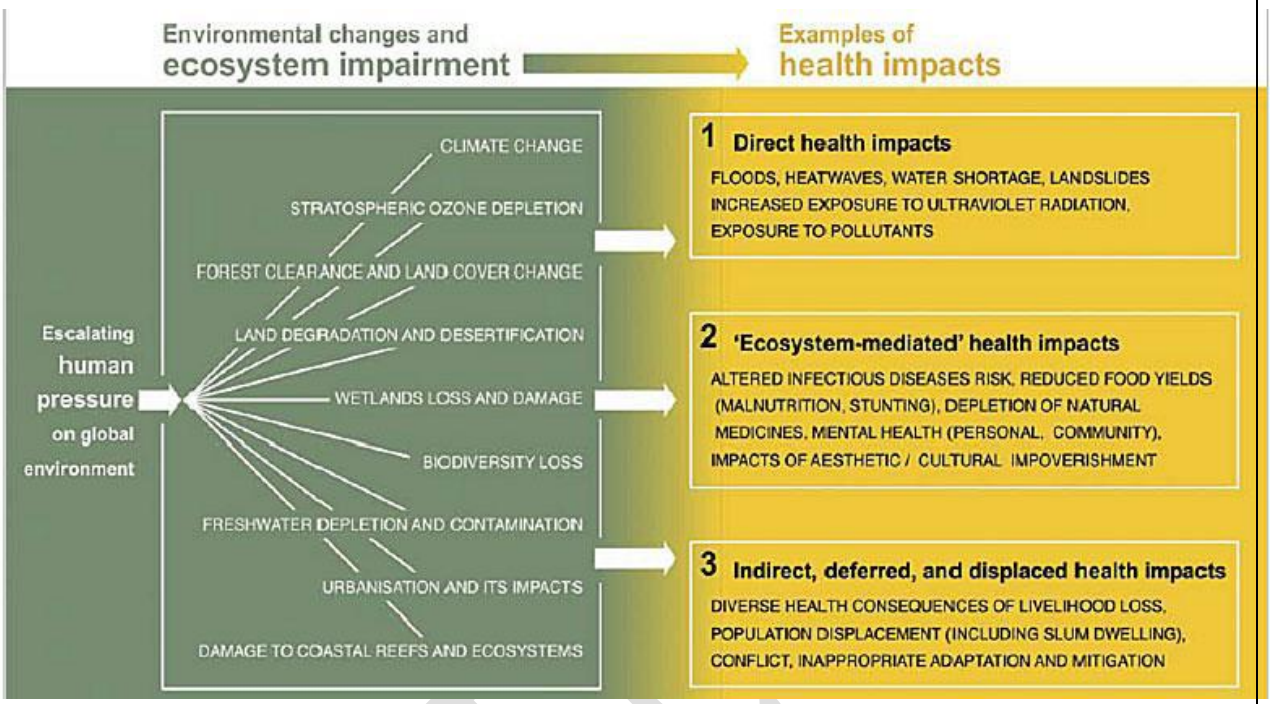
(xi) Smog

The fog deposited with smoke and chemical fumes forms a dark and thick covering, the smog. Smog is very common in almost all the industrial areas as the smog is trapped for many days by the stagnant air. It is harmful both for animals and plants.

