**Chapter-5**

# EVOLUTION

## Universe

- The universe is very old **– almost 20 billion years old**.
- Huge clusters of galaxies comprise the universe.
- Galaxies contain stars and clouds of gas and dust. Considering the size of universe, earth is indeed a speck.
- The **Big Bang** theory attempts to explain to us the origin of universe. It talks of a **singular huge explosion** unimaginable in physical terms.
- The **universe expanded** and hence, the temperature came down. **Hydrogen and Helium formed sometime later**. The gases condensed **under gravitation** and formed the galaxies of the present day universe.

## Earth

- In the **solar system** of the **milky way galaxy**, earth was supposed to have been formed about **4.5 billion years back**.
- There was no atmosphere on early earth.
- **Water vapour, methane, carbondioxide and ammonia** released from molten mass covered the surface.
- The UV rays from the sun brokeup water into Hydrogen and Oxygen and the lighter $H_2$ escaped.
- **Oxygen combined with ammonia and methane to form water, CO2 and others**.
- The ozone layer was formed. As it cooled, the water vapor fell as rain, to fill all the depressions and **form oceans**.

## Origin of life

- The origin of life is considered a unique event in the history of universe Life appeared **500 million years** after the formation of earth,
  i.e., almost **four billion years back**.
  There are several theories to explain the origin of life. Some of the theory are given below

**1.Theory of panspermia/ cosmozoic theory**

**Early Greek thinkers** thought units of life called **spores (Cosmozoa)** were transferred to different planets including earth.

**2. Spontaneous generation of life/ /theory of abiogenesis**

For a long time it was also believed that life **came out of decaying and rotting matter like straw, mud, etc**. This was the theory of spontaneous generation.

**Louis Pasteur** by careful experimentation demonstrated that life comes only from pre-existing life. He showed that in pre-sterilised flasks (Swann necked flask ), life did not come from killed yeast while in another flask open to air, new living organisms arose from 'killed yeast'. Spontaneous generation theory was dismissed once and for all. However, this did not answer how the first life form came on earth.

**3. Theory of biogenesis**

According to theory living organisms are formed from pre existing life.

**4. Theroy of special creation**

Religious literature tells us about the theory of special creation. This theory has three connotations.

i) All living organisms(species or types) that we see today were created as such.
ii) The diversity was always the same since creation and will be the same in future
iii) The earth is about **4000 years old**

**5. Chemical evolution/Organic evolution**

- **Oparin of Russia and Haldane of England** proposed Chemical evolution.
- According to this theory the first form of life could have come from **pre-existing non-living organic molecules (e.g. RNA, protein, etc.)** and that formation of life was **preceded by chemical evolution**,
  i.e., formation of **diverse organic molecules from inorganic constituents**.
- **The conditions on primitive earth were – high temperature, volcanic storms, reducing atmosphere containing $CH_4$, $NH_3$, etc.**

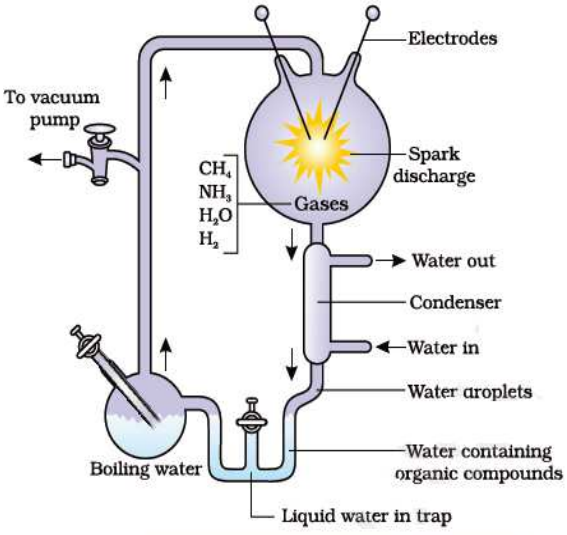
**Experimental proof of chemical evolution**

- ✓ **In 1953, S.L. Miller, an American scientist** created similar conditions in a laboratory scale similar to that of primitive earth.

- ✓ **He created electric discharge in a closed flask (Sparkle discharge apparatus ) containing $CH_4$, $H_2$, $NH_3$ (2:2:1) and water vapour at $800^0$C.**
- ✓ He observed formation of **amino acids**. In similar experiments others observed, formation of **sugars, nitrogen bases, pigment and fats**.
- **Analysis of meteorite content also revealed similar compounds indicating that similar processes are occurring elsewhere in space.** With this limited evidence, chemical evolution was more or less accepted.

- The **first non-cellular forms** of life could have originated **3 billion years** back. It would have been giant molecules (RNA, Protein, Polysaccharides, etc.).

- The first cellular form of life did not possibly originate till about **2000 million years ago**. These were probably single-cells. All life forms were in water environment only. This version of a biogenesis, i.e., the first form of life arose slowly through evolutionary forces from non-living molecules is accepted by majority.




Diagrammatic representation of Miller's experiment

# Evidences of evolution.

## 1. Comparative anatomy and morphology

Comparative anatomy and morphology shows similarities and differences among organisms of today and those that existed years ago. Such similarities can be interpreted to understand **whether common ancestors were shared or not.**

### a)Homologous organs

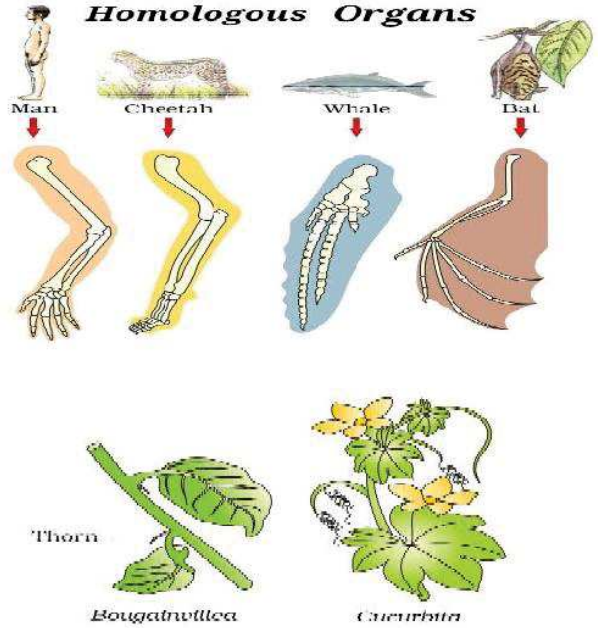
Homologus organs are organs having **same structure** and origin **but different functions**. This phenomenon is called **homology**. such organs are developed due to **divergent evolution**.

