HUMAN HEALTH AND DISEASE

INTRODUCTION

- **Health** is a state of complete physical, mental and social well being, and not merely an absence of disease or infirmity (W.H.O - 1948).
- Any change from the normal state that causes discomfort or disability or impairs the health is called **disease.**
- Time interval between the entry of pathogen and appearance of symptoms is called the **incubation period**. During this period, pathogens multiply.
- **Antibiotics** are those substances which are secreted by micro-organism that inhibit the growth or destroy the other micro-organism. This term was given by **Walksman** (streptomycin-first bacterial antibiotic obtained from bacteria-Streptomycin griseus).

E.g., Bacteriostatic - tetracycline, chloramphenicol,
Bacteriolytic or Bactericidal-streptomycin, ciprofloxacin, ampicillin.

- **Antiseptics and disinfectants** are agents that inhibit or kill microbes on contact. Conventionally, agents used on living surfaces are called antiseptics while those used for inanimate objects are called disinfectants.

In disinfection, it kills only vegetative forms of bacteria.

- Sterilization is the process that kills all forms of pathogens, including spores.
- The disease agent is a factor (substance or force) which causes a disease by its excess or deficiency or absence.
- Types of disease agents are biological, nutrient, chemical, physical, mechanical etc.
- **Biological agents - I**t includes viruses, rickettsias, bacteria, fungi, protozoans, helminthes and arthopods.
  - The biological agents are called **pathogens** (Gr. Pathos = disease; genes = producing).
  - Pathogens produce diseases in two ways : tissue damage and toxin secretion.
  - **Tissue damage :** The bacteria responsible for tuberculosis, damage cells and cause lesions in the lungs. Blood oozes from the lesions into the air sacs, leading to haemorrhages. The bacteria that cause meningitis attack the protective membranes covering the brain. The virus of rabies destroys brain tissue. The polio virus damages motor nerve cells in the spinal cord.
  - **Toxin secretion :** Many microbes produce powerful poisons, called **toxins**, which cause diseases.
  - Toxins are of 2 types : endotoxin and exotoxin.
  - **Exotoxins** are released as soon as produced. The diseases brought about by exotoxins include tetanus, scarlet fever, diphtheria, and botulism (food poisoning).
  - **Endotoxins** are retained in the bacterial cells and released when bacteria die and disintegrate. The diseases caused by endotoxins include typhoid fever, cholera, bubonic plague and dysentery.
- **Nutrient agents**

These comprise food components such as carbohydrates, fats, proteins, minerals, vitamins and water.

- **Chemical agents**
  - These are further of two types - endogenous and exogenous.
  - **Endogenous chemical agents** are formed in the body itself and include hormones, enzymes, urea and uric acid.
  - **Exogenous chemical agents** enter the body from outside by inhalation, ingestion or inoculation. Pollutants (fumes, gases, dusts, metals) and allergens (spores, pollen) are examples.
- **Physical agents**

These include heat, cold, humidity, pressure, radiation, electricity and sound.

- **Mechanical agents**

These comprise chronic friction or other mechanical forces which result in injury, sprain, dislocation, fracture.

- **Deficiency and excess of substances :** e.g., hormones, enzymes.
- Some diseases are caused by genetic disorders and lack or underdevelopment of organs. The agents for certain diseases such as peptic ulcers, coronary heart diseases and hypertension, are not fully known.

Table : Medical Terms

1.	Arthro	Joint (Arthritis)
2.	Aesthesia	Sensation (Anaesthesia means lack of sensation)
3.	Brachy	Short (Brachydactylia)
4.	Brady	Slow (Bradycardia)
5.	Coronary or Cardia	Heart
6.	Dropsy	Due to *Argemone maxicana*'s seeds. These seeds mix with mustard oil and produce poisoning.
7.	Encephalon	Brain
8.	Enteron	Intestine
9.	.....emia	Blood (Anemia, protenemia, hyperglycemia)
10.	Gastric	Stomach
11.	Hepatic	Liver
12.	..... itis	Infection or inflammation
13.	Myo	Muscles
14.	Metastasis	Cancer cells or tissue spread from one part to another part of body.
15.	Nephric /Renal	Kidney

16.	Pulmonary	Lungs
17.	Patho	Disease
	Pathology	Study of disease
	Pathogen	Disease agent
18.	..... .penia	Decrease (Neutropenia, Leucopenia)
19.	.... philia	Increase (Neutrophilia,
	or cytosis	Lymphocytosis)
20.	Phobia	Acrophobia, Hydrophobia, Agoraphobia
21.	Plegia	Paralysis (Hemiplegia, Paraplegia)
22.	Phrenic	Diaphargm
23.	Rhine	Nose
24.	Tachy	Fast (Tachycardia-fast heart rate)
25.	....uria -	Urine (Haematuria)

SCIENTISTS

- **Father of Medicine** : Hippocrates. He gave a scientific explanation of disease for the first time.
- **Father of Surgery:** Susruta. He used non-poisonous leeches as an anticoagulant during surgery.
- **Father of Ayurveda** : Charaka (Ayu → Life, Veda → Knowledge). He first gave concept of digestive, metabolism and immunity.
- **Father of Modern Pathology** : Rudolf Virchow.
- **Father of Immunity :** Edward Jenner (Smallpox vaccine).
- **Father of Blood grouping :** C. Landsteiner.
- **Father of Modern Bacteriology** : Robert Koch (Anthrax, T.B., Cholera)
- Nobel Prize for odorant receptor (olfaction) is given to Richard Axel and Linda B.Buck.

TYPES OF DISEASES

- The diseases may be broadly classified into two types : **congenital** and **acquired.**
- **Congenital Diseases** are anatomical or physiological abnormalities present from birth. They may be caused by –
  - A single gene mutation (alkaptonuria, phenylketonuria, albinism, sickle-cell anaemia, haemophilia, colour blindness).
  - Chromosomal aberrations (Down's syndrome, Klinefelter's syndrome, Turner's syndrome) or
  - Environmental factors (cleft palate, harelip).
- Unlike the gene and chromosome-induced congenital defects, environmentally caused abnormalities are not transmitted to the children.
- **Acquired Diseases** develop after birth. They are further of two types **: communicable** and **non-communicable.**

COMMUNICABLE DISEASES

- The diseases which are caused by pathogens (viruses and living organisms) and readily spread from the infected to the healthy persons are called **communicable or infectious diseases.**

- A German physician, **Robert Koch**, listed the following four conditions to establish that a specific pathogen causes a particular disease –
  - The suspected pathogen should be invariably present in the animals suffering from the disease and should not be found in healthy individuals.
  - The pathogens isolated from the diseased animal should be grown in a pure culture.
  - When this culture is inoculated into a healthy host, the latter should develop the disease and show its characteristic symptoms.
  - The pathogen should be recoverable from the experimental host, and it should be the same as the original one.

TRANSMISSION OF DISEASES (PATHOGENS)

- The diseases (pathogens) are transmitted from the reservoirs of infection to the healthy persons in the following ways : direct and indirect transmission.
- **Direct transmission :** The pathogens of some diseases reach the human body directly without intermediate agents. This can occur as under :
  - **Contact with Infected Persons :** Certain diseases produce sores or lesions on the skin. Contact with materials discharged from these sores or lesions brings about infection. Ringworm, athlete's foot, barber's itch, chickenpox, smallpox, syphilis and gonorrhoea are spread by direct contact. Kissing also spreads infection. The diseases that are transmitted by direct contact are called contagious diseases.
  - **Droplet Infection :** Some diseases are caught by merely being in a confined place (room, theatre, bus) with an infected person. The latter throws out tiny droplets of mucus by coughing, sneezing, spitting or even talking. These droplets may contain pathogens (viruses, bacteria) dislodged from nasal membrane, throat, and lungs. Many of these droplets are inhaled. Diphtheria, scarlet fever, influenza, common cold, measles, mumps, tuberculosis, pneumonia, and whooping cough are spread by droplets.
  - **Contact with Soil :** The bacteria responsible for tetanus and blood poisoning enter the human body from the soil through injuries. Hence, skin injuries should not be neglected.
  - **Animal Bites :** Virus of rabies, or hydrophobia, is introduced through the wound caused by the bites of rabid animals, most commonly dogs.
  - **Through Placenta :** In the later part of pregnancy, due to age or injury, the placenta becomes permeable to certain pathogens such as virus of german measles and bacteria of syphilis. The pathogens then pass from the maternal blood into the foetal blood.
- **Indirect Transmission :** The pathogens of certain diseases reach the human body through some intermediate agents. These agents are -
  - **Vectors** : Insects transmit diseases in two different ways -

Housefly carries the causative organisms of cholera, typhoid, dysentery and tuberculosis on the legs and mouth parts from faeces and sputum to food and drinks. The latter, if taken, cause infection. It also carries the microbes responsible for ophthalmia and conjunctivitis from eye to eye. Ants, cockroaches and house crickets also carry disease germs to articles of food.
Certain blood-sucking insects carry disease-causing organisms in their body and transmit them with bites. Human body-louse spreads typhus, rat flea transmits bubonic plague, tsetse fly spreads African sleeping sickness, sandfly transmits kala-azar and oriental sore, Aedes mosquito spreads yellow fever, Culex mosquito transmits filariasis, and Anopheles mosquito spreads malaria, ticks spread rocky mountain spotted fever.

  - **Vehicle-borne Method** : The causative organisms of dysentery, cholera and typhoid enter the human digestive tract with food and water. Most of the helminthes which produce diseases in man also get into the body in a similar way. Some diseases are transmitted through blood, e.g., AIDS.
  - **Air-borne Method** : The pathogens may reach the humans with air and dust. The epidemic typhus spreads by inhalation of dried faeces of infected lice.

CLASSIFICATION OF COMMUNICABLE DISEASE

Depending upon the type of causative agent, communicable diseases are the following types - bacterial, viral, rickettsial, spirochaetal, protozoan, fungal and helminthes etc.

BACTERIAL DISEASES

Types of bacterial diseases are cholera, pneumonia, typhoid etc.

