GENERAL

1. INTRODUCTION TO ECOLOGY

1.1 ORIGIN OF EARTH

- We live on a beautiful planet called earth, along with a wide variety of plants, animals and other organisms. Our earth, however, is part of a vast universe. The universe is about **15 to 20 billion years old**. The age of the earth is approximately 4 to 5 billion years, while human beings evolved only around 2 million years ago.
- The widely accepted theory of the origin of universe is the **"BIG BANG"** theory. According to this theory, universe started with a **huge explosion** and matter (dust and gases) filled the entire space. The temperature of the universe then, was about hundred billion degrees Celsius. Scientists believe that the big bang occurred about 15 to 20 billion years ago. The huge collection of dust and gases then began to spin. As it spun faster and faster, the centre became very hot. It became the **Sun**. From the edges of this ball of dust and gas, big blobs or chunks of dust broke off and formed eight ball shaped planets. This founded our **Solar system**. The earth broke off about 4.5 billion years ago with an explosion. It was a burning hot white mass of gas and dust. Over a long period of time, dust and gas gradually condensed to form solid rock. Such condensation and shrinking made the earth heat up so much that the rock melted into a gluey liquid. After millions of years, the outer surface of the earth or the earth's crust cooled and formed hard rock again, just as melted chocolate or wax solidifies upon cooling. The interior of the earth is still very hot.
- The crust of the earth was formed from cooling and hardening of the molten matter and hot gases. With cooling of the earth the crust hardened and formed the land. Cooling of the earth also condensed water vapour into liquid water filling the depressions to form **Seas.**

1.2 ORIGIN OF HUMAN BEINGS

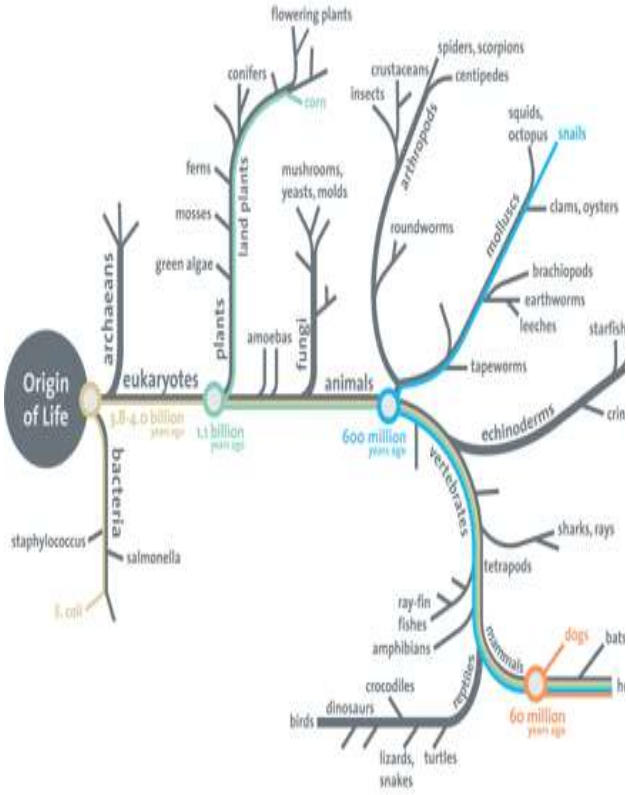
- To begin with, conditions on earth were inhospitable for life. Gases of the primitive atmosphere were primarily **methane, ammonia, carbon dioxide** and **hydrogen. Water vapour** filled the atmosphere but there was no free oxygen. It was thus a reducing atmosphere on primitive earth and no life existed.

Biological evolution- from the simple organisms to complex organisms

- As earth cooled, water vapour condensed to form liquid water. Rains poured to form water bodies on earth. The **molecules of life were formed in the water**. From the molecules of the life evolved **bacteria**, the **earliest** and **simplest** organisms. The oldest fossils of bacteria which were the first living organisms on earth have been found in rocks that are 3-5 billion years old. For almost two billion years, different kinds of bacteria lived on earth. One of these evolved a green pigment called **chlorophyll.** These chlorophyll-containing bacteria used **carbon dioxide** and **water** and released **oxygen** through **photosynthesis** and started accumulating in the atmosphere.
- Continued photosynthesis by such bacteria progressively accumulated oxygen in the atmosphere. **Thus the atmosphere gradually transformed**

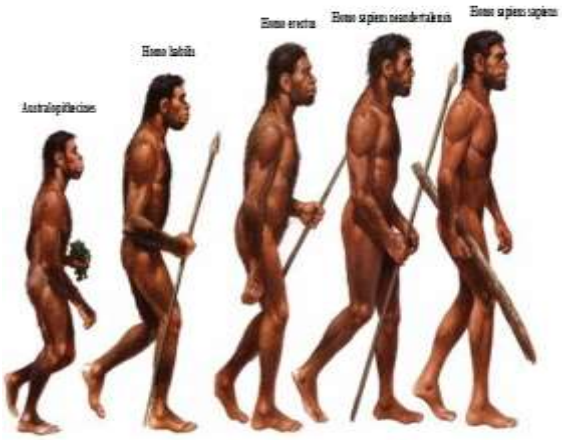
from reducing to oxidizing. At one point of time oxygen content in the atmosphere become 21%.