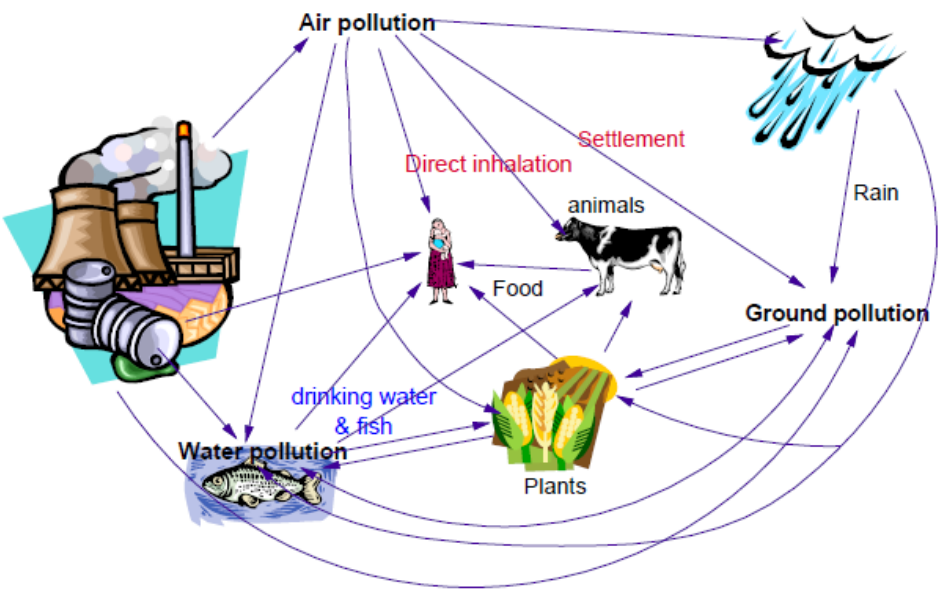
Effects of Air Pollution

1. If the proportion of pollutants in the air is more then it may affect human, animals, birds and vegetations adversely.
2. It is harmful to movable and immovable properties of men.
3. Adverse effect on human health:
    a) Asthma or respiration problem due to presence of sulphur dioxide.
    b) Lead particles leads to problem of enzyme processing in children.
    c) Cadmium leads to the problem of circulatory system
    d) Zinc and copper leads to digestion problem
    e) Nickel particles may create the possibility of lung cancer
    f) Mercury may lead to problems of sensory, nerves and kidney
    g) Carbon monoxide may result into giddiness and speech disorder on temporary basis.
    h) Nitrogen dioxide may create burning sensation in eyes.
4. Effects of Air pollution on Vegetation:
    a) A layer of pollution on leaves will reduce the process of photosynthesis.
    b) Sulphur dioxide ruins the chlorophyll.
    c) Nitrogen dioxide reduces the production of citrus fruits and tomatoes.
    d) Peroxy acetyl nitrate (PAN) ruins the peak of the leaves and creates adverse effect on grapes.
5. Effects of Air pollution on materials:
    a) Sulphur dioxide will rust steel.
    b) It also affects leather and cloths.
    c) Sulphuric acid will make marble and lime stones rusty.
    d) Ozone affects rubber, fibers of cotton and nylon.

e) Because of humidity and nitrate metals like nickel and brass may rust in excess.



Exposure to Pollutants



Control of Air Pollution

1. Physical- chemical observation: by taking regular samples of air and to note the proportion of the constituent components and to analyze them.

2. Recording the effect on human, animals and vegetations using biological observations: a record of human and animal health in a particular region will be kept and the reasons for the same will be identified. This will help to know that which type of pollutants causes a specific type of disease.

3. Establishing mutual relationship among physical, chemical and biological observation: with respect to the observations, charts can be prepared and proper planning can be done. Policies can be made to control specific pollutants in some specified regions.

POLLUTION IN INDIA

India supports a large network of factories and industries. These factories are generally localized in eight or ten large industrial centres. These are also a great source of air as well water pollution. To be on a safer side delocalisation of industries is the need of the time. This would lead to an even distribution of pollutants and faster degeneration of pollutants. The major pollutants coming out from these industries are -

(i) *Industrial Pollutants.* The common air pollutants from industries are SO_2, CO, CO_2, H_2S and hydrocarbons together with dust, smoke and grit. These are produced by the burning of coal and petroleum and by the combustion of lignite at thermal power stations. The chemical industries release HCl, chlorine, nitrogen oxide and oxides of copper, zinc, lead and arsenic.

The fertilizer factories at Gorakhpur and Ahmedabad; the steel industries at Bhilai, Rourkela, Jamshedpur and Durgapur pollute the air with above-said gases.

(ii) *Automobile Exhausts.* Automobiles run by petrol and diesel produce CO, nitrogen oxides and hydrocarbons. Hundreds and thousands tons of hydrocarbons and CO are emitted into air daily. Metropolitan cities harbour lakhs and crores of automobiles. Every gallon of petrol consumed by automobiles produces 3 pounds of carbon monoxide and 15 pounds. of nitrogen oxide.

(iii) *Ionizing Radiations from Radioactive Substances.* Ionizing radiations include alpha, beta particles and the gamma rays etc. These are produced by atomic explosions and testing of atomic weapons.