Table : Bacterial Diseases in Human

S. No.	Disease	Pathogen	Habitat	Main Symptoms	Mode of Infection	I. P.
1.	Cholera (Haiza)	Comma shaped -*Vibrio comma (V.cholerae)*	Intestine and parts of digestive tracts	Severe diarrhoea and vomiting	Contaminated food and water	2 to 3 days
2.	Pneumonia	*Diplococcus or Streptococcus pneumoniae*	Lungs	Sudden chill, chest pain, difficulty in breathing	Patient's sputum	1 to 3 days
3.	Typhoid	Rod like motile *Salmonella typhi*	Intestine	Constant fever	Contaminated food and water either directly or through flies.	1 to 3 weeks
4.	Tetanus (Lockjaw)	*Clostridium tetani*	Tissues	Painful muscular spasms and paralysis	Through wounds and burns or by use of improperly sterilized surgical instruments.	4 days to 3 weeks
5.	Diphtheria	*Corynebacterium diphtheriae* (gram + ve)	Mucous membrane of nose, throat & tonsils	Sore throat, difficulty in breathing	Oral & nasal discharges	2 to 5 days
6.	Whooping cough (pertussis)	*Bordetella pertussis* or *Haemophilus pertussis*	Respiratory tract	Severe coughing, characteristic gasping 'whoop'	Throat discharges and contact	10 to 16 days
7.	Tuberculosis	*Mycobacterium tuberculosis* (rod shaped). The bacteria damage tissue and releases a toxin named **tuberculin** which produces the diseases.	Lungs	Cough, bloody sputum, chest pain, loss of weight	Patient's sputum	Variable
8.	Plague (Also called **black death)**	*Pasteurella pestis*	Blood and lymph	Painful pubo of lymph nodes	Rat-flea (*Xenopsylla cheopsis*) bite on lower extremities. Head louse *(Pediculus* and bedbug *(Cimex)* may also transmit the germ from man to man.	2 to 6 days

9.	Leprosy (Discovered by Hansen)	*Mycobacterium leprae*	Skin, mucous membranes, peripheral nerves	Hypopigmented skin patches, ulcers, deformity of digits	Long and close contact with patients	2 to 5 years
10.	Syphilis	*Treponema pallidium*	Oral, genital, rectal mucosa	Lesions, ulcers on genitalia	Contact	3 to 5 weeks
11.	Gonorrhoea	*Neisseria gonorrhoeae*	Urinogenital mucosa	Burning sensation in micturition	Sexual contact	2 to 5 days
12.	Diarrhoeal diseases	*Shigella dysenteriae, Salmonella, Escherichia coli, Campylobacter*	Intestine	Food poisoning, abdominal cramps, diarrhoea.	Contaminated food, water, hands, fomite	

VIRAL DISEASES

Viral diseases are transmitted by contact fomite and droplet method. Types of viral disease are-influenza, small pox, etc.

Table : Viral Diseases in Humans

S. No.	Disease	Pathogen	Habitat	Main Symptoms	Mode of Infection	I. P.
1.	Influenza (Flu)	*Myxovirus Influenzae*	Mucous membrane of respiratory tract	Nasal discharge, sneezing, coughing, fever, body ache	By droplets from nose & throat	24 to 72 hours
2.	Smallpox (highly contagious disease)	*Variola virus*		Skin rash changing to pustules, then to scabs	By contact, droplets and fomite	12 days
3.	Chicken pox	*Varicella zoster* (DNA virus)		Skin sores that open & emit fluid	By contact	2 to 5 weeks
4.	Measles	*Rubeola virus*		Fever, inflammation of nasal mucous membrane, loss of appetite. Red watery eyes, skin rash	By droplets from nose & throat	10-14 days

S. No.	Disease	Pathogen	Habitat	Main Symptoms	Mode of Infection	I. P.
5.	Rabies (Hydrophobia)	*Rabies virus*	Brain & spinal cord cells	Biting behaviour, fear of water, inability to swallow. Severe headache.	Biting or saliva of rabid dog, monkey, cat etc.	1 to 3 months
6.	Mumps (Infectious parotitis)	*Paramyxo virus*	Salivary glands	Painful enlargement of parotid glands, difficulty in opening mouth	By contact and droplets from throat	12 to 26 days
7.	Poliomyelitis (polio) (Highly infectious disease of infants and childrens)	*Polio virus*	Nerve cells	Inflammation of nervous system, muscle shrinkage, limb paralysis	By contaminated food & water	7 to 14 days
8.	Trachoma	*Chlamydia trachomatis*	Eyelids, conjunctiva & cornea of eye	Granules on inner surface of eyelids, watery eyes	By contact	5 to 12 days
9.	Dengue	*Arbo virus (RNA)*		Mild conjunctivitis, high fever, backache, nausea, vomiting etc.	Biting of female mosquito. *Aedes aegypti*	4-10 days
10.	Yellow fever	*Arbo* virus		Headache, vomiting, fever, rupture of veins in kidney, spleen, liver etc.	Infected *Aedes aegypti*	3-6 days
11.	Hepatitis (Epidemic jaundice)	Infectious & serum hepatitis viruses (A, B, C, D & E)	Liver	Jaundice due to damaged liver cells	By contaminated food and water	20 to 35 days
	– Hepatitis A (also called catarrhal jaundice)	A virus	Liver	Hepatic anorexia resulting in liver damage	Faecal oral route	2-4 Weeks
	– Hepatitis B	B virus	Liver	Swelling of liver cells	Infected blood, tattoos, contact	2-6 Months
	– Hepatitis C	C-virus	Liver	It may have no symptoms, but can experience abdominal pain depression or weight loss, etc	Contact with infected blood	1-6 Months
	– Hepatitis D	Infection of D-virus and B-virus	Liver	Same as those of hepatitis B	Contact with infected blood	2-5 Months
	– Hepatitis E		Liver	Similar to those of hepatitis A	Faecal contaminated water and food	5-6 weeks

PROTOZOAN DISEASE

These are caused by protists. They include malaria, amoebiasis, giardiasis, kala azar, Ciliary dysentery, trypanosomiasis etc.

(a) Malaria

- **Laveran** (1880) discovered malarial parasite in blood of malaria patient.
- **Pfeiffer** (1892) proposed that malaria is spread by blood sucking insect.
- Discovery of Plasmodium and its transmission by Anopheles (female) was confirmed by Ronald Ross (1897).
- Malaria is caused by the toxins produced in the human body by the malarial parasites, Plasmodium.
- The malarial parasites are carried from the infected to the healthy persons by the female Anopheles mosquito. The mosquito picks up the parasites with the blood, when it bites an infected person. When this infected mosquito bites a healthy person, parasites migrate into his blood with the saliva, which the mosquito injects before sucking up blood to prevent its clotting.

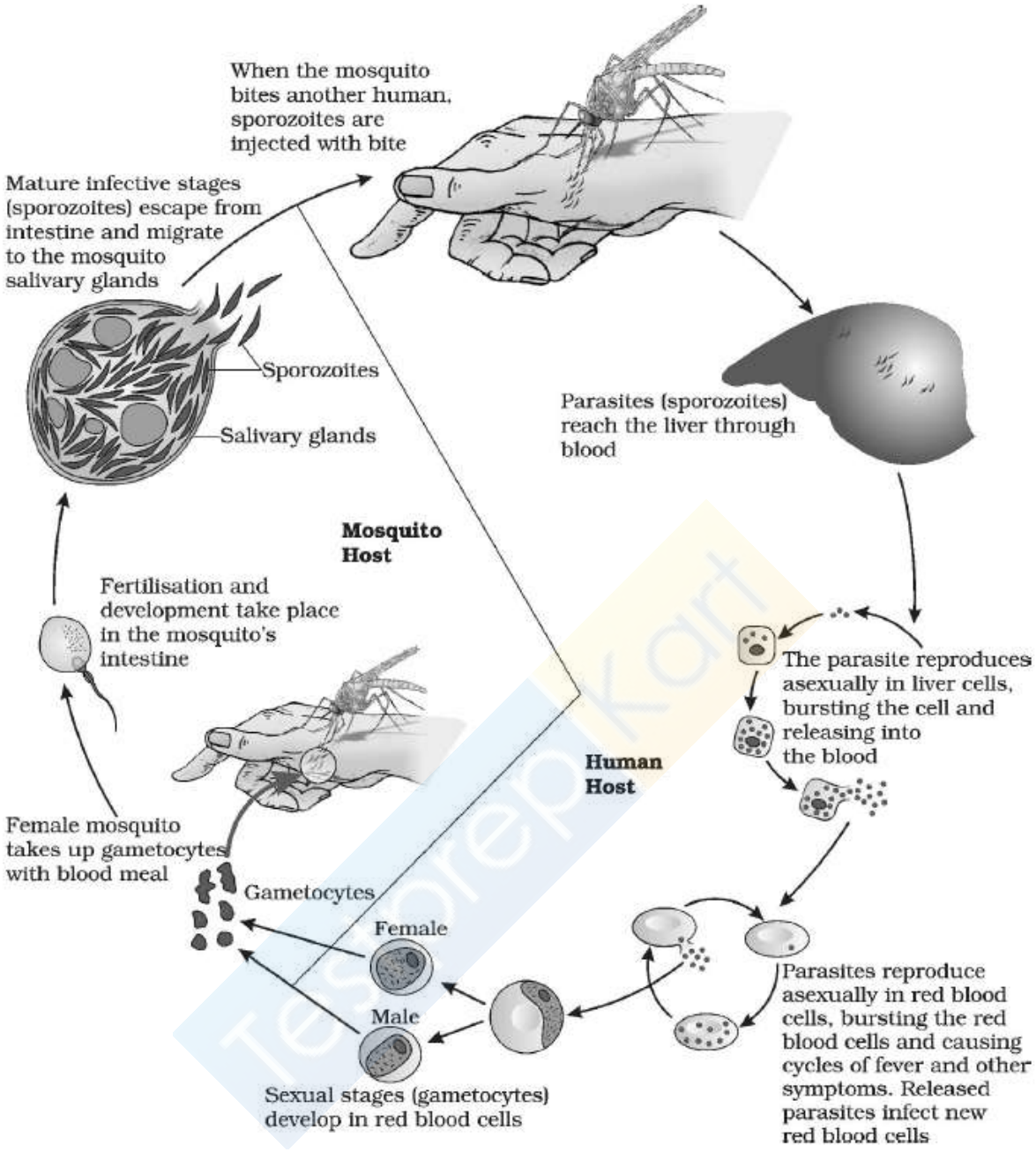


Fig. : Stages in the life cycle of Plasmodium

- There are **four species of Plasmodium**, which cause different kinds of human malaria
  - **P. vivax :** It causes **benign tertian malaria**, which attacks every third day, i.e., after 48 hours. The fever is mild and seldom fatal. This species is wide-spread in the tropical and temperate regions.
  - **P. ovale** : It also causes benign tertian malaria, which recurs every 48 hours. This species is found only in West Africa and South America.
  - **P. malariae :** It causes **quartan malaria,** which recurs every fourth day, i.e., after 72 hours. This species is found in both tropical and temperate regions, but it is not very common.
  - **P. falciparum :** It alone is capable of causing three types of malaria, viz., quartan malaria, which attacks almost daily, malignant tertian malaria, which occurs every 48 hours, but is very severe and often fatal; and irregular malaria. This species is found only in the tropical region.
- Malaria result in anaemia, toxaemia and splenomegaly (enlarged spleen).