**Eg:1) whales, bats, Cheetah and human (all mammals) share similarities in the pattern of bones of forelimbs**

Though these forelimbs perform different functions in these animals, they have similar anatomical structure – all of them have humerus, radius, ulna, carpals, metacarpals and phalanges in their forelimbs. Hence, in these animals, the same structure developed along different directions **due to adaptations** to **different needs**. This is **divergent evolution** and these structures are **homologous**

**Eg;2) the thorn and tendrils of *Bougainvillea* and *Cucurbita*** represent homology

**Eg;3) vertebrate hearts or brains**



**b) Analogous organ**

Organs having **same function** but different structure and origin. This phenomenon is called Analogy. Such organs are developed due to **Convergent evolution**.

**Eg;1) Wings of butterfly and of birds** look alike. They are not anatomically similar structures though they perform similar functions. – here different structures evolving for the same function and hence having similarity

**Eg;2) the eye of the octopus and of mammals**

**Eg;3) the flippers of Penguins and Dolphins.**

**Eg;4) Sweet potato (root modification) and potato (stem modification)**

- So one can say that it is **the similar habitat** that has resulted in selection of similar adaptive features in **different groups** of organisms but toward the same function. It results in the formation of Convergent evolution

**3. Biochemical evidence**

Similarities in proteins and genes performing a given function among diverse organisms give clues to common ancestry.

**4. Molecular evidence**

Similarity of organism at the molecular level indicate phylogenetic (Evolutionary history ) relationship. Human DNA differs in only 1.8% of its bp from chimpanzee DNA and there is no difference between two in the amino acid sequence for protein cytochrome C. Similarly molecular structure of **actin and tubulin** protein in all animal point their common ancestory.

A common **genetic code** is overhelming evidence that all organisms are related

**5.Embryological evidence**

It is proposed by **Earnst Heckel**. According to his observation certain features are common to all vertebrates during their embryological stage. It is absent in their adult (Ontogeny repeats phylogeny/ re capitulation theory)

Eg: appearance of **vestigial gill slit** behind the head during embryological development in all vertebrates. But it is functional only in fishes

This observation was disproved by Von Baer. He noted that embryos never pass through the adult stage of other animal.

**Horticulutre** :The art or practice of garden cultivation and management

# Industrial Melanism

- Interesting observation supporting evolution by natural selection comes from **England**.
- In a collection of **moths** made in **1850**s, i.e., before industrialisation set in, it was observed that there were **more white-winged moths on trees than dark-winged** or melanised moths.
- However, in the collection carried out from the same area, but after industrialisation, i.e., in **1920**, there were more dark-winged moths in the same area, i.e., the proportion was reversed.
- The explanation put forth for this observation was that 'predators will spot a moth against a contrasting background'. During post industrialization period, the **tree trunks became dark due to industrial smoke and soots.** Under this condition the white-winged moth did not survive due to predators, dark-winged or melanised moth survived**.**
- **Before industrialisation set in, thick growth of almost white-coloured lichen covered the trees** - in that background the white winged moth survived but the dark-coloured moth were picked out by predators. **the lichens can be used as industrial pollution indicators** They will not grow in areas that are polluted. Hence, moths that were able to camouflage themselves, i.e., hide in the background, survived. This understanding is supported by the fact that in areas where industrialisation did not occur e.g., in rural areas, the count of melanic moths was low.
- **This showed that in a mixed population, those that can better-adapt, survive and increase in population size**
- **Branching descent and natural selection are the two key concepts of Darwinian Theory of Evolution**

## Types of Natural selection

**a)Stabilsing selection/Normalizing selection**

Here more individuals acquire mean character value. This occurs when the environment doesnot change. Fossil evidence shows that , many species remain unchanged

for long period of geological time. One of the most stable environment on earth is the deep sea.

Eg: Birth weight of human. The heaviest and lightest babies have the highest mortality

**b)Directional selection**

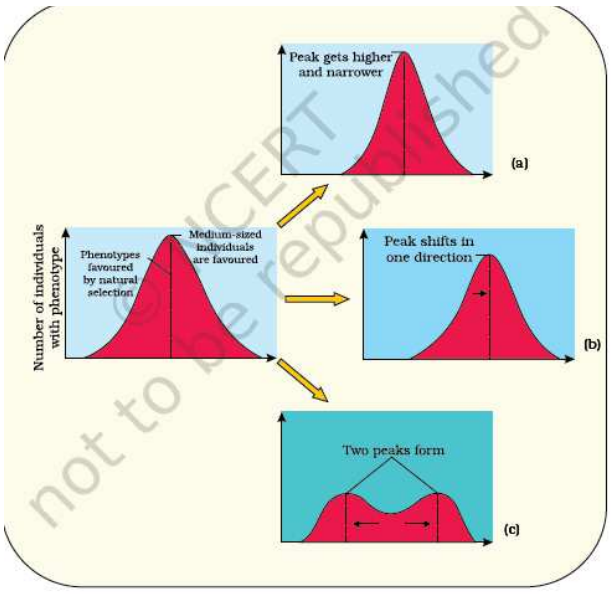
Here more individuals acquire value other than the mean character are favoured

**Eg:Industrial melansim**

**c)Disruptive selection**

Here more individuals acquire peripheral character value at both ends of the distribution curve

**Eg: adaptive radiation**




Diagrammatic representation of the operation of natural selection on different traits : (a) Stabilising (b) Directional and (c) Disruptive

# HARDY-WEINBERG PRINCIPLE

- Proposed by G.H Hardy and Wilhelm Weinerg.
- This principle says that allele frequencies in a population are stable and is constant from generation to generation.
- **The gene pool (total genes and their alleles in a population) remains a constant**. This is called genetic equilibrium.