Week 1
Lecture 2

Water

"Water is the essential element that makes life possible on earth. Any alteration in natural state of water causes water pollution."
The earth surface is covered by 71% water. About 97% of the total water available on earth is found in oceans and not useful for drinking or irrigation. The remaining 3% is fresh water, 2.997% is locked in ice caps or glaciers. So only 0.003%of the earth' total volume of water is easily available to us as soil moisture, groundwater, water vapour and water in lakes, streams, rivers and wetlands.

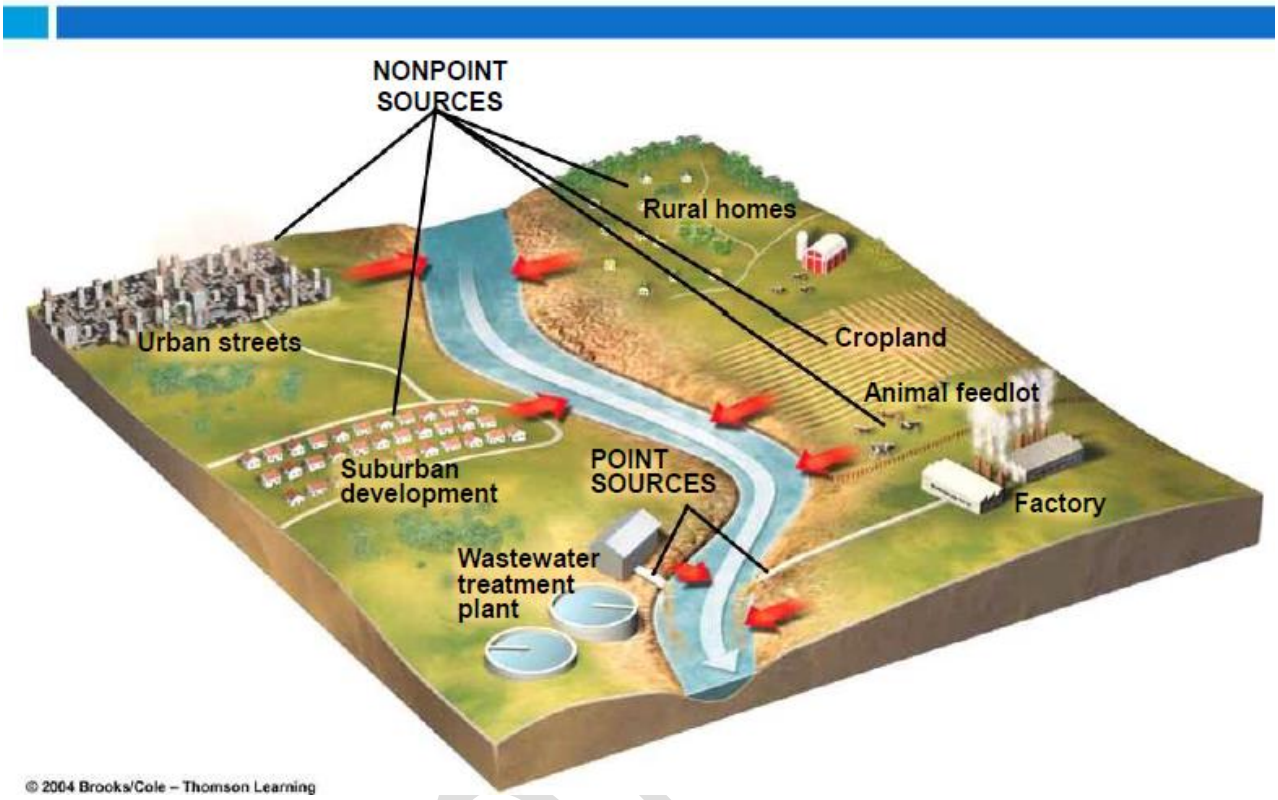
Water pollution:

Water is extremely essential for life, this common fact is known to all. It is required to meet our basic needs in day to day life viz., cooking, drinking, bathing, disposal of sewage, irrigation, generating electricity in power plants, cooling and manufacturing different products in industries and the disposal of industrial wastes. During all these processes the undesirable substances are added to the water resources to a great extent. This alters the basic chemistry of water in rivers and streams.