- **Antimalarial drugs** are quinine, chloroquine etc. Dalaprim drug kills the parasitic stages present in both liver cells and RBC's of blood.

(b) Amoebiasis

- It is caused by intestinal endoparasitic protozoan Entamoeba histolytica of man.
- Infection is transmitted by contamination.
- It is characterized by abdominal pain alternating diarrhoea and constipation etc.
- Entamoeba secretes **cytolysin** that erodes the mucous membrane of the intestine.

(c) Giardiasis

- Also called backpeper's disease, it is caused by Giardia intestinalis.
- It inhabits upper part of small intestine (duodenum and jejunum)
- Infection is transmitted by contamination of cysts with food and drinks.
- It is characterized by mild diarrhoea.

(d) Kala azar

- Kala azar or leishmaniasis is caused by Leishmania donovani and spread by sandfly (Phlebotomus)
- It is characterized by fever and enlargement of visceral organs.
- It is also known as **dum-dum fever**.
- Leishmania braziliensis causes espundia and **oriental sore** is caused by L.tropica.

(e) Ciliary dysentery (Balantidiasis)

- It is caused by Balantidium coli. It inhabits the human large intestine (colon).
- Infection occurs by ingesting cysts with food and drinks.
- Balantidium coli causes ulcers in the colon and invades mucous membrane by secreting an enzyme hyalurodinase. Thus, generally results in diarrhoea.
- Tetracycline or lodoquinol are effective treatment.

(f) Trypanosomiasis

- It is caused by different species of Trypanosoma.
- It is characterized by high fever, swelling of the neck and armpit, weakness, anaemia, lethargy, unconsciousness etc.
- T. gambiense causes Gambian fever of West African sleeping sickness, which is spread by both sexes of tse-tse fly (Glossina palpalis).
- Rhodesian or East African sleeping sickness, caused by **T. rhodesiense** is spread by G. morsitans.

Chagas disease or **South American sleeping sickness** is caused by T. cruzi and spread by Panstrongilus sp. It is more common in children and young adults.

Table : Sexually Transmitted Diseases (STD) in Human

Sr. No.	Disease	Causative organism	Nature of Disease	Symptoms-Treatment
1.	**AIDS**	*Retrovirus* – HIV	Viral	Enlarged lymph nodes, long fever, weight loss – Nil
2.	**Genital Herpes**	*Herpes simplex virus*	Viral	Painful ulcer on genitals – Nil
3.	**Genital warts**	*Human papilloma virus* (HPVs)	Viral	Tumor of the vulva, vagina, anus and penis – Nil
4.	**Gonorrhoea**	*Neisseria gonorrheae*	Bacterial	Infection of all genital organs or PID – Penicillin
5.	**Chlamydiasis**	*Chlamydia trachomatis*	Bacterial	White patches on vagina or PID – Nystatin
6.	**Syphilis**	*Treponema pallidum*	Bacterial	Cancer and skin eruption – Benzene and Penicillin
7.	**Trichomoniasis**	*Trichomonas vaginalis*	Protozoan	Greenish-yellow vaginal discharge–Metronidazole.
8.	**Chancroid**	*Haemophilus ducreyi*	Bacterial	Foul discharge and ulcer, Drug : Sulphonamide
9.	**Lymphogranuloma venerum**	*Lymphogranuloma psittacosis bacteria*	Bacterial	Inguinal lymphadenopathy, Drug : Tetracycline

HELMINTHIC DISEASES

Helminthes are multicellular parasites and includes roundworms and flatworms. Helminthes causes various diseases in man like, filariasis, taeniasis, ascariasis, enterobiasis etc.

(a) Filariasis

- It is caused by Wucheria bancrofti. It is also known as **elephantiasis** due to excessive enlargement of body parts like leg.

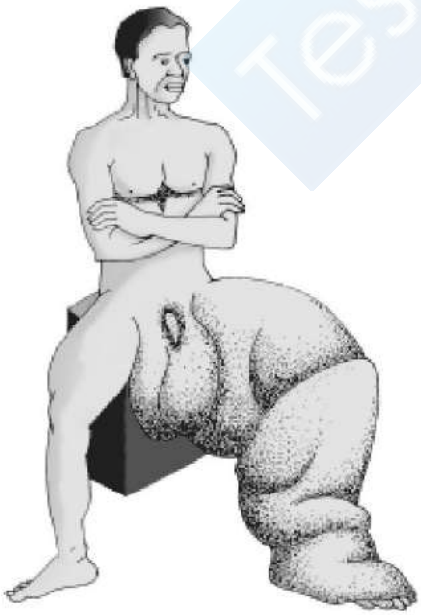


Fig. : Diagram showing inflamation in one of the lower limbs due to elephantiasis

- Symptoms include fever, proliferation of endothelial cells and deposition of metabolites in the wall of lymph vessels.
- It is transmitted by Culex or Aedes mosquitoes.

(b) Taeniasis

- It is caused by intestinal endoparasite, Taenia solium.
- It is characterized by abdominal pain, indigestion, loss of appetite, nausea etc.
- Cysticercosis larva of Taenia causes cysticercosis which causes damage to different body parts, blindness etc.

(c) Ascariasis

- It is caused by Ascaris lumbricoides.
- Vectors for this disease are flies and cockroaches.
- It is characterized by colic pain, indigestion, diarrhoea, vomiting, weakness etc.
- Scratch test, dermal test and stool test can be done to detect the roundworm infection.

(d) Enterobiasis (oxyuris)

- It is caused by Enteriobius vermicularis (pin or seat worm).
- Its transmission is direct by contaminated food.
- It causes anal itching, appendicitis, nervous problem.

(e) Ancylostomiasis

- It is caused by Ancylostoma duodenale.
- It is transmitted by infected larva via contaminated food and vegetables.
- Symptoms include chronic blood loss, depletion of body's iron stores leading to anaemia, inflammation of skin etc.

(f) Schistosomiasis (Bilharzia)

- It is caused by Schistosoma haematobium.
- It is transmitted by snail.
- It is found in urinary bladder, blood vessels and causes itching, rashes, aches, fever etc.

FUNGAL DISEASES

These are caused by fungi, the non green heterotrophic organisms. They include ringworm and athlete's foot.

(a) Ringworm

- Ringworm is caused by different genera of fungi - Microsporum, Trichophyton and Epidermophyton.
- It is an infection of skin, hair and nails.
- Its symptoms includes red scaly patch or bump.
- Ringworm is contagious and is easily spread from one person to another, so avoid touching an infected area on another person.

(b) Athletes foot

- It is caused by a fungus called Tinea pedis.
- It is a very common skin condition that affect the sole of the foot and the skin between the toes.
- Common symptoms include various degrees of itching and burning.

NON COMMUNICABLE (NON-INFECTIOUS) DISEASES

- These diseases remain confined to the person who develops them and do not spread to others.
- The main non-communicable diseases are **diabetes, inflammatory diseases of joints** such as arthritis, gout, cardiovascular diseases and cancer.

(a) Diabetes Mellitus

- Diabetes is characterized by chronic hyperglycemia which is excessive concentration of glucose in the blood.
- Diabetes is primarily a result of relative or complete lack of insulin secretion by the β cells of islets of Langerhans in pancreas.
- Diabetes is established by blood and urine sugar levels.

(b) Arthritis

- Arthritis is any inflammatory condition of the joints characterized by pain and swelling.
- Types of arthritis are : rheumatoid arthritis, osteoarthritis and gout.
- There is no cure for arthritis, drugs are available which relieve pain.
- **Rheumatoid arthritis**
  - It is characterized by inflammation of the synovial membrane.
  - A kind of rheumatoid arthritis that occurs in younger **people** is **Still's disease.**
  - It usually starts in the small joints in the hand and progress to other body joints.
- **Osteoarthritis**
  - It is a common disease among the elderly persons resulting from erosion of articular cartilage.
  - In osteoarthritis, the secretion of lubricating synovial fluid between the bones at the joint stops. The joints become inflammed, its movement becomes painful and its function is diminished.
  - It is common in old person, mainly affecting weight bearing joints.
- **Gout**
  - Gout results from accumulation of uric acid crystals in the synovial joints.
  - Gout is a disease associated with an inborn error of uric acid metabolism that increases production or interferes with excretion of uric acid.

- It is very painful, particularly at night and make movement difficult. Gout generally affects the great toe.