- Such changes served as a big trigger for biological evolution to begin and progress and this led to the invasion of land by living organism. **As time passed, protists evolved from bacteria. Both bacteria and protists are unicellular**. Then multicellular organisms evolved, **the fungi followed by plants and animals**. Today the diversity of living organisms is comprised of five kingdoms of life. They are **Monera, Prototictista, Fungi, Plantae and Animalia.**



Human Evolution

- When human evolution began, forests had dwindled because of glaciation. Much of the land surface was however, still covered by forest. **The common ancestors of apes and humans had to come down from trees where they lived**. They walked on all fours on the ground using all four limbs. Recent molecular studies have revealed that from common ancestors, evolution of apes (chimpanzee, gorilla, gibbon and orang-utan) and that of humans diverged about 6 million years ago.
- The **earliest human ancestors, the Australopithecines** which walked upright, evolved around 3.5 million years ago in South Africa. They made tools with various materials.
- **Australopithecines gave rise to Homo habilis,** probably around 2 million years ago. These human ancestors had ape like long arms but larger brain than the apes. The next stage,
- **Homo erectus is supposed to have existed between 1.5 million years to 200,000 years ago.** Their fossils have been found in China (Peking man), Java (Java man), and Germany (Heidelberg man). This suggests that they evolved in Africa and then spread to Asia and Europe. Their brain size was intermediate between apes and humans. Also they had heavy ridges above eyes like the apes. **Homoerectus** made stone axes. **Next to evolve from Homo erectus, were the Neanderthal man (Homosapiensne and ertalensis) but they belonged to the same species as do the modern humans Homo sapiens.** Remains of Neanderthals have been found in Europe, Asia and Africa. They fashioned a large variety of well-made tools and were successful hunters.
- For almost about 35,000 years, **Homo sapiens** or modern humans are the only living human species. (Homo: belonging to family Hominidae, sapiens: wise)

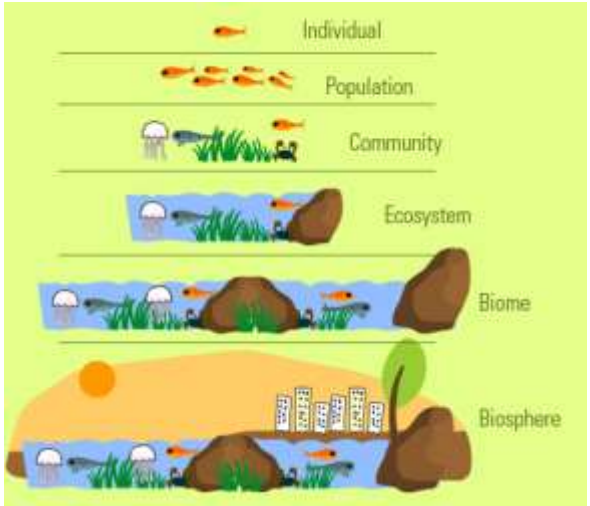


Evolution of Human Beings

Introduction to Ecology

- Ecology may be defined as the scientific **study of the relationship of living organisms with each other and with their environment.**
- Ecology is the branch of biology deals with the study of the relationships of living organisms with the abiotic (physical-chemical factors) and biotic components (other species) of their environment.
- Ecology is basically concerned with four levels of biological organisation – **organisms, populations, communities and biomes**.

1.3 LEVELS OF ECOLOGICAL ORGANIZATION



a) Organisms (Individual):

- Organism is an individual living being that has the ability to act or function independently.
- An organism consists of one or more cells; when it has one cell is a **unicellular organism**; and when it has more than one it is known as a **multicellular organism**.

b) Population:

- A group of organisms (organisms of same species) that living in a defined **area and interact with each other.**
- 'Population' is defined as a group of **freely interbreeding individuals of the same species** present in a specific area at a given time. For example, when we say that the population of a city is 50,000, we mean that there are 50,000 humans in that city.

c) Community:

- Organisms (populations) of different species interact with each other (together forming a community) in different ways.
- Community can be defined more exactly as **biotic community**, refers to the populations of **different kinds of organisms living together and sharing the same habitat.**
- In a community only those plants and animals survive which are adapted to a particular environment.
- The **climate determines the type of environment, hence, the type of organisms in a community**.
- ***find out what are all the various organisms given in the figure***

d) **Ecosystem** - A biological community of interacting organisms and their physical environment.

e) Biome:

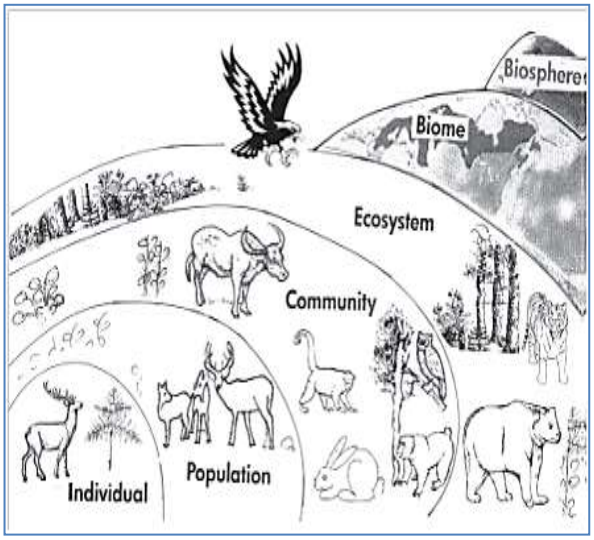
- A **large community unit**, characterized by a **major vegetation type and associated fauna, found in a specific climatic region**.
- **All the ecosystems taken together** in a geographical area form a bigger unit called **biome**.