**Sum total of all the allelic frequencies is 1.**

Disturbance in genetic equilibrium, or Hardy-Weinberg equilibrium, i.e., change of frequency of alleles in a population would then be interpreted as **resulting in evolution**

$$(p + q)^2 = p^2 + 2pq + q^2 = 1$$

Where:

p = the frequency of allele A
q = the frequency of allele a
$p^2$ = the frequency of individual AA
$q^2$ = the frequency of individual aa
2pq = the frequency of individual Aa

**Five factors are known to affect Hardy Weinberg equilibrium**. These are

**i) Gene migration or gene flow,**
**ii) Genetic drift,**
**iii) Mutation,**
**iv) Genetic recombination and**
**v) Natural selection.**

- ✓ When migration of a section of population to another place and population occurs, gene frequencies change in the original as well as in the new population. New genes/alleles are added to the new population and these are lost from the old population. There would be a gene flow if this gene migration, happens multiple times.
- ✓ Change in gene frequency occurs by **chance**, it is called **genetic drift.**

**(c) Sixteen percent of the population of Europe is Rhesus negative. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be heterozygous for the Rhesus gene. Show your working. (2)**

$$q^2 = \frac{16}{100}$$

$$q = \sqrt{0.16} = 0.4$$

$p = 1 - 0.4 = 0.6$

$2pq$ = heterozygotes = $2 \times 0.6 \times 0.4 = 48\ \%$

- ✓ The **founder effect** is change in allele frequency that occurs when a new population is established by a very small number of individuals from a larger population. Here the change in allele frequency is so different in the new sample of population that they become a different species. The original drifted population becomes founders and the effect is called **founder effect**.

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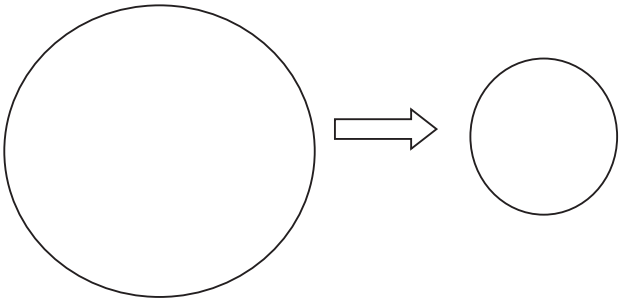

## ORIGIN AND EVOLUTION OF MAN

**Ape→ Drypithecus → Ramapithecus → Australopithecus→ *Homo habilis* → *Homo erectus* → Neanderthal man→*Homo sapiens***

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# HUMAN HEALTH AND DISEASE

## DISEASE

Diseases can be broadly grouped into **infectious and non-infectious.**

**1-Infectious disease**

Diseases which are easily transmitted from one person to another are called infectious diseases.

Eg : **AIDS**

**2-Non infectious disease**

Diseases which are not easily transmitted from one person to another

Eg : **cancer , Goiter, ulcer**

## COMMON DISEASES IN HUMANS

### A)Bacterial disease

It include Typhoid fever, pneumonia, Dysentery, plague, diphtheria, TB, cholera, Leprosy, Whooping cough, Gonorrhoea

### a)Typhoid fever

- **Pathogen :** *Salmonella typhi*
- **Part of the body it infect :**
  These pathogens generally enter the **small intestine through food and water** contaminated with them and migrate to other organs through blood.
- **Symptoms :**
  - **Sustained high fever (39° to 40°C),**
  - Weakness,
  - Stomach pain,
  - Constipation,
  - Headache and
  - Loss of appetite.
  - **Intestinal perforation and death may occur in severe cases.**
- **Spread :**
  Contaminated food and water
- **Test :**
  Typhoid fever could be confirmed by **Widal test.**

**Mary Mallon :**

A classic case in medicine, that of **Mary Mallon** nicknamed **Typhoid Mary**, is worth mentioning here. She was **a cook by profession** and was a typhoid carrier who continued to spread typhoid for several years through the food she prepared.

### B) Viral disease

It include Common cold, AIDS, Chicken Pox, Small pox, Polio, Rabies, Mumps,

### a)Acquired Immuno Deficiency Syndrome (AIDS)

**Introduction**

- AIDS means, Deficiency of immune system, acquired during the lifetime of an individual indicating that it is **not a congenital disease**. 'Syndrome' means a group of symptoms.
- AIDS was first reported in **1981 in USA** and in the last twenty-five years or so, it has spread all over the world killing more than **25 million persons**.

- **Pathogen :**
  HIV **(Human immuno deficiency virus )**
- **Part of the body it infect :**
  Helper T lymphocyte/Immune system
- **Symptoms :**
- Progressive **decrease in the number of helper T lymphocytes.**
- During this period, the person suffers from bouts of **fever, diarrhoea and weight loss**..
- Due to decrease in the number of helper T lymphocytes, the person starts suffering from infections that could have been otherwise overcome such as those due to bacteria especially **Mycobacterium, viruses, fungi and even parasites like Toxoplasma.**
- The patient becomes so immuno-deficient that he/she is unable to protect himself/herself against these infections.
- There is always a time-lag between the infection and appearance of AIDS symptoms. This period may vary from a few months to many years **(usually 5-10 years).**
- **Spread :**
  Transmission of HIV-infection Generally occurs by
  **(a) Sexual contact with infected person,**
  **(b) By transfusion of contaminated blood and blood products,**
  **(c) By sharing infected needles as in the case of intravenous drug abusers**

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**(d)From infected mother to her child through placenta.**

**Following individual are at high risk of getting HIV infections**

1. **individuals who have multiple sexual partners,**
2. **drug addicts who take drugs intravenously,**
3. **individuals who require repeated blood transfusions and**
4. **children born to an HIV infected mother.**

**Test :**

**Enzyme linked immune sorbent assay (ELISA)**

HIV/AIDS is not spread by mere touch or physical contact; **it spreads only through body fluids**. It is, hence, imperative, for the physical and psychological well-being, that the HIV/AIDS infected persons are not isolated from family and society.