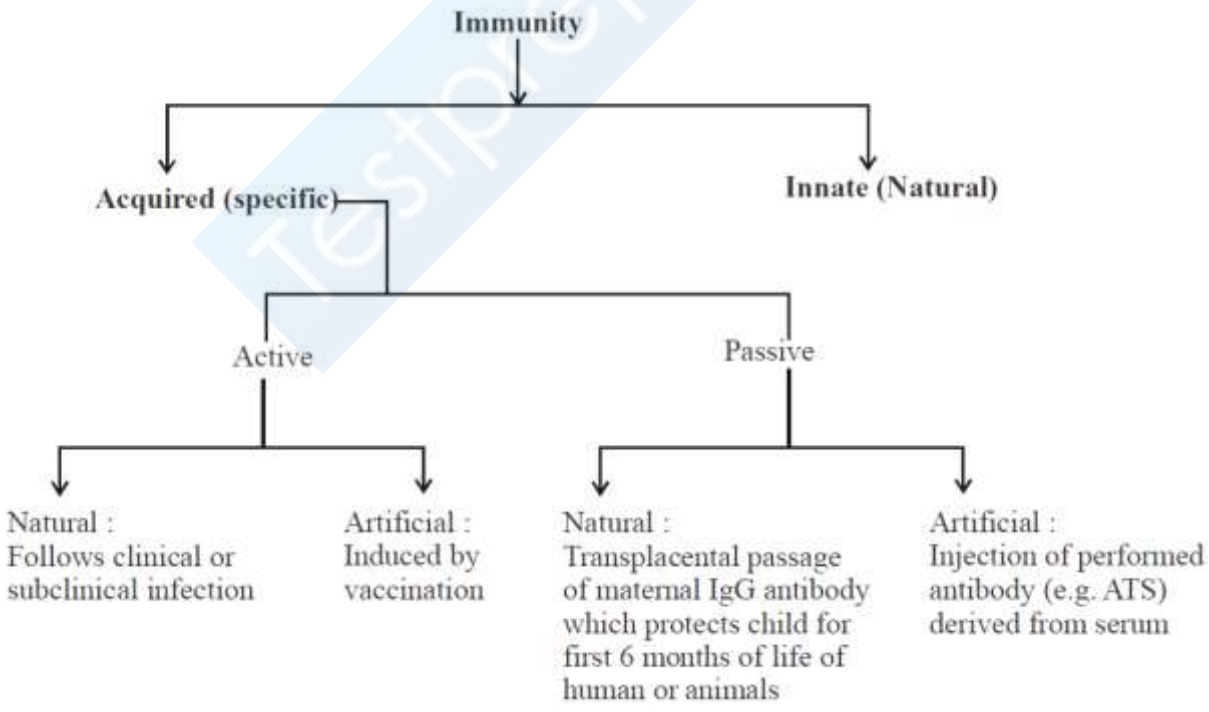
CARDIOVASCULAR DISEASES

- Cardiovascular diseases refer to a number of diseases associated with the blood vascular system.
- Some major cardiovascular diseases are **rheumatic heart disease, hypertensive heart disease and coronary heart disease.**
- **Rheumatic heart disease**
  - Rheumatic heart disease is an autoimmune disease, most common in children after a severe throat infection by certain strain of Streptococcus bacteria.
  - An antigen on the surface of these bacteria is very similar to an antigen on the surface of myocardium.
  - The antibodies against Streptococcus may react with myocardium and cause heart difficulties.
- **Hypertensive heart disease**
  - Hypertensive heart disease are caused by hypertension, i.e., increased blood pressure.
  - Serious hypertension is a common cause of chronic heart failure particularly in older people.
- **Coronary heart diseases**
  - Coronary heart diseases are characterized by impaired heart function due to inadequate blood flow to the heart. **Angina pectoris** is the chest pain caused most often by myocardial anoxia.
  - Attacks of angina pectoris are often related to exertion, emotional disturbance and exposure to excess cold.
  - Myocardial infarction is commonly called coronary or heart attack.
  - Coronary heart disease may be due to raised serum cholesterol, cigarette smoking, high blood pressure, physical inactivity, obesity and diabetes.
  - **Cyanosis** refers to a bluish coloration of the skin and mucous membranes due to too much deoxygenated haemoglobin in the blood.
- **Stroke**
  - It is the most common degenerative disease in man.
  - It is a brain damage due to stoppage of blood supply resulting from cerebral thrombosis, cerebral haemorrhage etc.
  - It is characterized by degeneration of motor nerves of brain due to reduced supply of oxygen resulting in paralytic attack of some body parts especially limb, loss of memory, speech and even death.

IMMUNE SYSTEM

- System which protects the body from diseases is called **immune system.**
- The immune system consisting of several organs as well as WBC in blood and lymph has the job of fighting off invading pathogens and preventing growth and spread of cancers.
- Lymphoid organs are those organs where origin and maturation and proliferation of lymphocyte occurs.
- The **primary lymphoid organs** are **bone marrow** and **thymus**.
- Bone marrow manufactures billions of WBC needed by the body everyday. Some newly produced WBC remain in the bone marrow to mature and specialize while others travel to the thymus to mature.
- **Secondary lymphoid organs** includes lymph node, adenoids tonsils, spleen, peyer's patches (within intestine) and the appendix.

- **Lymph** nodes filter pathogens from the lymph and exposes them to WBC.
- **Spleen** filters pathogens from blood. It is stocked with WBC that respond to the trapped pathogen.
- Lymphoid tissue located within the lining of the major tracts (respiratory, digestive and urogenital tracts) is called **mucosal associated lymphoid tissue (MALT)**. It constitutes about 50% of the lymphoid tissue in human body.
- Immunology is the science of development of immunity against particular pathogen.
- The foundations of science of immunology were discovered by workers-Edward Jenner (1796), Louis Pasteur (1879) and Von Behring (1841).
- **Some terms related to immune system are –**
  - **Immunity:** Resistance of the body against a pathogen or disease.
  - **Antigen or Agglutinogen :** Proteinous substance which stimulates the production of antibodies.
  - **Antibody :** It is a complex glycoprotein secreted by B-lymphocytes in response to an antigen. It is also called agglutinin.
  - **Antiserum:** Serum of any animal which contains the antibody for a specific antigen.
  - **Venom (poison)** : Toxic substances secreted by snake and some insect.
  - **Toxoid:** A bacterial exotoxin which is detoxicated by special procedures to allow its safe use in immunization against the disease.
- Immunity was defined by Sir Mac Farlane Burnet.
- Immunity developed in 3 ways-by vaccination, antitoxin and through disease.
- Immunity are of two types-
  - **Congenital immunity or innate immunity or Non-specific immunity**.
  - **Acquired immunity or Adaptive or specific immunity**



INNATE OR NON SPECIFIC IMMUNITY

- **Innate immunity,** present from birth, are specific (acts on many organism) and does not become more efficient on subsequent exposure to the same organism.

- The non-specific defence mechanisms is further of two types-**external defence** (first line of defence) and **internal defence** (second line of defence)
- **First line of defence** comprise **physical** and **chemical barriers** to the entry of pathogens into the blood.
- Physical barrier includes skin and mucous membrane and **chemical** barriers includes **chemicals** secreted by **skin** and **mucous membrane** like skin secretion and bacteria, nasal secretion, cerumen (ear wax), saliva, tear, vaginal bacteria.
- Acid in stomach, saliva in mouth, tears from eyes, all prevent microbial growth.
- **Second line of defence/internal defence** is carried out by WBC, macrophages, inflammatory reactions, fever, interferons and complement system.
- Inflammatory response is a reaction that causes redness, heat, swelling and pain in the area of infection.
- Body temperature rise causes fever, fever is caused by the release of chemical called **pyrogen** from damaged tissues.
- **Interferons** (discovered by Issacs and Lindermann) are produced against viral infection.
- **The complement system** plays an important role in host defence against infectious agents and in the inflammatory response.

ACQUIRED IMMUNITY

- It is the resistance that an individual acquires during life. This is generated in response to an exposure to the microorganism in question.
- This type of immunity is found only in vertebrates.
- It is also called **adaptive or specific immunity.**
- This immunity is acquired after birth by experience.
- This immunity recognise and selectively eliminate the pathogen.

FEATURES OF ACQUIRED IMMUNITY

- **Specificity** : Acquired immunity is specific for specific microorganisms.
- **Diversity:** This system recognises the vast variety of microorganisms.
- **Discrimination between self and non-self :** It can recognise self (body or tissue) and non-self (foreign tissue) and respond according to them.
- **Memory:** When a pathogen enter inside the body, body takes longer time to recognise and respond to it. This is called **primary immune response** but the memory of this encounter remain in immune system.

When this pathogen enters second time inside the body, the body's immune system rapidly recognises this pathogen and responds quickly to it. This is called **secondary immune response.** This is based on **memory of the immune system**.

TYPES OF ACQUIRED IMMUNITY

- **Active acquired immunity :** Resistance developed by an individual as a result of an antigenic stimulus.

Natural : Results from a clinical or inapparent infection by a microorganism.
Artificial : Resistances induced by vaccine.

Vaccines are prepared by live or killed microorganisms or their products and is used for immunisation.

- **Passive immunity :** It is received passively by host without participation or contribution from host's immune system. Immunological memory is absent here and the readymade antibodies are given in immunosuppressive individual.

Natural : Resistance passively transferred from mother to baby. Mother milk gives passive immunity to the newborn child by colostrum (first mother milk).
Artificial: Resistance passively transferred to a recipient by administration of antibodies.

E.g. : Human immunological administration.

Anti - Tetanus serum (ATS)

Anti - rabies serum (ARS)

Anti - diptheria serum (ADS)

Table : Difference between Active and Passive immunity

S.No.	Active immunity	Passive immunity
1.	Produced actively by the immune system of host.	Received passively by the host and the host's immune system does not participate.
2.	Induced by infection or by contacts with immunogen, e.g. vaccines.	Conferred by introduction of ready-made antibodies.
3.	Immune response is durable and effective	Immune response is short lived and less effective.
4.	Immunity develops only after a lag period.	Immunity is effective immediately.
5.	Immunological memory present. Subsequent challenge with booster dose more effective.	No immunological memory. Subsequent administration of antibody is less effective due to immune elimination.
6.	Serves no purpose in immunodeficient host.	Applicable in immunodeficient host.
7.	Used for prophylaxis to increase body resistance.	Used for treatment of acute infection.

TYPES OF ACTIVE IMMUNE SYSTEM

CELL MEDIATED IMMUNE SYSTEM (CMIS) OR CELLULAR IMMUNITY

This immune system is based on T-cells (60-70%) with antigen specific receptors on their surfaces.

Table : Cells of Immune System

S.No.	Cell Type	Function
1.	Helper T Cell	Assists the immune process by helping other cells in the immune system to achieve an efficient immune response.
2.	Cytotoxic T Cell	Detects and kills infected body cells recruited by helper T cells.
3.	Suppressor T Cell	Guards against the overproduction of antibodies and overactivity of cytotoxic T cells.
4.	Memory cell	"Remembers" the original stimulation by the immune system and remains in the lymphoid tissue.
5.	Natural killer cell (NK)	The lymphocyte without receptor site; helps to attack and neutralize virus-infected and tumor cells.
6.	B Cell	Precursor of plasma cell, specialized to recognize a specific foreign antigen.
7.	Plasma cell	Biochemical factory devoted to the production of antibodies directed against a specific antigen.
8.	Mast cell	Initiator of the inflammatory response which aids the arrival of leucocytes at a site of infection, secretes histamine and is important in allergic response.
9.	Monocyte	Precursor of macrophage.
10.	Macrophage	The body's first cellular line of defence; also serves as antigen presenting cell to B and T-cells and engulfs antibody covered cells.

ANTIBODY MEDIATED IMMUNE SYSTEM (A.M.I.S.) OR HUMORAL IMMUNITY

- **Antibody or immunoglobulin** are complex glycoprotein molecule made up of 4 polypeptide chains-two light and two heavy chains.
- These two chain held together by disulphide bond in shape of Y molecule.

Two tips of this molecule bind with antigen (large and complex foreign molecules mainly proteins that activate the specific immunity) like lock and key fashion and make **antigen-antibody complex**.

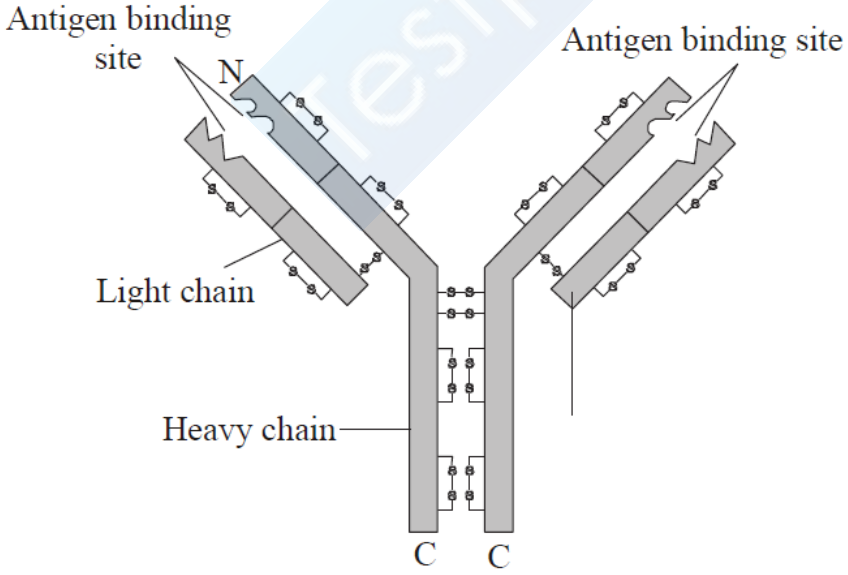


Fig. : Structure of an antibody molecule

- **Precipitation :** Antibodies combine with the antigens to form precipitates that are early ingested by the phagocytes. They are known as precipitins.