Source of water pollution

1. Point sources of pollution: When a source of pollution can be readily identified because it has a definite source and place where it enters the water. ie. Municipal and Industrial Discharge Pipes.
2. Non - Point sources of pollution: When a source of pollution cannot be readily identified, such as agricultural runoff, acid rain, etc, they are said to be non-point sources of pollution

Sources of Water Pollution



Ground Water Pollution: Ground water forms about 0.6% of the total water available on earth and is about 30 times more than surface water (streams, lakes and estuaries). Ground water seems to be less prone to pollution as the soil mantle through which water passes helps to retain various contaminants due to its cation exchange capacity. However, there are a number of potential sources of ground water pollution. Septic tanks, industry (textile, chemical, tanneries), deep well injection, mining etc., are mainly responsible for ground water pollution, which is irreversible. Ground water pollution with arsenic, fluoride and nitrate are posing serious health hazards.

Surface water pollution: The major sources of surface water pollution are:
1. Sewage. Emptying the drains and sewers in fresh water bodies causes water pollution.
2. Industrial effluents. Industrial wastes containing toxic chemicals, acids, alkalis, metallic salts, phenols, cyanides, ammonia, radioactive substances, etc., are sources of water pollution. They also cause thermal (heat) pollution of water.
3. Synthetic detergents. Synthetic detergents used in washing and cleaning produce foam and pollute water.

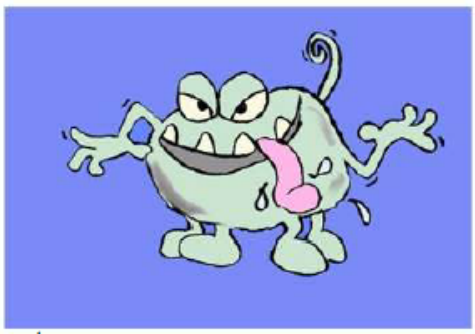
4. Agrochemicals. Agrochemicals like fertilizers (containing nitrates and phosphates) and pesticides (insecticides, fungicides, herbicides etc.) washed by rain-water and surface runoff pollute water.
5. Oil spillage into sea-water during drilling and shipment pollute it.
6. Waste heat. Waste heat from industrial discharges increases the temperature of water bodies and affects distribution and survival of sensitive species.

Effects of Water Pollution:

1- Oxygen demanding wastes: **BOD**
2- Nitrogen and phosphorus compounds (nutrients): Eutrophication
3. Pathogens
4. Toxic compounds

Biochemical Oxygen Demand (BOD)

- A chemical procedure for determining how fast biological organisms use up oxygen in a body of water.
- BOD can be used as a gauge of the effectiveness of wastewater treatment plants.
- The BOD test is carried out by:
  - 1. diluting the sample (sludge) with oxygen saturated de-ionized water,
  - 2. inoculating it with a fixed aliquot of seed, measuring the dissolved oxygen (DO) and then sealing the sample to prevent further oxygen dissolving in.
  - 3. sample is kept at 20 C in the dark to prevent photosynthesis (and thereby the addition of oxygen) for five days, and the dissolved oxygen is measured again.
  - 4. difference between the final DO and initial DO is the BOD.