**Treatment of AIDS :**

Treatment of AIDS with **anti-retroviral drugs** is only partially effective. They can only prolong the life of the patient

**Prevention of AIDS :**

- In our country the **National AIDS Control Organisation (NACO)** and other non-governmental organisation (NGOs) are doing a lot to educate people about AIDS. WHO has started a number of programmes to prevent the spreading of HIV infection.

1. **Making blood (from blood banks) safe from HIV,**
2. **ensuring the use of only disposable needles and syringes in public and private hospitals and clinics,**
3. **free distribution of condoms, controlling drug abuse,**
4. **advocating safe sex and promoting regular check-ups for HIV in susceptible populations, are some such steps taken up. but cannot prevent death, which is inevitable.**

## C)PROTOZOAN DISEASE

It include **malaria and amoebiasis**

# a)Malaria

- **Pathogen** :

  Plasmodium (a tiny protozoan) Different species of Plasmodium (***P. vivax, P. malaria*** **and** ***P. falciparum***) are responsible for different types of malaria.
  Of these, malignant malaria caused by ***Plasmodium falciparum*** is the most serious one and can even be **fatal.**
- **Part of the body it infect :**

  Liver, RBC
- **Symptoms :**
  - The rupture of RBCs is associated with release of a toxic substance, **haemozoin,** which is responsible for the chill and high fever **recurring** every three to four days
- **Spread :**

  Female Anopheles mosquitoes transmitting agent

**Life cycle of Plasmodium**

- Plasmodium enters the human body as **sporozoites (infectious form)** through the bite of infected **female Anopheles mosquito.**
- The parasites initially multiply within the liver cells and then attack the red blood cells (RBCs) resulting in their rupture.
- The rupture of RBCs is associated with release of a toxic substance, **haemozoin**, which is responsible **for the chill and high fever recurring every three to four days**.
- When a female Anopheles mosquito bites an infected person, these parasites enter the mosquito's body and undergo further development. The parasites multiply within them to form sporozoites that are stored in their salivary glands.
- When these mosquitoes bite a human, the sporozoites are introduced into his/ her body, thereby initiating the events mentioned above.
- **It is interesting to note that the malarial parasite requires two hosts – human and mosquitoes – to complete its life cycle the female Anopheles mosquito is the vector (transmitting agent) too.**

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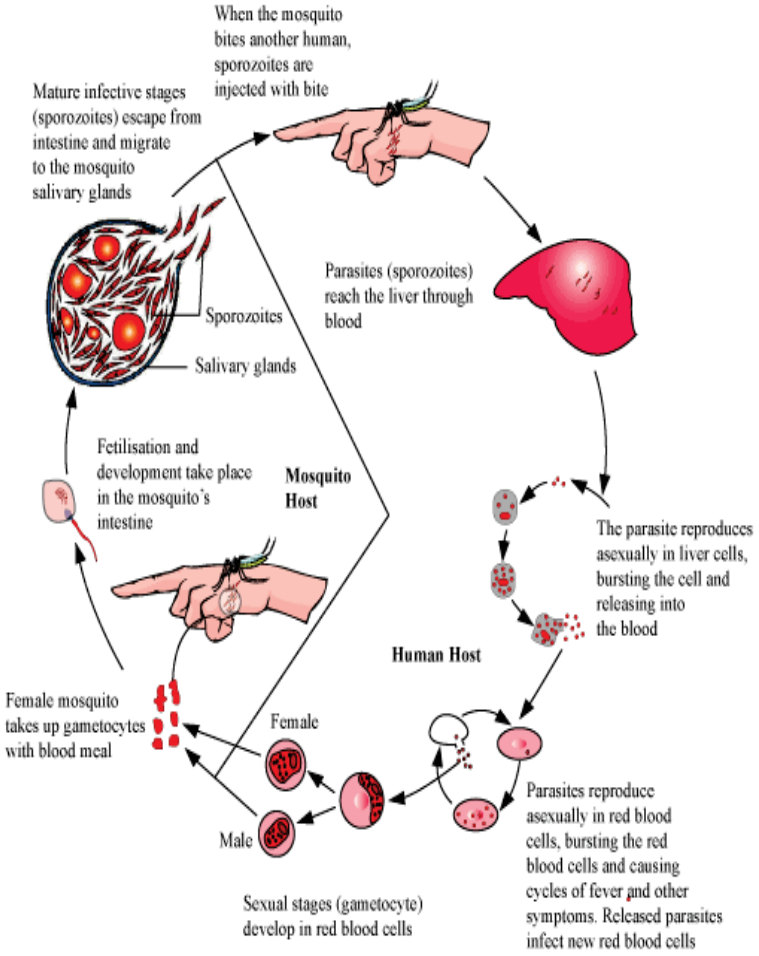


# CANCER

- Cancer is one of the most dreaded diseases of human beings and is a major cause of death all over the globe.
- More than **a million Indians** suffer from cancer and a large number of them die from it annually
- Our body, cell growth and differentiation is highly controlled and regulated.
- In cancer cells, there is breakdown of these regulatory mechanisms.
- Normal cells show a property called **contact inhibition** by virtue of which contact with other cells inhibits their uncontrolled growth. Cancer cells appears to have lost this property. As a result of this, cancerous cells just continue to divide giving rise to masses of cells called tumors.
- Tumors are of two types: **benign and malignant**.

## 1) Benign tumors

- It normally remain confined to their original location and do not spread to other parts of the body and cause little damage.

## 2) The malignant tumors,

- **This is** a mass of proliferating cells called neoplastic or tumor cells.
- These cells grow very rapidly, invading and damaging the surrounding normal tissues.
- As these cells actively divide and grow they also starve the normal cells by competing for vital nutrients.
- **Cells sloughed from such tumors reach distant sites through blood, and wherever they get lodged in the body, they start a new tumor there. This property called metastasis is the most feared property of malignant tumors.**

### Causes of cancer :

- Transformation of normal cells into cancerous neoplastic cells may be induced by physical, chemical or biological agents. These agents are called carcinogens.