Coral Bleaching:
Most evidence indicates that elevated temperature is the cause of mass coral bleaching events. Sixty major episodes of coral bleaching have occurred between 1979 and 1990, with the associated coral mortality affecting reefs in every part of the world. Correlative field studies have pointed that warmer-than normal conditions (at least 1 °C higher than the summer maximum) as being responsible for triggering mass coral bleaching events.

- It is characterized by vegetation and associated fauna.
- For example, **in forest biomes one may find ponds, lakes, grasslands and forests.**
- Biome is resulting from the interaction of a regional climate, substrate, plant life and animal.
- The types of biomes are **grasslands, deserts, coniferous forests, deciduous forests, tundra, fresh water** and **marine environment**.

  Biosphere: Biosphere is a part of the earth, where life can exist. Otherwise, it is a **narrow zone where atmosphere, lithosphere, hydrosphere interact with each other to support life form**.

TASK:
In the given figures find out the various components in each level of organization
Eg:community –group of fishes



BASIC DEFINITIONS

Ecological Niche: The functional unit of species in its habitat is called ecological niche.

Ecology consists of two major factors:

i. Biotic factors
ii. Abiotic factors

1.4 BIOTIC AND ABIOTIC FACTORS

- The most important abiotic factors are temperature, water, light and soil.
- The physical and chemical (abiotic) components alone do not characterise the habitat of an organism completely; the habitat includes biotic components also – pathogens, parasites, producers, consumers and predators – of the organism with which they interacts constantly.
- It is assumed that over a period of time, the organism had through natural selection, evolved adaptations to optimise its survival and reproduction in its habitat.

1.4.1. Major Abiotic Factors

a) Temperature

- Temperature is the most ecologically relevant environmental factor. It ranges from sub-zero levels in polar areas and high altitudes to more than 50°C in tropical deserts in summer.
- There are, however, unique habitats such as thermal springs and deep-sea hydrothermal vents where average temperatures exceed 100° C.
- The significance of temperature to living organisms is that, it affects the **kinetics of enzymes** and through it the **basal metabolism**, activity and other physiological functions of the organism.
- In recent years, there has been a growing concern about the gradually increasing average global temperatures.

A few organisms can tolerate and thrive in a **wide range of temperatures**, they are called **eurythermal**, but, a vast majority of them are restricted to a **narrow range of temperatures**, such organisms are called **stenothermal**. The levels of thermal tolerance of different species determine to a large extent their geographical distribution.

Sample effect of increase in global temperature:

When coral bleaching happens, it adversely affects all the other marine organisms which are in symbiotic relationship with corals.

b) Water

- Next to temperature, water is the most important factor influencing the life of organisms.
- In fact, life on earth originated in water and is unsustainable without water.
- Its availability is so limited in deserts that only special adaptations make it possible to live there.
- The productivity and distribution of plants is also heavily dependent on water.
- Organisms living in oceans, lakes and rivers also face water-related problems. For aquatic organisms the quality of water like chemical composition, salinity and pH becomes important.
- The salt concentration (measured as salinity in ppt (parts per thousand)), is less than 5% in inland waters, 30-35% in the sea and more than 100% in some hypersaline lagoons.
- Many freshwater animals cannot live for long in sea water and vice versa because of the **osmotic problems**, they would face.

Some organisms are tolerant of a **wide range of salinities** (**euryhaline**) but others are restricted to a **narrow range** (**stenohaline**)

c) Light

- Since plants produce food through photosynthesis, a process which is only possible when sunlight is available as a source of energy, Many species of small plants (herbs and shrubs) growing in forests are adapted to photosynthesise optimally under very low light conditions because they are constantly overshadowed by tall, canopied trees.
- Many plants are also dependent on sunlight to meet their **photoperiodic requirement** for flowering.
- For many animals too, light is important in that they use the diurnal and seasonal variations in light intensity and duration (photoperiod)

as cues for timing their foraging, reproductive and migratory activities.

- The availability of light on land is **closely linked with that of temperature** since the **sun is the source for both.**

Using source of sunlight, along with Carbon dioxide (air) and water, plants (autotrophs) synthesise its own food. Leaves capture Solar energy from the sunlight and save it as **Potential energy**. This saved energy further converted into number of forms, when it is consumed by other living beings.

- But, deep (greater than 500m depth) in the oceans, the environment is perpetually dark and its inhabitants are not aware of the source of energy from the Sun.

- The **spectral quality of solar radiation** is also important for life. The **UV component** of the spectrum is harmful to many organisms while not all the colour components of the visible spectrum are available for marine plants living at different depths of the ocean.

UV components and its effects:

Ultraviolet (UV) light is an electromagnetic radiation with a wavelength from 400 nm to 100 nm, shorter than that of visible light but longer than X-rays.