- **Complement activation :** Antibody antigen complexes activate complement proteins which may opsonise antigen, lyse cell wall of bacteria causing their disintegration, attract phagocytes to the area of infection.

Table : Type of antibodies

S. No.	Group of Antibodies	Total Quantity (%)	Main Characters and occurrence	Functions
1.	IgA	10	The primary antibodies present in colostrum, M.W 1,70,000, present in saliva, mucus and other secretions.	Protection of mucous membranes and outer surface of body and protection from inhaled ingested pathogens.
2.	IgD	13	Present in trace amount on the surface of lymphocytes in blood. M.W 1,85,000.	Activation of B-lymphocytes and development and maturation of immune reactions.
3.	IgE	0.05	Present in very small quantities, show specific linkage with mast cells and basophils, M.W. 1,88,000.	Stimulation of mast cells. Related to allergic reactions and protection from parasites.
4.	IgG	75-80	Most abundantly found antibodies, main immunoglobulin of blood and interstitial fluid which has capacity to pass through placenta, M.W.1 ,46,000 (lightest).	Stimulate the complementary system, provide immune power to human embryo and specific linkage with phagocytic cells for phagocytosis.
5.	IgM	5-10	Oldest and first antibody generated in response to antigens, present in blood plasma (80%) and interstitial fluids and largest sized immunoglobulin with pentameric form, M.W. 9,60,000 (heaviest).	First line of defence against bacteria, perfection of agglutination, related to complement system.

ALLERGY

- Allergy or hypersensitivity is the excessive immune response to common antigens. These antigens are present on / in certain substances called **allergens** (e.g., dust, pollen, moulds, certain foods, some medicines)
- Allergy **involves mainly IgE antibodies and histamine**
- **Antihistamine** is a medicine that gives relief from allergy.
- **Types of hypersensitive reactions** are -

○ **Type I reaction** (immediate hypersensitivity reactions) involve IgE mediated release of histamine and other mediators from mast cells and basophils.

○ **Type II reactions** (cytotoxic hypersensitive reaction) involve IgG or IgM antibodies bound to cell surface antigens with subsequent complement fixation.

○ **Type III reactions** (immune complex reaction) involve circulating antigen antibody immune complexes that deposit in postcapillary venules with subsequent complement fixation.

○ **Type IV reaction** (delayed hypersensitive reactions or cell mediated immunity) are mediated by T cells rather than by antibody.

VACCINATION AND IMMUNISATION

- **Vaccine** is the suspension of inactivated pathogens or antigenic protein of pathogen which is taken orally or injected to provide immunity for that pathogen.

- Principle of vaccination is based on memory of the immune system. When an antigenic material is injected in a healthy person, it generates antibodies and memory cells as a primary immune response. When this active pathogen enters second time inside this body of vaccinated person, memory cells rapidly recognise and respond with massive production of lymphocytes and antibodies. So it destroys pathogens rapidly and the disease does not appear. Person becomes resistant for that disease after vaccination.
- **Types of vaccines**
  - **First generation vaccines:** These vaccines are prepared by inactivating the whole pathogen but they have side effects, e.g., Oral polio vaccine (OPV), DPT.
  - **Second generation vaccines :** Antigenic polypeptides of pathogens are produced with recombinant DNA technology in transgenic organisms.

These are made by multiplication of surface antigen by genetic engineering. They have no side effects. E.g., Hepatitis B vaccine produced from transgenic yeast.

  - **Third generation vaccine :** These are highly potent, synthetic in nature & prepared by genes. They are also called **DNA vaccine.**
- **Passive immunisation** may be induced by administration of an antibody containing preparation, transfer of maternal antibodies across the placenta and by transfer of lymphocytes to induce passive cellular immunity.
- Passive immunisation may be natural or artificial.
- **Natural passive immunisation** includes the passage of maternal IgG across the mammalian placenta. In humans, IgA is transmitted to the babys' gut via colostrum and milk.
- **Artificial passive immunisation** is affected when immunodeficient patients are given doses of antibodies from a donor.

Table : Some Important Vaccines

S. No.	Name of Vaccine	Category of Vaccine	Used for treatment of
1.	B.C.G.	Live vaccine (actual weakened germs)	Tuberculosis
2.	Cholera vaccine	Killed vaccines (micro-organisms are killed)	Cholera
3.	Mumps vaccine (MMR)	Live vaccine (actual weakened germs)	Mumps, Measles & Rubella
4.	Oral Polio Vaccine (OPV)	Live vaccine	Polio, 1st dose given when child is 3 months old. Booster dose is given after 1 year
5.	Rubella vaccine	Live vaccine	German measles and small pox
6.	Rubeolla vaccine	Live vaccine	Measles
7.	Tetanus toxoid (TT)	Toxoid (bacterial toxin looses toxicity but retains antigenicity)	Tetanus
8.	Toxoid serum	Toxoid (bacterial toxin looses toxicity but retains antigenicity)	Diphtheria
9.	Typhoid vaccine (TAB)	Killed vaccine (micro-organisms are killed)	Typhoid (Typhoid & Paratyphoid)
10.	Triple Antigen (DPT) (Diphtheria, Pertussis Tetanus)	Toxoid	Diphtheria, tetanus and whooping cough, Ist dose given when child is 3 months old. Booster dose at 2 years.

NOTES

- **Edward Jenner** (1796) noticed that milkmaids did not suffer from smallpox but they had scabs of cowpox. He transported the material from the sore of milkmaid who was suffering from cowpox to the young body of 8 year old. After sometime, he injected live smallpox material into that boy. But symptoms of diseases did not appear. He tried this procedure on other person and got success. He gave the term vaccination for this process.
- **Louis Pasteur:** He discovered the process of inactivating the pathogen & prepared vaccines for anthrax, cholera, rabies.
- **Von Behring :** He discovered the process of passive immunization and prepared the antidiphtherial serum by injecting diphtheria antigen into sheep.

Von Behring is known as '**Father of passive immunization**'.

CANCER

- Cancer is an abnormal and uncontrolled division of cells, known as cancer cells, that invade and destroy the surrounding tissues.
- Generally cancer is defined as uncontrolled proliferation of cells without any differentiation.
- Cancer cells are different from normal cells in some aspects. They do not remain confined to one part of the body.
- **Neoplasm** (called **tumor**) is a new abnormal tissue which is capable of continued growth.
- Tumors may be **benign** and **malignant**.
- Benign tumor is a large localized mass of abnormal tissue enclosed in connective tissue which does not invade adjacent tissue.
- **Malignant tumor** is not encapsulated and is capable of invading adjacent tissues and distant sites.
- They penetrate and infiltrate into the adjoining tissues and dislocate their functions. Some of the cancer cells get detached from the main site of origin and travel by blood and lymph to sites distant from the original tumour and form fresh colonies, called metastasis or secondary growth.

SYMPTOMS OF CANCER

- Thickening or lump in the breast or any other part of the body.
- Changes in bowel or bladder habits.
- Indigestion or difficulty in swallowing.
- Unexplained changes in weight.

TYPES OF CANCER

- Types of cancer are **carcinoma, sarcoma, leukemia** and **lymphoma.**
- **Carcinoma** is a cancer of epithelial tissue and their derivatives like mucous membrane, skin, lungs, breast etc.
- **Sarcoma** is a cancer of primitive mesodermal tissue like connective tissue, bone, muscle, lymph nodes etc.
- **Leukemia** is a blood cancer. It involves increased WBC count of blood due to increased formation in the blood marrow resulting in decreased erythropoiesis and RBC count.
- Bone marrow grafting is used for the treatment of leukemia.
- **Lymphomas** affect the lymphatic system.

CAUSES OF CANCER

- **Chemical** or **physical agents** that can cause cancer are known as **carcinogen**.

Depending on their mode of action, carcinogens fall into the following main categories:

- Agents that can cause alterations in the genetic material (DNA), resulting in oncogenic transformation.

- Agents that promote the proliferation of cells, which have already undergone genetic alterations responsible for oncogenic transformation. These agents are called **tumour promoter**, e.g., some growth factors and hormones.
- Cancer causing DNA and RNA viruses (tumour viruses) have been shown to be associated with oncogenic transformation.

- Transformation of a normal cell into a cancer cell, if the regulation is upset.

TREATMENT

- **Surgery :** By removing the entire cancerous tissue and infected lymph nodes.
- **Radiation:** Cobalt therapy (Co-60), X-rays radiations are given. These radiations destroy the rapidly dividing cells.
- **Chemotherapy :** Anti-cancerous drugs (like : Vincristine (weed - Catharanthus roseus = Vinca rosea), Vinblastine (weed - Catharanthus roseus = Vinca rosea), (Cyclophosphamide) inhibit the DNA synthesis in cell cycle of cancerous cell but this has side effects.
- Most of the cancers are treated by combination therapy of surgery, radiation and anti-cancerous drug.

AIDS

- AIDS (Acquired Immuno Deficiency Syndrome) is a chronic life threatening disorder which damages the human body's immune system.
- AIDS is caused by **HIV** (human immuno-deficiency virus) which belongs to retrovirus (group of RNA virus)
- The HIV can only survive in body fluids like blood, semen, vaginal secretion etc.
- HIV is transmitted through body fluids by-
  - Sexual contact (most common mode of transmission) (Probability < 1 %)
  - Blood contact (100%),
  - By mother to child by placenta (33%), by mother milk
- HIV is not transmitted through ordinary contact (hugging, dancing, talking, touching etc.) with someone who has HIV or AIDS; sweat, tears or saliva etc.
- The major cell affected by HIV is the **helper-T-lymphocyte.**
- The HIV virus multiplies and slowly begins to destroy the CD4 lymphocyte (T cells or helper T-cells)
- AIDS was first recognised in **Hatai (**USA) in 1981 among a group of young homosexuals who were addicts of heroin and other narcotics.