### Example for carcinogens

- **Ionising radiations ( X-rays and gamma rays )**
- **Non-ionizing radiations (UV )cause DNA damage leading to neoplastic transformation.**
- The chemical carcinogens present in tobacco smoke have been identified as a major cause of lung cancer.
- Cancer causing viruses called **oncogenic viruses have genes called viral oncogenes**.
- Furthermore, several genes called **cellular oncogenes (c-onc) or proto oncogenes** have been identified in normal cells which
- When activated under certain conditions, could lead to oncogenic transformation of the cells.

### Cancer detection and diagnosis :

- Early detection of cancers is essential as it allows the disease to be treated successfully in many cases.
- Cancer detection is based on **biopsy and histopathological studies** of the tissue and

blood and bone marrow tests for increased cell counts in the case of **leukemias (blood cancer)**

- **In biopsy,** a piece of the suspected tissue cut into thin sections is stained and examined under microscope (histopathological studies) by a pathologist.
- Techniques like radiography (use of X-rays), CT (computed tomography) and MRI (magnetic resonance imaging) are very useful to detect cancers of the internal organs.
- **Computed tomography** uses **X-rays** to generate a three-dimensional image of the internals of an object.
- **MRI** uses **strong magnetic fields and non-ionising radiations** to accurately detect pathological and physiological changes in the living tissue.
- **Antibodies** against cancer-specific antigens are also used for detection of certain cancers.
- **Techniques of molecular biology** can be applied to detect genes in individuals with inherited susceptibility to certain cancers. Identification of such genes, which predispose an individual to certain cancers, may be very helpful in prevention of cancers. Such individuals may be advised to avoid exposure to particular carcinogens to which they are susceptible (e.g., tobacco smoke in case of lung cancer).

**Treatment of cancer :**

- The common approaches for treatment of cancer are **surgery, radiation therapy and immunotherapy.**
- **In radiotherapy,** tumor cells are irradiated lethally, taking proper care of the normal tissues surrounding the tumor mass.
- **Several chemotherapeutic drugs** are used to kill cancerous cells. Some of these are specific for particular tumors. Majority of drugs have side effects like hair loss, anemia, etc.
- Most cancers are treated by combination of **surgery, radiotherapy and chemotherapy**.
- Tumor cells have been shown to avoid detection and destruction by immune system. Therefore, the patients are given substances called biological response modifiers such as α-interferon which activates their immune system and helps in destroying the tumor.

# IMMUNOLOGY

- The overall ability of the host to fight the disease-causing organisms, conferred by the immune system **is called immunity**. Immunity is of two types:

**(i) Innate immunity and**
**(ii) Acquired immunity.**

## i)Innate immunity/inborn immunity /non specific immunity

- This type of immunity is present **at the time of birth**. This is accomplished by providing different types of barriers to the entry of the foreign agents into our body. Innate immunity consist of **four types of barriers**. These are

**(a) Physical barriers** :

- **Skin** on our body is the main barrier which prevents entry of the micro-organisms.
- **Mucus coating** of the epithelium lining the respiratory, gastrointestinal and urogenital tracts also help in trapping microbes entering our body.

**(b) Physiological barriers :**

- **Acid** in the stomach,
- **Saliva** in the mouth,
- **Tears** from eyes–all prevent microbial growth.
- Saliva and tear contain antibacterial agent called **Lysozyme**

**(c) Cellular barriers :**

- Certain types of **leukocytes** (WBC) of our body like **polymorpho-nuclear leukocytes** (PMNL-neutrophils) and monocytes and **natural killer** (type of lymphocytes) in the blood as well as macrophages in tissues can **phagocytose** and destroy microbes.

**(d) Cytokine barriers :**

- Virus-infected cells secrete proteins called **interferons** which protect non-infected cells from further viral infection.

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### ii) Acquired immunity/adaptive immunity/specific immunity

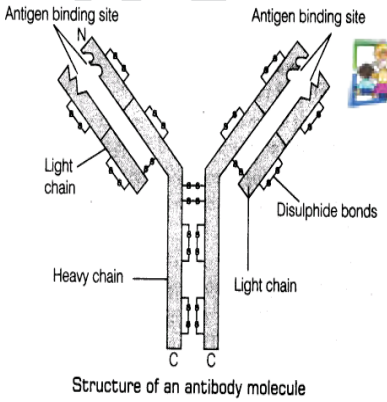
- It is **pathogen specific**.
- It is characterised by **memory**.
- This means that our body when it encounters a pathogen for the **first time** produces a response called **primary response** which is of low intensity. Subsequent encounter with the same pathogen elicits a highly intensified **secondary or anamnestic response.** .

### B-lymphocytes and T lymphocytes

- The primary and secondary immune responses are carried out with the help of two special types of lymphocytes present in our blood, **i.e., B-lymphocytes and T lymphocytes.**
- Certain cells of bone marrow produce lymphocytes (Haematopoiesis). These cells mature in the bone marrow lymphocytes. The B-lymphocytes produce an army of proteins in response to pathogens into our blood to fight with them. These proteins are called **antibodie**s. **The B lymphocytes give rise to plasma cells and memory B cells.**
- Some stem cells in the Bone marrow give rise to immature lymphocytes. These lymphocytes migrate via the blood **to the thymus**, where they mature as **T cells**. In the thymus, these cells mature as T lymphocytes. **The T-cells themselves do not secrete antibodies but help B cells produce them**

### Structure of Antibody

Each antibody molecule has **four peptide chains**, two small called **light chains** and two longer called **heavy chains**. Hence, an antibody is represented as $H_2L_2$. Different types of antibodies are produced in our body. IgA, IgM, IgE, IgG are some of them



Structure of an antibody molecule

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### HUMORAL IMMUNITY & CELL MEDIATED IMMUNITY

- Immune response by the **B-cells** by production of antibody is called **Antibody mediated immune response (AMI) or humoral immune response.**
- Immune response **by T-cells** which detects and destroys the foreign cells and also cancerous cells **called cell mediated immune response.(CMI)**
- Rejection of organs in transplantation are due to **T-lymphocytes.**
- Tissue matching, blood group matching are essential for organ transplantation.
- **Immune-suppressants** (Eg.Cyclosporin A) is required before and after transplantation.