Suntan, freckling and sunburn are familiar effects of over-exposure, along with higher risk of skin cancer. Ultraviolet is also responsible for the formation of bone-strengthening vitamin D in most vertebrates, including humans. Thus, the UV spectrum has effects both beneficial and harmful to human health.

d) Soil

- The nature and properties of soil in different places vary; it is dependent on the climate, the weathering process, whether soil is transported or sedimentary and how soil development occurred.
- Various characteristics of the soil such as **soil composition**, **grain size** and **aggregation** determine the **percolation** and **water holding capacity** of the soils.
- These characteristics along with parameters such as pH, mineral composition and topography determine to a large extent the vegetation in any area.
- This is in turn dictates the type of animals that can be supported.
- Similarly, in the **aquatic** environment, the sediment-characteristics often determine the type of **benthic animals** that can thrive there.

Types of Soil and its percolation capacity

Sandy soil – Highest percolation rate of water (least water retaining capacity)

Loamy soil – Moderate percolation rate of water and water retaining capacity

Clayey soil – Least percolation rate of water (Highest water retaining capacity)

2. RESPONSE OF ORGANISMS TO ABIOTIC FACTORS

2.1. HOMEOSTASIS OF ORGANISMS

- ❖ The abiotic conditions of many habitats may vary drastically in time, but organisms living in suchhabitats cope or manage with stressful conditions.
- ❖ One would expect that during the course of millions of years of their existence, many species would have evolved a relatively constant internal (within the body) environment that permits all biochemical reactions and physiological functions to proceed with maximal efficiency and thus, enhance the overall 'fitness' of the species.
- ❖ This constancy, for example, could be in terms of **optimal temperature** and **osmotic concentration of body fluids**.
- ❖ Ideally then, the organism should try to maintain the constancy of its internal environment (a process called homeostasis) despite varying external environmental conditions that tend to upset its homeostasis.

Homeostasis is a process that maintains the stability of the human/animal body's internal environment in response to changes in external conditions. Examples of homeostasis include the regulation of temperature and the balance between acidity and alkalinity (pH).

a) Regulate

- Some organisms are able to maintain homeostasis by physiological (sometimes behavioural also) means which ensures **constant body temperature (thermore gulation)**, **constant osmotic concentration (osmore gulation)**, etc.
- All birds and mammals, and a very few lower vertebrate and invertebrate species are indeed capable of such regulations.
- Mammals have good abilityto maintain a constant body temperature.
- The mechanisms used by most mammals to regulate their body temperature are similar to the ones that we humans use.
- **Thermoregulation in Human beings:** Constant **body temperature of humans** is **37°C**. In summer, when outside temperature is more than our body temperature, we sweat profusely. The resulting evaporative cooling brings down the body temperature to 37°C. In winter when the temperature is much lower than 37°C, we start to shiver, a kind of exercise which produces **heat** and raises the body temperature. Plants, on the other hand, do not have such mechanisms to maintain internal temperatures.

Thermoregulation is the ability of an organism to keep its body temperature constant, irrespective of the surrounding temperature. E.g. Temperature of human being is always 37°C irrespective of his habitat (either in cold polar region or in hot desert region).

Osmoregulation is the active regulation of the osmotic pressure of an organism's fluids to maintain the homeostasis of the organism's water content; that is, it keeps the organism's fluids from becoming too diluted or too concentrated.

b) Conform

- An overwhelming majority (99 per cent) of animals and nearly all plants cannot maintain a constant internal environment.
- Their body temperature changes with the ambient temperature. Inaquatic

animals, the osmotic concentrations of the body fluids change with that of the ambient water osmotic concentration. These **animals** and **plants** are simply **conformers**.

- Thermoregulation is energetically expensive for many organisms.
- This is particularly true for small animals like shrews and humming birds.
- **Heat loss** or **heat gain** is a function of **surface area**.
- Since small animals have a larger surface area relative to their volume, they tend to lose body heat very fast when it is cold outside; then they have to expend much energy to generate body heat through metabolism. This is the main reason why very small animals are rarely found in **Polar Regions.**
- Some species have evolved the ability to regulate, but only over a limited range of environmental conditions, beyond which they simply conform.
- If the **stressful external conditions** are **localised** or remain only for a short duration, the organism has two other alternatives. That is to **migrate** and **suspend**.

c) Migrate

- The organism can **move away temporarily from** the **stressful habitat** to a more hospitable area and return when stressful period is over.
- Many animals, particularly **birds**, during winter undertake long-distance migrations to more hospitable areas. Every winter the famous **Keoladeo National Park (Bharatpur)** in Rajasthan host thousands of migratory birds coming from Siberia and other extremely cold northern regions.

d) Suspend

- In bacteria, fungi and lower plants, various kinds of **thick-walled spores** are formed which help them to **survive unfavorable conditions** – these germinate on availability of suitable environment.
- In higher plants, seeds and some other vegetative reproductive structures serve as means to tide over periods of stress besides helping in dispersal – they **germinate** to form new plants **under favourable moisture** and **temperature conditions**.
- They do so by reducing their metabolic activity and going into a state of 'dormancy'.
- In animals, the organism, if unable to migrate, might avoid the stress by escaping in time.
- They follow **hibernation** during **winter** is an example of escape in time.
- Some snails and fish go into **aestivation** to avoid **summer–related problems**-heat and desiccation.
- Under unfavorable conditions many zooplankton species in lakes and ponds are known to enter **diapause,** a stage of suspended development.