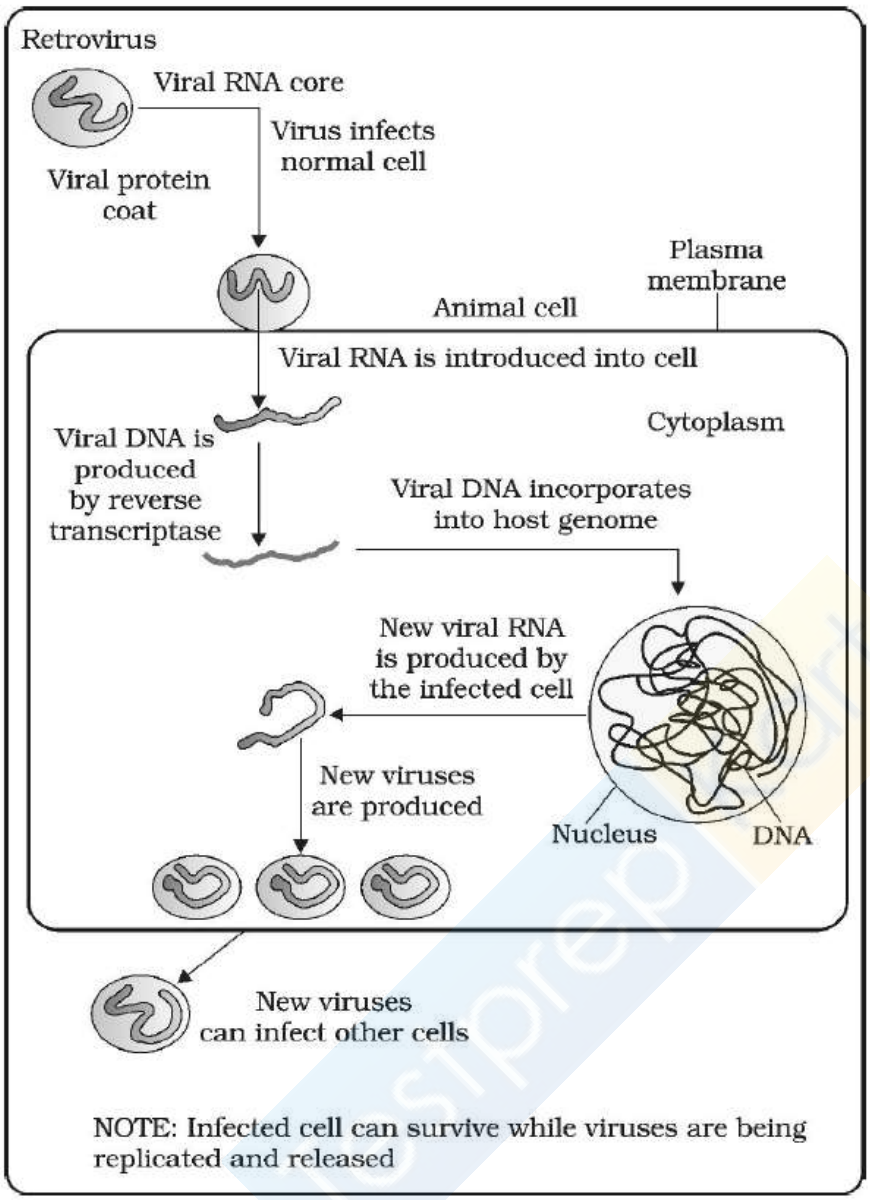


Fig. : Replication of retrovirus

- AIDS includes 3 phases-

○ **Asymptomatic phase -** Initially within 2-12 weeks, there is no antibody production so infectivity of patients or activeness of virus is maximum in this period. This period is called the **window period** (No specific symptoms appear in this phase so ELISA test is negative in window period.)

Low grade fever, body aches, sore throat.

○ **AIDS related complex (A.R.C.)** - 3 to 6 weeks

It is characterized by -

- Diarrhoea
- Weight loss (> 1 0%)
- Cough
- Generalised lymphadenopathy
- Fever.

○ **Full blown AIDS** – In this, patient becomes fully immune deficient and T-Iymphocytes or CD^4 count is less than 200×10^6 / litre.

INVESTIGATION

- **Screening test** is Enzyme Linked Immuno Sorbent Assay (E.L.I.S.A.) .
- **Confirmatory tests : Western blot test :** Detects antibodies (proteins) in patient's serum.
- ELISA is a technique which can detect and even quantitate extremely small amount of a protein, antibodies or antigens with the help of enzymes. The commonly used enzymes are **peroxidases** and **alkaline phosphatase**.
- **Western blot test** is the culturing of blood and testing plasma for virus.
- **Viral load test** measures the amount of virus in the blood which will help in determining the probable progression of the disease.

TREATMENT

- Drugs used are -
  - AZT (Azidothymidine) or Zidowdine
  - DDI (Dideoxyinosine)
  - Foscarnet

These drugs inhibit the enzyme of HIV.

- Highly active antiretroviral therapy (HAART) is a combination of three or more antiretroviral agents (called triple therapy or HAART), which has been highly effective in reducing the number of HIV particles in the bloodstream and as a result increases the CD^4 count.

DRUGS AND ALCOHOL ABUSE

- **Drug abuse** is defined as self administration of a drug for non-medical reasons. Abused drug include anabolic steroids, analgesics and antibiotics.
- Drugs are classified on the basis of their mode of action on brain into two categories-
  - Psychoactive or psychotropic drugs
  - Psychedelic or hallucinogenic drugs.
- **Psychoactive drugs** are also called as mood altering or neurological drugs.
- Psychedelic drugs produce psychological effects like illusions and hallucinations.
- Four categories of psychoactive drugs are- sedative and tranquilizers, opiate narcotics, stimulants and hallucinogens.
- Alcoholism is the consumption of or preoccupation with alcoholic beverages to the extent that this behaviour interferes with the alcoholics normal personal, family, social life.
- Alcohol decreases the activity of CNS thereby, reducing anxiety, tensions and inhibitions.
- Alcohol decreases the secretion of ADH from the posterior pituitary gland causing increased urine output.
- In the liver, alcohol is converted into a more toxic substance **acetaldehyde** which is used for energy by the cells.
- Liver synthesizes fat from the alcohol, the extra fat decreases the production of enzymes and structural proteins.
- The accumulation of fats results in **fatty liver syndrome**, leading to **cirrhosis** (replacement of liver cells by fibrous tissue)
- Alcohol addiction lowers blood sugar levels, adversely affecting the brain.
- Tobacco is the dried leaves of the plant Nicotiana tabacum and N. rustica.
- Nicotine is the substance that causes addiction to tobacco.
- Nicotine is highly poisonous, nicotine present in a cigarette is sufficient to kill a person if taken intravenously.

- Nicotine - stimulates passage of nerve impulse, causes muscles to relax and causes increased heart rate.
- Tobacco smoke contains carbon monoxide, polycyclic aromatic hydrocarbons and tar.
- The main harmful effects of smoking are respiratory diseases and cardiovascular disease.
- One of the common cancer attributed to cigarette smoking is **lung cancer.**
- The withdrawal symptoms include irritability, anxiety, craving, sleep problems, headache and lethargy. It may continue for 4-6 weeks and craving may continue for many months.
- Some of the important measures for the prevention and control of alcohol and drug abuse among adolescents are as follows-
  - Drug education and counselling program.
  - Looking for danger signs.
  - Avoid undue peer pressure.
  - Seeking help from parents and peers.
  - Seeking professional and medical help.
  - Enforcing stronger laws and penalties.

Table : Categories of Psychotropic Drugs, their Effects and Clinical uses.

Type of drug	Examples	Effects	Clinical Uses
Sedatives and tranquilizers (depressant)	Barbiturates, Benzodiazepines (e.g., Valium)	Depress brain activity and produce feeling of calmness, relaxation, drowsiness and deep sleep (high doses)	Hypnotic, antianxiety
Opiate narcotics	Opium, morphine, heroin, pethidine, methadone	Suppress brain function, relieve intense pain (physical and mental), produce temporary euphoria	Analgesic
Stimulants	Caffeine (very mild), amphetamines (including dexamphetamine), cocaine and its derivative, Novacaine	Stimulate the nervous system; make a person more wakeful, increase alertness and activity, produce excitement.	Weight control Neurotic (Depressive) disorder
Hallucinogens	LSD, mescaline, psilocybin, charas, hashish, marijuana (bhang)	Alter thought, feelings and perceptions; hallucinations.	None

STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

INTRODUCTION

- Science of rearing, improvement and caring of domesticated animals is called **animal husbandry.**
- Domesticated animals, especially the farm animals, kept for profit are collectively called **livestock.**

E.g., Cow (Bos indicus), buffaloes (Bos bubalus), sheep, goat, pigs, horses, camel etc.

ANIMAL HUSBANDRY

CATTLE

BREEDS OF CATTLE

- There is a variety of breeds of cattle and buffaloes in our country. All of them differ in general body build, colour, form of horns and geographical distribution.
- The **best cattle** breeds occur in the drier region of the country. There are **26 breeds of cattle.**
- In India, the most important breeds of buffaloes are – Surti, Niliravi, Nagpuri (ellichpuri), Jaffrabadi, Bandawari, Murrah, Mehsana.
- Depending upon the utility, the cattle are classified into the following groups
  - **Milk breeds** (Milk producing animal)
  - **Draught breeds** (Used for working)
  - **General utility breeds** (Used for safety)

Table : Important breeds of Indian Cattle

S. No	Milk Breeds	Distributions
(i)	Gir	Rajasthan, Gujarat
(ii)	Sahiwal	Punjab, Haryana, U.P.
(iii)	Red Sindhi	Andhra Pradesh
(iv)	Deoni	Andhra Pradesh

SUPEROVULATION AND EMBRYO TRANSPLANTATION

- **Superovulation** is a technique where in a cow is made to ovulate more ova by injection of luteinizing hormone (LH).
- High quality cow (e.g., more milk producing) is chosen and is given hormonal injections to induce superovulation.
- Fertilization is achieved by artificial insemination.

- From this cow, 4 to 10 embryos are collected at a time.
- Each of the embryo is transplanted into carrier cow (Surrogate mother).
- By deep freezing (– 196°C), it is possible to preserve the seven days old foetus for several years and transplanted when required.
- This embryo transplantation technique can also be used for other livestock like sheep and goat etc.
- Fertility in local breeds of cattle has been overcome through the use of pregnant mare serum gonadotropin(LH + FSH).
- Sterile and immature cows can be induced to lactate through stilbestrol.

CATTLE DISEASES

- Anthrax, foot and mouth disease, rinderpest, black quarter, blue tongue, mastitis, tuberculosis are some of the common diseases among farm animals.
- Use of uncontaminated water, fodder and proper nutrition, immunization and sanitation make the animals disease resistant.
- Lice, ticks are external parasites of cattle.