# Effects of Drug/Alcohol

- The reckless behavior,
- Vandalism
- Violence.
- Excessive doses of drugs may lead to coma and death due to respiratory failure, heart failure or cerebral hemorrhage.
- A combination of drugs or their intake along with alcohol generally results in overdosing and even deaths.

### Warning signs of drug/alcohol abuse

- Drop in academic performance,
- Unexplained absence from school/college,
- Lack of interest in personal hygiene,
- withdrawal,,isolation from family and friends
- Depression,
- Fatigue,
- Aggressive and rebellious behaviour,
- Loss of interest in hobbies,
- Change in sleeping and eating habits
- Fluctuations in weight, appetite, etc.

- If an abuser is unable to get money to buy drugs/alcohol he/she may turn to stealing. The adverse effects are just not restricted to the person who is using drugs or alcohol.
- a drug/alcohol addict becomes the cause of mental and financial distress to his/her entire family and friends.

- Those who take drugs **intravenously (direct injection into the vein using a needle and syringe), are much more likely to acquire serious infections like AIDS and Hepatitis B.**
- The viruses, which are responsible for these diseases, are transferred from one person to another by sharing of infected needles and syringes. Both AIDS and Hepatitis B infections are chronic infections and ultimately fatal. Both can be transmitted through sexual contact or infected blood.
- The use of alcohol during adolescence may also have long-term effects. It could lead to heavy drinking in adulthood. The chronic use of drugs and alcohol damages nervous system and liver (cirrhosis).
- The use of drugs and alcohol during pregnancy is also known to adversely affect the foetus.
- Another misuse of drugs is what certain sportspersons do to enhance their performance. They (mis)use narcotic analgesics, anabolic steroids, diuretics and certain hormones in sports to increase muscle strength and bulk and to promote aggressiveness and as a result increase athletic performance.

**The side-effects of the use of anabolic steroids in females**

- Masculinisation (features like males),
- Increased aggressiveness, mood swings,
- Depression, abnormal menstrual cycles,
- Excessive hair growth on the face and body,
- Enlargement of clitoris,
- Deepening of voice.

**The side-effects of the use of anabolic steroids in Males**

- Acne,
- Increased aggressiveness,
- Mood swings,
- Depression,
- Deduction of size of the testicles,
- Decreased sperm production,
- Potential for kidney and
- Liver dysfunction,
- Breast enlargement,
- Premature baldness,
- Enlargement of the prostate gland.

## Prevention and Control

'Prevention is better than cure' holds true here also.

- **(i) Avoid undue peer pressure -** Every child has his/her own choice and personality, which should be respected and nurtured. A child should not be pushed unduly to perform beyond his/her threshold limits; be it studies, sports or other activities.
- **(ii) Education and counselling -** Educating and counselling him/ her to face problems and stresses, and to accept disappointments and failures as a part of life. It would also be worthwhile to channelize the child's energy into healthy pursuits like sports, reading, music, yoga and other extracurricular activities.
- **(iii) Seeking help from parents and peers -** Help from parents and peers should be sought immediately so that they can guide appropriately. Help may even be sought from close and trusted friends. Besides getting proper advise to sort out their problems, this would help young to vent their feelings of anxiety and guilt.
- **(iv) Looking for danger signs -** Alert parents and teachers need to look for and identify the danger signs discussed above. Even friends, if they find someone using drugs or alcohol, should not hesitate to bring this to the notice of parents or teacher in the best interests of the person concerned. Appropriate measures would then be required to diagnose the malady and the underlying causes. This would help in initiating proper remedial steps or treatment.
- **(v) Seeking professional and medical help** - A lot of help is available in the form of highly qualified psychologists, psychiatrists, and deaddiction and rehabilitation programmes to help individuals who have unfortunately got in the quagmire of drug/alcohol abuse. With such help, the affected individual with sufficient efforts and will power, can get rid of the problem completely and lead a perfectly normal and healthy life

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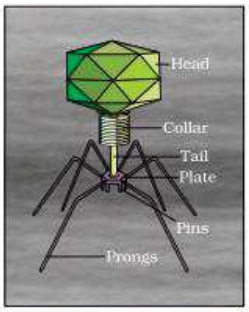
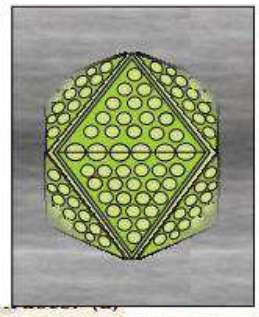
# CHAPTER-10

# MICROBES IN HUMAN WELFARE

Microbes are present everywhere – in soil, water, air, inside our bodies and that of other animals and plants. They are present even at sites where no other life-form could possibly exist–sites such as deep inside the geysers (thermal vents) where the temperature may be as **high as 100$^0$C**, deep in the soil, under the layers of snow several metres thick, and in highly acidic environments. Microbes are diverse–protozoa, bacteria, fungi and microscopic plant viruses, viroids and also prions that are proteinacious infectious agents




A bacteriophage;



Adenovirus which causes respiratory infections;

Microbes like bacteria and many fungi can be grown on nutritive media to form colonies , that can be seen with the naked eyes.

## 1. Microbes in Household products

- **LACTIC ACID BACTERIA (LAB)**

- Micro-organisms such as **Lactobacillus** and others commonly called **Lactic acid bacteria (LAB**) grow in milk and convert it into **curd**.
- During the growth, LAB produces acids that coagulate and partially digest the milk proteins. A small amount of curd added to the fresh milk as **inoculums** or **starter** contains millions of LAB, which at suitable temperature multiply and convert milk into curd.
- LAB also improves nutritional quality by increasing **vitamin $B_{12}$ (Cyanocobalamine**).
- In our stomach LAB check the disease causing microbes.