Hibernating Animals

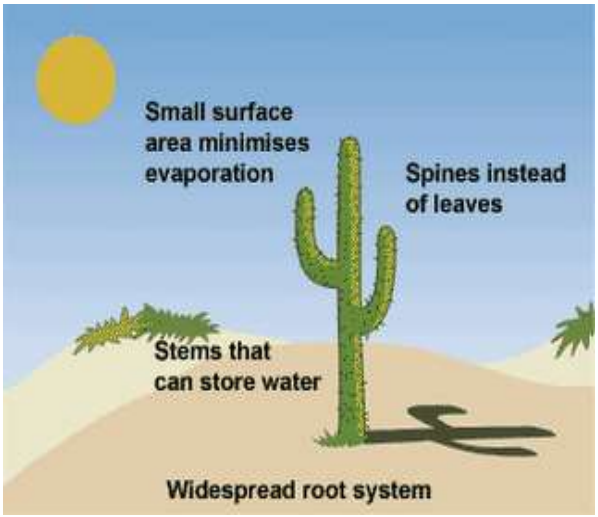
Mostly tropical mammals do not undergo hibernation, as there is no such hostile condition prevails in tropical regions. Some hibernating animals are Fat-tailed dwarf lemur of Madagascar (tropical animal), Bears, Bats, prairie dogs, species of ground squirrels, other rodents, mouse lemurs, the European hedgehog and marsupials, and even butterflies such as the small tortoiseshell.

2.2 ADAPTATIONS

- An adaptation is "the appearance, behaviour, structure and mode of life of an organism that allows it to survive and reproduce in a particular environment".
  - ❖ It can be observed in structure, behaviour and physiology of an organism. Adaptations have genetic basis and have been produced and **perfected** through **evolution** and developed over many generations to help a species survive successfully in its environment.
  - ❖ While considering the various alternatives available to organisms for coping with extremes in their environment, some are able to respond through certain physiological adjustments while others do so behaviorally (migrating temporarily to a less stressful habitat). These responses are also actually, their adaptations.

Some familiar adaptation techniques in some extreme habitats

a) Structural Adaptations



- **Desert Plants:** Many desert plants have a **thick cuticle** on their leaf surfaces and have their **stomata** arranged in **deep pits** to minimise water loss through transpiration. They also have a special photosynthetic pathway that enables their stomata to remain closed during day time. Some desert plants like **Opuntia** have **no leaves**, they are reduced to **spines** and the photosynthetic function is taken over by the flattened stems.

- **Desert Animals:** In the absence of an external source of water, the kangaroo rat in North American deserts is capable of meeting all its water requirements through its **internal fat oxidation** (in which water is a by-product). It also has the ability to **concentrate** its **urine** so that minimal volume of water is used to remove excretory products.

- **Colder Habitats:** Mammals from colder climates generally have **shorter ears** and **limbs** to **minimise heat loss**. (This is called the **Allen's Rule**). In the polar seas **aquatic mammals** like seals have a **thick layer of fat** (blubber) below their skin that acts as an insulator and reduces loss of body heat.

b) Physiological adaptations

- Some organisms possess adaptations that are physiological which allow

them to respond quickly to a stressful situation.

- When we climb a high altitude, we will experience some uncomfortable feelings like nausea, fatigue and heart palpitations, this is known as **Altitude sickness.** This happens because in the low atmospheric pressure of high altitudes, the body does not get enough oxygen.
- But, gradually we get **acclimatised** and stop experiencing **altitude sickness**. The body **compensates low oxygen availability by increasing red blood cell production, decreasing the binding capacity of hemoglobin and by increasing breathing rate**.
- This is a kind of physiological adaptation.
- In most animals, the metabolic reactions and all the physiological functions proceed optimally in a narrow temperature range (in humans, it is **37°C**). But there are **microbes** (**archaebacteria**) that flourish in **hot springs** and **deep sea hydrothermal vents** where temperatures far exceed 100°C.
- Organisms living in such extreme environments show a fascinating array of biochemical adaptations.

Acclimatisation is the process in which an individual organism adjusts to a gradual change in its environment (such as a change in temperature, humidity, photoperiod, or pH), allowing it to maintain performance across a range of environmental conditions. Acclimatisation occurs in a short period of time, whereas adaptation takes long span of time. Examples are acclimatisation of human beings in higher altitude; Sheep grow very thick wool in cold to prevent heat loss.

c) Behavioural adaptations

- Some organisms show behavioural responses to cope with variations in their environment.
- E.g. **Desert lizards** lack the physiological ability that mammals have to deal with the high temperatures of their habitat, but manage to keep their body temperature fairly constant by **behavioural means**.
- They bask in the sun and absorb heat when their body temperature drops below the comfort zone, but move into shade when the ambient temperature starts increasing. Some species are capable of burrowing into the soil to hide and escape from the above-ground heat.

2.3 SPECIES FORMATION: SPECIATION & EXTINCTION

- The number of species surviving in the world today is the outcome of two processes **speciation** and **extinction**.