SHEEP (OVIS ARIES)

- Today, sheep are raised in all parts of the world. They are reared for wool and mutton, mostly in hilly tracts.
- Sheep graze on grass and herbs.
- Farm waste, mineral mixture, oil cake and other cattle feeds can also be given.
- The fine soft wool (called **Pashmina**) is the **underfur of Kashmir and Tibbet goat.**
- High quality soft wool **shahtoosh is obtained from the animal Chiru.**
- A sheep lives for about 13 years.

Table : Some breeds of Indian Sheep

S.No.	Breed	Distribution	Use
1.	Lohi	Punjab, Rajasthan	Good quality wool, milk
2.	Rampur-Bushair	Uttar Pradesh, Himachal Pradesh	Brown coloured fleece for superior cloth
3.	Nali	Haryana, Punjab, Rajasthan	Superior-carpet wool
4.	Bhakarwal	Jammu and Kashmir	Under-coat used for high quality woollen shawls
5.	Deccani	Karnataka	Mutton, no wool
6.	Nellore	Maharashtra	Mutton, no wool
7.	Marwari	Gujarat	Coarse wool
8.	Patanwadi	Gujarat	Wool for army hoisery

BREEDING OF SHEEP

- Sheep begin breeding at the age of about two years and then have young ones every year.
- After that, sheep feed on tender grass, weeds of pasture and hill side.
- To improve the quality of a sheep, cross breeding experiments are usually done.

For this purpose, a good quality wool yielding or mutton producing sheep is chosen and cross breed with-exotic breed like Dorset, Horn and Merino.

GOAT (CAPRA)

- Goat is also called poor mans cow because it yields a small quantity of milk and feeds on a variety of wild plants even prickly ones.
- Goat destroy vegetation and forests if not kept under control.
- bout 19% of world goat population occurs in India.
- Goats are reared in open sheds.
- The wild goat Baluchistan and Sindh is the ancestral stock of all breeds of domesticated goats.
- An adult male goat is also called **bully goat or a buck** and a female adult is a **nanny goat or a doe.**
- The goats are **less prone to serious diseases.** They suffer from some contagious diseases such as anthrax, goat pox, pleuropneumonia and foot and mouth disease. The general signs of illness are as in the cows. Parasitic infection is common in goats.

Table : Indian breeds of goats

S.No.	Name	Distribution
1.	Gaddi and Chamba	Himachal Pradesh
2.	Kashmiri and Pashmina	Himachal Pradesh, Kashmir, Tibet
3.	Jamunapari	Uttar Pradesh, Madhya Pradesh
4.	Beetal	Punjab
5.	Marwari	Rajasthan
6.	Berari	Maharashtra
7.	Malabari	Kerala
8.	Bengal	Bihar, Orissa

HORSES

- The horses (Equus cabalus) are solid- hoofed, non-ruminant quadrupeds with long, pendant mane and tail bearing long hair all over.
- If compared to other animals, horses have a low reproductive rate. Controlled natural mating in horses has been in practice in India for a long time. A high professional skill is required for rearing, training and medical care of race horses.

Table : Breeds of Indian Horses

S.No.	Name	Regions
1.	Kathiawari	Rajasthan and Gujarat
2	Marwari	Rajasthan
3.	Bhutia	Punjab and Bhutan
4.	Manipuri	North-eastern mountains
5.	Spiti	Himachal Pradesh
6.	Zanskari	Ladakh

POULTRY

- Poultry is rearing of domesticated fowls (chicken), ducks, geese, turkeys, guinea fowls, pigeons, partridges, etc. for the meat and eggs.
- Poultry and poultry products are a rich source of animal protein and the right kind of fats for good health.
- In our country, poultry mainly means domestication of chickens for meat and eggs.
- Poultry birds are easy to raise and can acclimatize to a wide range of climate conditions. They are prolific (highly reproductive and have a short life span).
- Poultry farming yields quick return, needs little space and easy to manage.
- Chickens are bred in large colonies in special places called **poultry farms.**
- The poultry birds are kept in dry comfortable and well ventilated cages.
- Domestic fowl (Gallus domesticus) constitute the major poultry bird.
- Poultry birds exclusively grown for meat are called **broilers** (e.g., Plymouth rock), **layers** are for egg production, **cockerel** are young male fowls and **rooster** are mature male fowls.
- **Broilers** are generally quick growing birds which are generally males but can also be female. Broilers are sold in fresh and frozen form after dressing (removal of feathers, head and feet).
- The domestic fowl (gallus gallus) can be classified as –
  - I**ndigenous (Desi) or Indian breeds**
    - Aseel, Ghagus, Karaknath, Brahma, Bursa, Black Bengal, Chittagong, Tellicherry, etc.
    - Assel is **best game bird**, it is used in cock fighting.
    - Indian breeds are slow growing, less efficient converters and produce fewer eggs (60/years).
  - **Exotic Breeds**
    - White leghorn, Red Rhode island, Plymoth rock, New Hampshire, Sussex, Barre Plymoth, Austraiorp, Light, Minoreha etc.
    - HH 260 lays more than 260 eggs in a year and its mortality rate is low.
    - The broilers (bird grown for meat), with high nutritive value have been produced by cross breeding (heterosis).

COMMON DISEASE OF POULTRY

- **Viral diseases :** Fowlpox, infectious bronchitis, lymphoid leukosis and ranikhet diseases are common viral diseases of poultry. **Ranikhet** (New Castle) disease is the **most common disease** of hens and fowls in which the affected individuals suffer from fever and diarrhoea. With the progression of this disease, the birds show mucus secretion from their beaks, paralysis of wings and birds repeatedly moving round.
- **Bacterial diseases :** These include fowl cholera, Pullorum, Coryza, Mycoplasmosis and Spirochaetosis.
- **Fungal diseases :** These include Aflotoxicosis, Brooder pneumonia and aspergillosis.
- **Parasitic diseases :**
  - **Internal parasites :** Roundworms, tapeworms and threadworms.
  - **External parasites :** Fowl mite, chicken mites, fleas, ticks etc.

If any of the infectious disease has affected a mass proportion of the chicken and hens, then the best and safer decision to avoid the fatal consequence is to destroy the affected individuals.

POULTRY DEVELOPMENT IN INDIA

Poultry contributes about Rs. 7,500 crores to the Gross National Product (GNP) of India. **India ranks fifth in the world's egg production**. Egg is one such food commodity which cannot be adulterated. The average per capita consumption is about 32 eggs and 600 grams of poultry meat a year. At present, poultry is estimated to provide employment to about seven lakh families.

ANIMAL BREEDING

- Animal breeding aims at improving the genotypes of animals to make them more useful to us.
- The chief objectives of animal breeding may be summarised as follows :
  - Improved growth rate.
  - Increased production of milk, meat, egg, wool, etc.
  - Superior quality of resistance to various diseases.
  - Increased productive life.
  - Increased or at least, acceptable reproduction rate etc.
- A variety of strategies have been used for breeding of animals. The main approaches for animal breeding, viz., **inbreeding**, **out-breeding**, **out-crossing**, **cross breeding** and **interspecific hybridization**, are briefly described below which are based mainly on the breeding work with cattle.

IN-BREEDING

- **In-breeding** refers to the mating of more closely related individuals within the same breed for 4-6 generation.
- All domesticated animals have male and female individuals. As a result, these are strictly cross-fertilized and highly heterozygous. Each domesticated animal species consists of several distinct breeds that differ from each other in several morphological and other features. Animals belonging to a single breed differ from each other in genotype because of the mode of their reproduction and their heterozygous nature. Therefore, **mating between animals of the same breed provides opportunities for genetic improvement.** Superior cows and superior bulls of the same breed are identified and mated in pairs. The progeny obtained from such mating are evaluated and superior males and females are identified for further mating. A superior female, in the case of cattle, is a cow that produces more milk or lactation. On the other hand, a superior male is that bull, which gives rise to superior progeny as compared to those of other males. Inbreeding, as a rule, increases homozygosity.
- In-breeding exposes harmful recessive genes that are eliminated by selection.
- In-breeding also helps in accumulation of superior genes and elimination of less desirable genes. Therefore, this approach increases the productivity of inbred population. Practically, every breed was developed by some type of inbreeding.

But continued inbreeding, especially close in-breeding, usually reduces fertility and even productivity (**inbreeding depression**). Whenever this becomes a problem, the selected animals of the breeding population should be mated with such superior animals of the same breed that are unrelated to those in the breeding population.

- **In-breeding depression** refers to the loss of vigour associated with inbreeding.

OUT-BREEDING

- Outbreeding is the breeding of unrelated animals, which may be between individuals of the same breed (but having no common ancestors), or between different breeds (cross breeding) or different species (interspecific hybridization).

OUT-CROSSING

- Out-crossing is the practice of mating of animals within the same breed but having no common ancestors on either side of their pedigree up to 4-6 generation.
- The offspring of such a mating is known as an **outcross.**
- A single outcross often helps to overcome in-breeding depression.

CROSS-BREEDING

- In cross-breeding, superior males of one breed are mated with superior females of another breed.
- Cross-breeding allows the desirable qualities of two different breeds to be combined in a single breed. The progeny animals may themselves be used as hybrids for commercial production. Alternatively, they may be subjected to some form of inbreeding and selection to develop new stable breeds that may be superior to the existing breeds. Many new animal breeds have been developed by this approach.
- Progeny produced through cross-breeding may be mated according to various schemes to achieve specific objectives. For example, cows of an inferior breed may be mated to bulls of a superior breed. In each successive generation, the progeny cows are mated to the bulls of the same superior breed that was used in the original cross. Thus, in 6-7 generations, the progeny will be almost similar to the breed of bulls used for the mating. But these progeny would retain some original advantageous conditions, etc., of the other breed from which the cows were used in the original mating.
- **Hissardale** is a new breed of sheep developed in Punjab by crossing Bikaneri Eves and Marino rams.

INTERSPECIFIC HYBRIDIZATION

- In this strategy, male and female animals of two different species are mated. The progeny obtained from such a mating are usually different from both the parental species.
- In some cases, the progeny may combine desirable features of both the parents, and may be of considerable economic value. An example of this type is mule, which is produced from a cross between a female horse (mare) and male donkey. Mules are sturdier and hardier than their parental species, that are well suited for hard work in difficult terrains like mountainous regions.