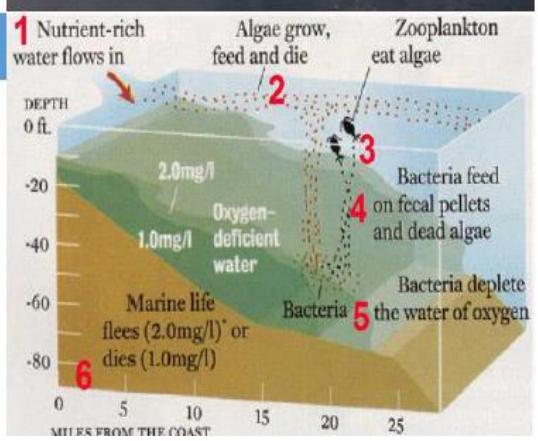


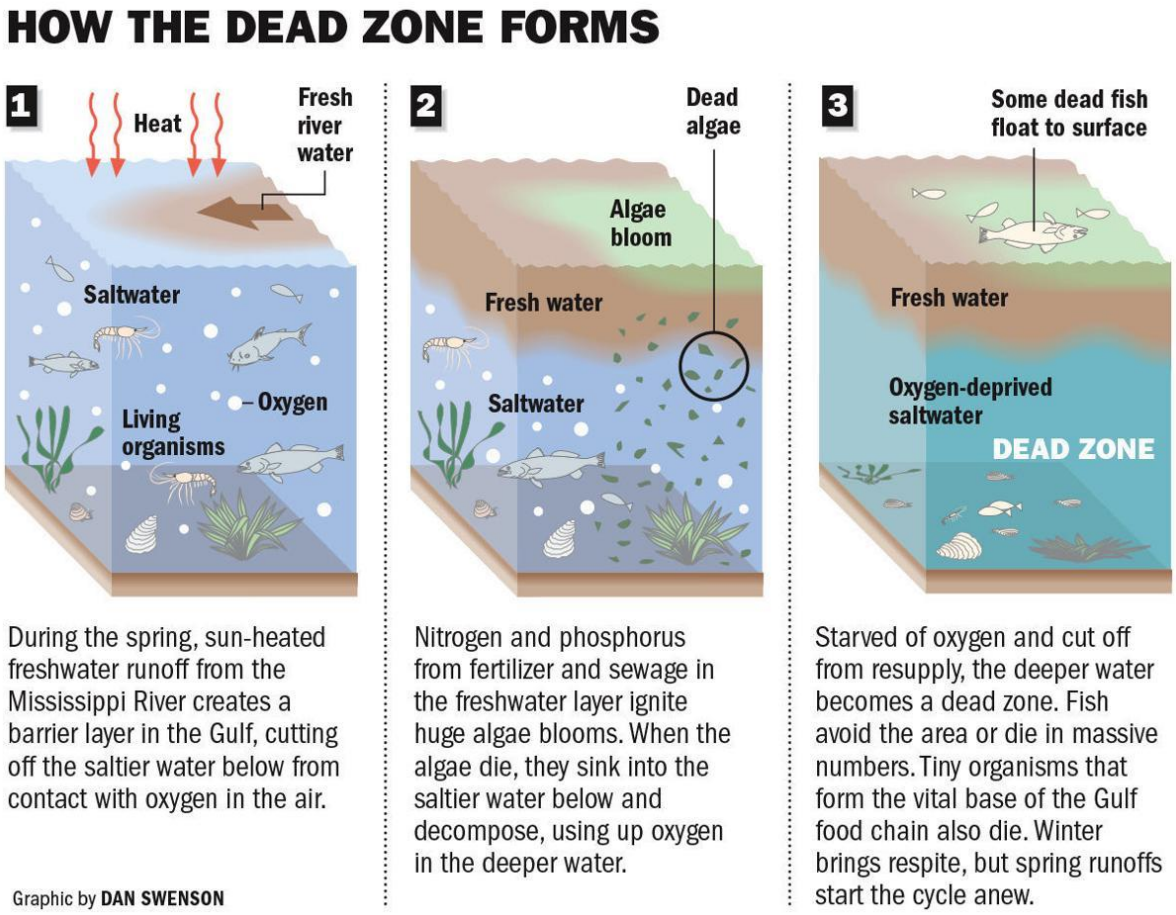
Eutrophication

An increase in chemical nutrients — compounds containing nitrogen or phosphorus — in an ecosystem, and may occur on land or in water. However, the term is often used to mean the resultant increase in the ecosystem's primary productivity (excessive plant growth and decay), and further effects including lack of oxygen and severe reductions in water quality, fish, and other animal populations.

Hypoxia

A phenomenon that occurs in aquatic environments as dissolved oxygen (DO; molecular oxygen dissolved in the water) becomes reduced in concentration to a point detrimental to aquatic organisms living in the system.
Oxygen depletion can be the result of a number of factors including natural ones, but is of most concern as a consequence of pollution and eutrophication in which plant nutrients enter a river, lake, or ocean, phytoplankton blooms are encouraged.





Control Measure of Water Pollution:

1. Judicious use of agrochemicals like pesticides and fertilizers.

2. Use of nitrogen fixing plants to supplement the use of fertilizers.

3. Adopting integrated pest management to reduce greater reliance on pesticides.

4. Prevent run-off of manure. Divert such run-off to basin for settlement. The nutrient rich water can be used as fertilizer in the fields.

5. Separate drainage of sewage and rain water should be provided to prevent overflow of sewage with rain water.

6. Planting trees would reduce pollution by sediments and will also prevent soil erosion.

7. Waste waters should be properly treated by primary and secondary treatments to reduce the BOD, COD levels up to the permissible levels for discharge.