2.3.1. Speciation

- Speciation is the process by which **new species** are **formed** and **evolution** is the **mechanism** by which speciation is brought about.
- Different populations of a species remain isolated due to some geographic barrier such as mountain, ocean, river, etc. Geographic isolation occurs when a physical barrier develops between two populations of a species**.**
- The most common way a population undergoes speciation is by **geographic isolation**.

Sample for speciation

Humans have genetic similarities with chimpanzees and bonobos, their closest relatives, suggested that having common ancestors. The variants in shared ancestral

species is said to be due to multiple genetic lineages. It was determined that the human genetic lineage must have started evolving before the differentiation of humans, chimpanzees, and gorillas.

2. 3.2. Extinction

- Ever since life evolved on earth, new species better suited or adapted to the environment have appeared and older less successful forms have died or become extinct.
- Extinction is generally a natural occurrence.
- The primary reason for these extinctions is **environmental change** or **biological competition**.
- Extinction occurs when species cannot evolve fast enough to cope with the changes taking place in their environment.
- Many species have gone extinct during geological history of the earth. Fossils are the preserved remains of animals, plants, and other organisms that lived in the geological past.

Species that are said to be Extinct in Indian Subcontinent

- **Indian aurochs:** It is a subspecies of the extinct aurochs. It is considered as the ancestor of the zebu cattle. It is mainly found in southern Asia and has been introduced in many other parts of the world, like Africa and South America.
- **Hyperodapedon:** It was a heavily built, stocky, animal around 1.3 metres (4.3 ft) in length. Fossils from the various species have been identified from Argentina, Brazil, India, Scotland and possibly from Canada, USA and Wyoming.
- **Gigantopithecus:** is an extinct genus of ape that existed from perhaps nine million years to as recently as one hundred thousand years ago, identified in India, China and Vietnam.
- **Exaeretodon:** This genus was an herbivore up to 1.8 meters long (5.9 ft), identified in India, Brazil and Argentina.
- **Bharattherium:** It is a mammal that lived in India during later Cretaceous period .Bharattherium molar forms are high, curved teeth, with a height of 6 to 8.5 millimeters (0.24 to 0.33 inches).

Variation

- Species are generally composed of a number of distinct populations which **freely interbreed** even though they appear to be different in appearance and results in the **variation**.
- Variations are produced as a result of **chance mutation**. **Competition** and **natural selection** determines as to which variation will **succeed** and **survive**. Those variations that enable a species to survive in the struggle for existence are encouraged and promoted.
- Difference in colour of skin, type of hair, eye colour among different ethnic groups represents variation within human species. Similarly, different shape and size of cows, dogs and cats etc. are examples of variation with in each of these species.
- In plants, tall and short pea varieties, various shape and size of Brinjal exhibit variation among these plant species.

3. POPULATION INTERACTIONS

Interdependence of Species

- The essence of biological understanding is to know how organisms, while remaining an individual, interact with other organisms and physical habitats as a group and hence behave like organised wholes, i.e., population, community, ecosystem or even as the whole biosphere.
- For any species, the minimal requirement is one more species on which it can feed or interact. Even a plant species, which makes its own food, cannot survive alone; it needs soil microbes to break down the organic matter in soil and return the inorganic nutrients for absorption.
- It is obvious that in nature, animals, plants and microbes do not and cannot live in isolation but interact in various ways to form a **biological community**.
- Even in minimal communities, many interactive linkages exist.

3.1. BIOTIC INTERACTION

- The biological community of an area or ecosystem is a **complex network of interactions.**
- The interaction that occurs among different individuals of the **same species** is called **intraspecific interaction** while the interaction among individuals of **different species** in a community is termed as **interspecific interaction**.
- Interspecific interactions arise from the interaction of populations of two different species. They could be beneficial, detrimental or neutral (neither harm nor benefit) to one of the species or both.
- Signs assigned as **'+'** sign for **beneficial** interaction, **'-'** sign for **detrimental** and **0** for **neutral** interaction, at all the possible outcomes of interspecific interactions.

Types of Interactions and their Effects

S.No.	Type of interaction	Species A	Species B
I	**POSITIVE INTERACTIONS**		
a.	Mutualism	+	+
B	Commensalism	+	0
II	**NEGATIVE INTERACTIONS**		
a.	Competition	–	–
b.	Predation	+	–
c.	Parasitism	+	–
d.	Amensalism	0	–
III	**NEUTRAL INTERACTIONS**		
a.	Neutralism	0	0
+ is beneficial, – is detrimental and 'O' is no effect.			

- Both the species benefit in **mutualism** and both lose in **competition** in their interactions with each other.
- In both **parasitism** and **predation** only one species benefits (parasite and predator, respectively) and the interaction is detrimental to the other species (host and prey, respectively).
- The interaction where one species is benefitted and the other is neither benefitted nor harmed is called **commensalism**.
- In **amensalism,** one species is harmed whereas the other is unaffected.
- Predation, parasitism and commensalisms share a common characteristic– the interacting species live closely together.

3.1.1. Types of Interactions

a) Predation

- Predation is nature's way of **transferring energy** fixed by **plants** to **higher trophic levels**. Although animals eating plants are categorised separately as herbivores, in a broad ecological context, they are also a kind of predators (for plants).

Role of Predators in ecosystem

- Predators keep **prey populations** under **control**. In the absence of predators, prey species could achieve very high population densities and cause **ecosystem instability**.
- When certain **exotic species** are introduced into a geographical area, they become invasive and start spreading fast because the invaded land does not have its natural predators.
- Predators also help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species.