✓ The **dough**, which is used for making dosa and idli is also fermented by bacteria. The puffed-up appearance of dough is due to the production of **carbon dioxide**

✓ The dough, which is used for making bread, is fermented using **baker's yeast**- **Saccharomyces cervisiae**

✓ **Toddy** is made by **fermenting sap from palms**

✓ Various microbes are also used to ferment fish, soyabean and bamboo shoots to make food**.**

✓ Large holes in **'swiss cheese'** are due to production of a large amount of **$CO_2$** by a bacterium **Propionibacterium sharmani**i.

✓ The **'Roquefort cheese'** are ripened by growing a specific **fungi** on them, which gives them a particular flavor

## 2. Microbes for the production of acids and Alcohol

Some microbes are used for the commercial and industrial production of certain chemicals like **organic acids, alcohol and enzymes**

| | |
|---|---|
| *Aspergillus niger*(Fungus)--------- | Citric acid |
| *Acetobacter aceti*(Bacteria)----- | Acetic acid |
| *Clostridium butylicum* (Bacteria)--- | Butyric acid |
| Lactobacillus (Bacteria) ---------- | Lactic acid |
| *Saccharomyces cervisiae*---------- | Ethanol (Alcohol) |

## 3. Microbes for the production of Enzymes

- **Lipase** are used in Detergent formulations for removing oily stains in laundry
- Bottled fruit juices bought from market are clearer as compared to those made at home. This is because the bottled juices are clarified by the use of **Pectinase and Protease**

## 4. Microbes used as Bioactive molecule

Bioactive molecules are substance that can be acted on a living organism or an extract from a living organism. It can be extracted from micro organism. Bio active molecues are secondary metabolites

- **Streptokinase** produced by the bacterium Streptococcus and modified by genetic engineering is used as **a 'CLOT BUSTER'** for **removing clots from blood vessels** of patients who have undergone myocardial infarction leading to heart attack

- **Trichoderma polysporum (fungus)** produces **Cyclosporin A** . It is used as a **immunosuppressive** agent in organ transplantation
- **Monascus purpureus (Yeast**) Produce **Statins**. It is used as **blood cholesterol lowering agent**. Statin act on enzyme responsible for synthesis of cholesterol.

## 7. Microbes as Bio control agents

- **Biocontrol:** It refers to the use of **biological methods** for controlling plant diseases and pests. Biocontrol measures **greatly reduce our dependence on toxic chemicals and pesticides**.

  Eg: (1)-The beetle with red and black marking-)-Ladybird and dragonflies are useful to get rid of **aphids and mosquitoes** respectively

  Eg:(2)-Introduction of **Bacillus thuringiensis** (Bt) is used to control **butterfly catterpiller** is an example for microbial Biocontrol. These are available in sachet as dried spores which are mixed with water and sprayed onto vulnerable plants such as Brassicas and fruit trees, where these are eaten by insect larvae. The bacterial disease will kill the caterpillars but leave the other insects unharmed.

  Eg: (3)-Using genetic engineering skills, scientist introduced B.thuringiensis toxin gene into plants.Such plants are resistant to attack by insect pests. **Eg:Bt-Cotton**

  Eg: (4)-**Trichoderma** (Free living fungi present in the root ecosystem) used in the treatment of plant diseases.

  Eg(5) Baculoviruses (Genus:Nucleopolyhedrovirus) are viruses that attack the insects and other arthropods. The virus has no harmful effect on plants and animals such as Mammals, Birds, Fishes or even on non-target insects. These viruses play a vital role for conserving the beneficial insects in Integrated pest management (IPM) programme.

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# Biodiversity and Conservation

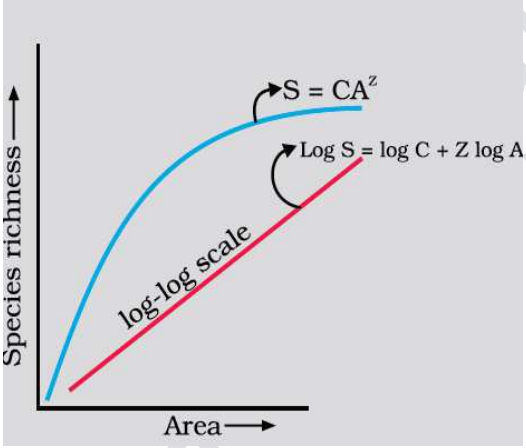
## Biodiversity

- There are more than **20,000 species** of ants, **3,00,000 species** of beetles**, 28,000** species of fishes and nearly **20,000** species of orchids.
- Biodiversity is the term popularized by the sociobiologist **Edward Wilson** to describe the combined diversity at all the levels of biological organization
- **Biodiversity can be described as the sum total of genes, species and ecosystem of a region**

## Patterns of Biodiversity

**(i) Species-Area relationships**:

- According to **German naturalist** and geographer **Alaxander Von Humboldt**, species richness increased with increasing explored area,but only upto a limit.
- The relationship between species richness and area for a wide variety of taxa (angiosperm plants, birds, bats, freshwater fishes) turns out to be a **rectangular hyperbola.**
- On a logarithmic scale, the relationship is a **straight line** described by the equation




**log S = log C + Z log A**

where

**S= Species richness A= Area**
**Z = slope of the line (regression coefficient)**
**C = Y-intercept**

- Ecologists have discovered that the value of Z lies in the range of **0.1 to 0.2,** regardless of the taxonomic group or the region (whether it is the plants in Britain, birds in California or molluscs in New York state, the slopes of the regression line are amazingly similar)
- The species-area relationships among very large areas like the entire continents, you will find that the slope of the line to be much steeper **(Z values in the range of 0.6 to 1.2).**
- For example, for frugivorous (fruit-eating) birds and mammals in the tropical forests of different continents, the slope is found to be **1.15**

## The importance of Species Diversity to the Ecosystem

- A community with more species tend to be more stable than those with less stable.
- A community which should not show too much variation in productivity from year to year called **Stable community. Such community are resistant to occasional disturbance ( natural or man made) and resistant to alien species invasion.**
- **David Tilman** conducted some long term experiments using outdoor plots, explained that increased diversity contributed to higher productivity.
- Rich diversity and higher productivity are not only essential for a healthy ecosystem but also important for the survival of human race

## RIVET POPPER HYPOTHESIS

- Proposed by Stanford ecologist **Paul Ehrlich.**
- In an airplane (ecosystem) all parts are joined together using thousands of rivets (species).
- If every passenger travelling in it starts popping a rivet to take home (causing a species to become extinct), it may not affect flight safety (proper functioning of the ecosystem) initially, but as more and more rivets are removed, the plane becomes dangerously weak over a period of time.
- Furthermore, which rivet is removed may also be critical.
- Loss of rivets on the wings (**key species that drive major ecosystem functions**) is obviously a more serious threat to flight safety than loss of a few rivets on the seats or windows inside the plane.