A wide variety of chemical substances that extracted from plants on a commercial scale like nicotine, caffeine, quinine, strychnine, opium, etc., are produced by them actually as **defense mechanism** against grazers and browsers.

These are the reasons why predators in nature are 'prudent'.

- For plants, herbivores are the predators. Nearly 25% of all insects are known to be **phytophagous** (feeding on plant sap and other parts of plants). The problem is particularly severe for plants because, unlike animals, they cannot escape from their predators.
- Plants therefore have evolved an astonishing variety of morphological and chemical defences against herbivores.
- **Morphological Control:** Thorns (Acacia, Cactus) are the most common morphological means of defence.
- **Chemical Control:** Many plants produce and store chemicals that make the herbivore sick when they are eaten, inhibit feeding or digestion, disrupt its reproduction or even kill it.

b) Competition:

- Interactions between organisms belonging to the same trophic level often involve **competition**. Individuals of population may compete for food, space and mates. It was convinced that interspecific competition is a potent force in organic evolution.

Facts about competition

- ❖ It is generally believed that competition occurs when closely related species compete for the same resources that are limiting, but this is not entirely true. Unrelated species could also compete for the same resource.
- ❖ For instance, in some shallow South American lakes visiting flamingos and resident fishes compete for their common food, the zooplankton in the lake.
- ❖ Sometimes, Resources need not be limiting for competition to occur; in **interference competition**, the feeding efficiency of one species might be reduced due to the interfering and inhibitory presence of the other species, even if resources (food and space) are abundant.
- ❖ Therefore, competition is best defined as a process in which the fitness of one species is significantly lower in the presence of another species.
- ❖ When resources are **limited** the **competitively superior species** will eventually **eliminate** the **other species** (if resources are limiting), but evidence for such competitive exclusion not occurs in nature.
- ❖ The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats. This is called '**competitive release**'.
- ❖ Species, whose distribution is restricted to a small geographical area because of the presence of a competitively superior species, is found to expand its **distributional range** dramatically when the competing species is experimentally removed.
- ❖ In general, **herbivores and plants appear to be more adversely affected by competition than carnivores**.
- ❖ While they do not rule out the occurrence of interspecific competition in nature, they point out that species facing competition might evolve mechanisms **that promote co-existence rather** than **exclusion**.
- ❖ One such mechanism is '**resource partitioning**'. If two species compete for the same resource, they could avoid competition by choosing, for instance, different times for feeding or different foraging patterns.

c) Parasitism

- Parasitism has evolved in so many taxonomic groups from plants to higher vertebrates.
- Many parasites have evolved to be **host-specific** (they can parasitise only a single species of host) in such a way that both **host** and **parasite** tend to **co-evolve**.

Characteristics of Parasites with respect to their Host

- ❖ If the host evolves special mechanisms for rejecting or resisting the parasite, the parasite has to evolve mechanisms to counteract and neutralise them, in order to be successful with the same host species.
- ❖ In accordance with their life styles, parasites evolved special adaptations such as the loss of unnecessary sense organs, presence of adhesive organs or suckers to cling on to the host, loss of digestive system and high reproductive capacity.
- ❖ The life cycles of parasites are often complex, involving one or two

intermediate hosts or vectors to facilitate parasitisation of its primary host.

- ❖ The **human liver fluke** (a treated parasite) depends on two intermediate hosts (a snail and a fish) to complete its life cycle.
- ❖ The malarial parasite needs a vector (mosquito) to spread to other hosts.
- ❖ Majority of the parasites harm the host; they may reduce the survival, growth and reproduction of the host and reduce its population density.
- ❖ They might render the host more vulnerable to predation by making it physically weak.

Ectoparasites and Endoparasites

- ❖ Parasites that **feed** on the **external surface** of the **host** organism are called **ectoparasites**.
- ❖ The most familiar examples of this group are the lice on humans and ticks on dogs.
- ❖ Cuscuta, a parasitic plant that is commonly found growing on hedge plants, derives its nutrition from the host plant.
- ❖ The female mosquito is not considered a parasite, although it needs our blood for reproduction.
- ❖ In contrast, **endoparasites** are those that **live inside** the **host body** at different sites (liver, kidney, lungs, red blood cells, etc.). The life cycles of end parasites are more complex because of their extreme specialisation.

Brood parasitism in birds is fascinating examples of parasitism in which the parasitic bird lays its eggs in the nest of its host and lets the host incubate them. During the course of evolution, the eggs of the parasitic bird have evolved to resemble the host's egg in size and colour to reduce the chances of the host bird detecting the foreign eggs and ejecting them from the nest. Cuckoo (Koel) and the crow are the best examples of Brood parasitism.

d) Commensalism

- This is the interaction in which **one species benefits** and the **other** is **neither harmed nor benefited**.
- For example, Orchid growing as an **epiphyte** on a mango branch, the mango tree is not benefitted.
- The cattle egret and grazing cattle in close association, in farmed rural areas, is a classic example of commensalism. The egrets always forage close to where the cattle are grazing because the cattle, as they move, stir up and flush out from the vegetation insects that otherwise might be difficult for the egrets to find and catch.

e) Mutualism

- This interaction confers **benefits** on **both** the **interacting species**. **Lichens** represent an intimate mutualistic relationship between a **fungus** and photosynthesising **algae** or **cyanobacteria**.
- Similarly, the **Mycorrhizae** are associations between **fungi** and the roots of higher **plants**. The fungi help the plant in the absorption of essential nutrients from the soil while the plant in turn provides the fungi with energy-yielding carbohydrates.
- The wasp pollinates the fig inflorescence while searching for suitable egg-laying sites. In return for the favour of pollination the fig offers the wasp some of its developing seeds,

as food for the developing wasp larvae.

f) Amensalism

- In amensalism, **one species harms** or **restricts** the **other species without** itself being **adversely affected** or **harmed** by the presence of the other species. For example, organisms that secrete **antibiotics** and the species that get **inhibited** by the antibiotics are examples of amensalism.

g) Neutralism

- Two species which **do interact** but **do not affect each other** is known as **Neutralism**. A perfect neutralism is extremely impossible to prove.

ECOSYSTEM

INTRODUCTION TO AN ECOSYSTEM

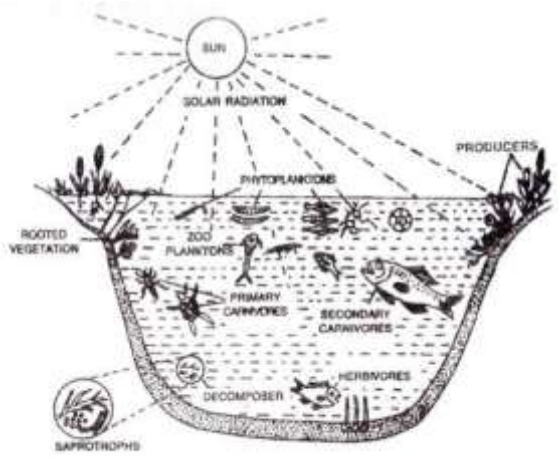
- All organisms such as plants, animals, microorganisms and human beings as well as the physical surroundings interact with each other and maintain a balance in nature. **All the interacting organisms in an area together with the non-living constituents of the environment form an Ecosystem**. Thus, an ecosystem consists of both biotic and abiotic components.

FUNCTIONS OF ECOSYSTEM

- Ecosystem varies greatly in size from a small pond or small grassland to a large forest or sea. The entire biosphere as a whole considered as a global ecosystem, as a composite of all local ecosystems on Earth.

Significant functions of an ecosystem are:

1. Productivity
2. Decomposition
3. Energy Flow
   - 3.1. Food chain
   - 3.2. Food web
   - 3.3. Trophic level
   - 3.3. Ecological Pyramids
   - 3.4. Ecological succession
4. Nutrient Cycling



PONDS AS ECO-SYSTEM

Productivity

- A constant **input of solar energy** is the basic requirement for any ecosystem to function and sustain, except for the deep ocean ecosystem.
- **Primary production** is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.
- **Primary productivity** is the rate of capture of solar energy or biomass production of the **producers**. It is divided into two types: **gross primary productivity** (GPP) and **net primary productivity** (NPP).

GPP-R=NPP

- Gross Primary Productivity (GPP) minus Respiration loss (R) is the Net Primary Productivity (NPP). Considerable amount of NPP is utilised by plants for **respiration**.

- Rate of capture of solar energy or total production of organic matter is called as GPP. NPP is the remaining biomass or the energy left after utilisation of producers, as well as the energy left over for consumers.
- **Secondary productivity** is the rate of assimilation of food energy by the consumers.

Primary productivity varies to different plant species, depending on its habitat. It also depends on variety of environmental factors and hence varies for different ecosystems. Of this, despite occupying 70 per cent of the biosphere, the net **primary productivity of ocean is much lesser than the productivity of Land ecosystem.**

Decomposition

- **Decomposers** or **Detritivores** breakdown complex **organic** matter **into inorganic** substances like carbon dioxide, water and nutrients and the process is called **decomposition**.
- Dead plant remains such as leaves, bark, flowers and dead remains of animals, including faecal matter, constitute **detritus**, which is the raw material for decomposition.
- The important steps in the process of decomposition are **fragmentation, leaching, catabolism, humification and mineralisation.**
- **Detritivores** (e.g., earthworm) break down detritus into smaller particles. This process is called **fragmentation.**
- By the process of **leaching,** water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.
- Bacterial and fungal enzymes degrade detritus into simpler inorganic substances. This process is called as **catabolism**.
- It is important to note that all the above steps in decomposition operate simultaneously on the detritus.
- Humification and mineralisation occur during decomposition in the soil.
- **Humification** leads to accumulation of a dark coloured amorphous substance called **humus** that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate. Being colloidal in nature it serves as a reservoir of nutrients.
- The humus is further degraded by some microbes and release of inorganic nutrients occurs by the process known as **mineralisation**.

Decomposition requires **oxygen** and it largely depends on **chemical composition of Detritus** and **climatic factors**. Decomposition is **quicker**, if detritus is richer in **Nitrogen** and **water soluble substances** and **slower**, if detritus is rich in **lignin** and **chitin**. Bacteria and fungi are the two well-known decomposers (virus or parasite is not a decomposer, as it is a non-living thing outside a host)