# Loss of Biodiversity

- The colonisation of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds.
- The IUCN Red List (2004) documents the extinction of **784 species (including 338 vertebrates, 359 invertebrates and 87 plants**) in the last 500 years.
- **Some examples of recent extinctions include**
  - **The dodo (Mauritius),**
  - **Quagga (Africa),**
  - **Thylacine (Australia),**
  - **Steller's Sea Cow (Russia)**
  - **Three subspecies of tiger (Bali, Javan, Caspian)**.

- Loss of biodiversity in a region may lead to
  (**a) Decline in plant production,**
  **(b) Lowered resistance to environmental perturbations such as drought**
  **(c) Increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycle.**

# Causes of biodiversity losses:

- There are four major causes
  **('The Evil Quartet' is the sobriquet)**

## (i) Habitat loss and fragmentation:

- This is the most important cause driving animals and plants to extinction.
- The most dramatic examples of habitat loss come from **tropical rain forests**. Once covering more than **14 % of the earth's land surface**, these rain forests now cover **not more than 6 %**. They are being destroyed fast. By the time you finish reading this Printout of zoology, **100 more hectares of rain forest** would have been lost.
- **The Amazon rain forest (it is so huge that it is called the 'lungs of the planet')** harboring probably millions of species is being cut and cleared for cultivating ***soya beans*** or for conversion to grasslands for raising beef cattle.
- Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species.
- When large habitats are broken up into small fragments due to various human activities, mammals and birds requiring large territories and certain animals with migratory habits are badly affected, leading to population declines.

## (ii) Over-exploitation:

- Humans have always depended on nature for food and shelter, but when 'need' turns to 'greed' it leads to **over-exploitation of natural resources**.
- Eg: Many species extinctions in the last 500 years **(Steller's sea cow, passenger pigeo**n) were due to overexploitation by humans.

## (iii) Alien species invasions:

- When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species.
- Eg 1: **The Nile perch introduced into Lake Victoria in east Africa** led eventually to the extinction of an ecologically unique assemblage of more than 200 species of **cichlid fish in the lake.**
- **Eg 2:** the environmental damage caused and threat posed to our native species by invasive weed species like **carrot grass (*Parthenium*), *Lantana* and water hyacinth (*Eicchornia*)**.
- **Eg 3:** The recent **illegal introduction of the African catfish *Clarias gariepinus*** for aquaculture purposes is posing a threat to the indigenous catfishes in our rivers.

## (iv) Co-extinctions:

- **When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct**.
- **Eg 1:** When a host fish species becomes extinct, its unique assemblage of parasites also meets the same fate.
- **Eg 2:** a coevolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

# BIODIVERSITY CONSERVATION

**How do we conserve Biodiversity?**

Conservation of biodiversity can be done by two ways

**a)In-situ conservation**
**b)Ex-situ conservation**

**a)In-situ (On site) conservation**

The conservation of genetic resources through their maintenance **within natural or even human-made ecosystem in which they occur** is called In-situ conservation.

Examples.

1. **National park,**
2. **Sanctuaries,**
3. **Biosphere reserves,**
4. **Natural monuments,**
5. **Hot spots,**
6. **sacred grooves,**
7. **cultural landscapes**

**India** has
**14 biosphere reserves**,
**90 national parks** and
**448 wildlife sanctuaries.**

- **Sacred groves** are found in **Khasi and Jaintia Hills in Meghalaya, Aravalli Hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areas of Madhya Pradesh**. In Meghalaya, the sacred groves are the last refuges for a large number of rare and threatened plants

## Hotspots:

- Scientists identified certain regions with very **high level of species richness and high degree of Endemism (species that is confined to that region and not found anywhere else)** to protect biodiversity.
- Hot spots are the richest and most threatened reservoirs of plants and animal life on earth.
- Initially 25 biodiversity hotspots were identified but subsequently nine more have been added to the list, bringing the total number of **biodiversity hotspots in the world to 34**. These hotspots are also regions of accelerated habitat loss.
- Three of these hotspots – **Western Ghats and Sri Lanka, Indo-Burma and Himalaya – cover our country's exceptionally high biodiversity regions.**
- Although all the biodiversity hotspots put together cover less than **2% of the earth's land area**, the number of species they collectively harbour is extremely high and strict protection of these hotspots could reduce the **ongoing mass extinctions by almost 30 per cent.**

**(b) Ex situ (off site) Conservation**

Conservation **outside their habitat** is called ex-situ conservation. In this approach, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care.

Examples

1. **Cryoprservation,**
2. **Zoological parks,**
3. **Botanical gardens**
4. **Wildlife safari parks**

**Cryopreservation**

- Storage of materials (Like seeds, gametes) at very low temperature is called cryopreservation.
- Gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques.

Biodiversity knows no political boundaries and its conservation is therefore a collective responsibility of all nations.

- ✓ **The historic Convention on Biological Diversity ('The Earth Summit') held in Rio de Janeiro in 1992,** called upon all nations to take appropriate measures **for conservation of biodiversity and sustainable utilisation of its benefits**.

- ✓ In a follow-up, the **World Summit on Sustainable Development held in 2002 in Johannesburg, South Africa, 190 countries pledged their commitment to achieve by 2010, a significant reduction in the current rate of biodiversity loss at global, regional and local levels**.

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