APICULTURE

- The scientific method of care and management of honey bees is called **apiculture.** Although bees are very active throughout the year but in winter they become sluggish and very active in spring.
- Honeybee is a social insect and show **polymorphism and good division of work.**
- The diameter of a normal bee hive is about 30-90 cm. In it, the number of bees is about 50-60 thousands.
- **Bee-Hive :** Honey bee is one of the few domesticated insects. In modern days, bee colonies are reared in artificial wooden boxes for maximum production of honey and wax. The artificial box where the bee colony is maintained and managed is called **hive.** The place where hives are kept and managed is called **apiary.**

- The hives should be set in places where there are plenty of flowering plants. The place should be neat and clean and free from any obnoxious smell. There should be clean drinking water nearby because each bee colony requires two glasses of water per day for their survival.
- Bees are pollinators for sunflower, Brassica, apple and pear.

IMPORTANT VARIETIES OF HONEYBEE

- **Apis dorsata (Rock bee) :** It is also named as sarang bee. It is of largest size and produces highest yield of honey. However, it is of highly aggressive nature and migratory species which is not suitable for rearing by man.
- **Apis indica (Indian Mona-bee) :** It lives across the whole country of India and is smaller in size than sarang-bee. It is mild in nature so that it is easily manageable during rearing. Mona-bee yields about 3-4 kg. of honey per hive.
- **Apis florea (Bhringa-bee) :** This bee is smallest in size and of timid nature. It only yields about 250gms. of honey every hive. Hence, it is not suitable for commercial purpose.
- **Apis mellifera (European bee) :**This bee is of mild nature. It yields 9-10 times more honey than mona-bee. It is the **most useful bee for commercial purpose.** The Italian variety of this species is by far the most important variety.

SOCIAL ORGANISATION

- A highly organised division of labour is found in the colony of honey bee.
- Each colony has 40,000 to 50,000 individual consisting of 3 casts - **queens, drones** and **workers.**

QUEENS

- It is about 15-20 mm long and its body is about three times larger and 3 times heavier than a worker bee. It lives only for 5 years. The legs and wings are short but crop is long. It has ovary which is filled with eggs.
- Only one queen develops from fertilized egg (i.e. it has 32 chromosomes). It feeds on Royal jelly. Its sole function is reproduction. It lays 2000 eggs everyday. One queen lays approx. 1500000 egg in its whole life time.

DRONES

- Drones are males which mate with the queen. Their number in the colony is not much. They are smaller but shorter than queen with broader abdomen, longer appendages and larger wings.
- Drones are developed from unfertilized eggs so there are only 16 chromosomes present in them.
- In drones, salivary and wax secreting glands and stings are absent.
- Their life span is of 45 days or 5 weeks.
- Like the queen, they also depend on worker bees for nutrition.
- Their sole duty is to fertilize the queen.

WORKERS

- Their number is maximum in a hive.
- They are darker and the **smallest bees** of the colony.
- Their wings and mouth parts are very strong.

Their mouth parts and legs are modified to suck the nectar of flowers and to collect the pollen grains respectively.

- Pollen basket is present on hind leg (tibial) for collection of pollen. Pocket like **wax glands** are present at base 2nd to 5th abdominal segment.
- Worker bees are **sterile females.** These are developed from fertilized eggs. Due to high labour, the lifetime of a worker bee is about **6-8 weeks.**

LIFE CYCLE

- When the colony becomes overcrowded, the old queen leaves the hive along with some workers and drones. They fly to a new place to establish another colony. This is called **swarming.**
- Swarming takes place during the spring or early summer. New queen is then formed in the old colony. She soon undertakes a **marriage or nuptial flight** with the drones. **Mating occurs in the air.**
- Drones **die during the course of copulation.** The queen mates only once in a lifetime.
- After mating, the queen generally lays one egg in one brood cell.
- he eggs are pinkish coloured, elongated with cylindrical body generally attached to the bottom of the cell.
- Larvae emerge out from both the fertilized as well as unfertilized eggs. Thus, the larvae from the unfertilized eggs form the drones while the workers are developed from the larvae of the fertilized eggs. Amongst the larvae of the workers, one is fed on the royal jelly, a special diet secreted by the young workers in the colony, and becomes the queen of the colony.
- The royal jelly consists of digested honey and pollen, mixed with a glandular secretion into the mouth of the workers.
- The life cycle of honeybees includes complete **metamorphosis or holometabolic development.**
- The worker bees have a **pollen collecting apparatus, honey storing mechanism and wax secreting glands.**

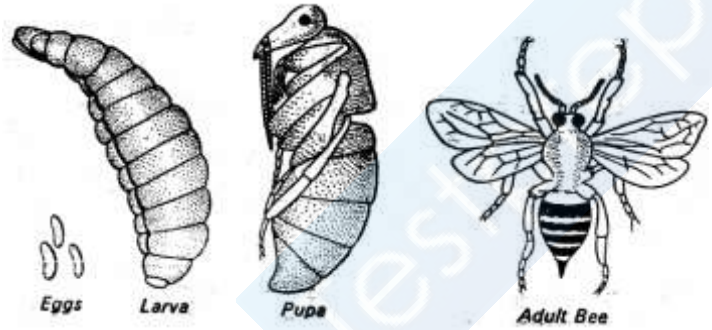


Fig. : Life cycle of Apis indica

ECONOMIC IMPORTANCE

- **Formation of honey :** Honey is a viscous sugary fluid formed from the nectar within the stomach of the honey bee. The bees visit flowers, suck the nectar, store it in the stomach and return to the hive. In the stomach, the nectar is processed. It is regurgitated and swallowed repeatedly for about 240 times. Then the processed nectar is deposited in the comb cells. This processed nectar is called **unripe honey or green honey.** It contains about 80% water. The unripe honey is converted into ripe honey by evaporation. The ripe honey contains less than 20% water. When the honey becomes ripe, the cells are capped or closed. The honey in the unsealed cell is unripe.
- **Bee wax :** Bee wax is **secreted by the abdominal gland of bees.** It is used for the construction of comb. It is a yellowish solid, insoluble in water. It is used for the preparation of paints, varnishes, candles, models, etc. It is used as a ground substance for the preparation of ointments, creams etc. It has many industrial uses. It is used extensively in engineering industries, railways, textiles, leather industries etc.
- **Bee venom :** Bee venom is secreted by the poison-glands of stings. Bee venom is a curative toxin in humans. It is transparent and it has a bitter, burning taste. It is acidic in nature. It contains formic acid, histamine, tryptophan, sulphur, many proteins, volatile oils, enzymes like hyaluronidase and phospholipase and magnesium phosphate.

- **Propolis :** It is a resin derived from plants (axillary buds). It has antiseptic and antibiotic properties.

FISHERIES

- Fishes and other aquatic animals are reared and caught for food which is rich in protein, vit. A and D.
- **Aquaculture** is rearing and management of useful aquatic plants and animals like fishes, oyster, prawns, mussel etc.
- **Pisciculture** is rearing, catching and management of fishes.
- **Culture fishery** is the raising of fishes in tanks and ponds.
- **Capture fishery** is management of catching of fish without actually raising them.
- **Inland fisheries** includes culture and capture fishery.
- The per capita consumption of fish in India is estimated at 1.52 kg/yr.
- India is at present the 6th foremost sea food producing nations in the world.
- **Blue revolution** is effort to increase fish yield in India.

Table : Cultivable fish species

S.No.	Zoological name	Common Name	Areas of availability
	Fresh water		**Fishes**
1.	*Catla catla*	Catla	All over India, common in Krishna and Godavari rivers
2.	*Labeo rohita*	Rohu	North, East and South India
3.	*Labeo calbasu*	Calbasu	North and South India
4.	*Cirhinus mrigala*	Mrigal	North and South India
5.	*Mystus singhala*	Singhara	All over India
6.	*Heteropneustes fossilaris*	Singhi	All over India
7.	*Wallago attu*	Malli	North, east and South India

8.	*Clarius batrachus*	Fresh water shark magur	All over India
9.	*Sardinella longiceps*	Oil sardine	West and south coasts
10.	*Harpodon heherius*	Bombay duck	Maharastra coast
11.	*Hilsa ilisha*	Hilsa/ Indian shed	Coastal India
12.	*Stromateus sinensis*	Pomfret	Indo pacific coast
13.	*Anguilla anguilla*	Eel	Coastal India
14.	*Eluetheronema*	Salmon	East and west coast
15.	*Cyanoglossus semifasciatus*	Flat fish	East coast of India

PLANT BREEDING

- The branch of botany, which is related with the studies about genetic improvement of crop plants is known as **plant breeding.** Improved varieties of crop plants are developed by its application.
- **Improvement of crop plants is made to obtain following characters :**
  - Increased yield of seeds, oil and fibres.
  - To develop, insect, disease and frost resistance.
  - To acclimatize in adverse conditions.
  - To change maturation period.

NOTES

EMINENT PLANT BREEDER

- **Norman Borlaug :** He was famous plant breeder of Mexico, who proposed dwarf varieties of wheat, e.g., Sonora-64, and Lerma Rojo-64. These are high yielding varieties. He was awarded Nobel prize for peace on the basis of this substantial contribution in resolving food problem of world. He is also known as **Father of Green Revolution.**
- **Dr. M.S. Swaminathan :** Mainly contributed in mutation breeding. He developed "Sharbati sonora" variety of wheat by mutation breeding. He is also known as **"Father of Indian Green revolution".**

METHODS OF PLANT BREEDING

- Methods of plants breeding are –
  - Plant introduction and Acclimatization
  - Selection
  - Hybridization
  - Polyploid breeding
  - Mutation breeding
  - Tissue culture

PLANT INTRODUCTION AND ACCLIMATIZATION

- This is the easiest and most rapid method of crop improvement. The growing or establishment of a plant to a new place, by transfer from its centre of origin is known as **plant introduction.**
- If the plant material is brought from foreign country then it is known as **exotic collection** and if it is brought from some other place of the same country then it is known as **"Indigenous collection"**.
- **Acclimatization** is the adaptation of introduced plant in newly changed climatic conditions. First of all introduced plant material is put to quarantine law/plant-protection inspection. During this process, inspection or screening is made about the presence of weed or insect pest along with introduced plant. Once the plant material is found totally suitable then only it is used for agriculture.
- Several weeds, e.g., Argemone mexicana, Eicchornia and Parthenium also invaded our country due to uncontrolled introduction.

SELECTION

- This is most **primitive** and **simplest method used for crop improvement.**
- Selection is sorting out of the plants having desired characters e.g., high yield or disease resistance from plant population on the basis of homozygous characters. Plant selection is always done by breeder, e.g., in case of maize dispersal and propagation is done by man, hence it is known as "pampered corn."
- **There are three methods of artificial selection :**
  - **Pure line selection :** Progeny of self pollinated homozygous plant is known as pure line. This word was coined by **Johanson (1903).** To develop new variety from pure line is known as pure line selection. This method is only useful for self pollinated crops,
    e.g., Wheat.
  - **Mass-selection :** This method is applied for self as well as cross pollinated crops both, but more useful for cross pollinated crops. It is based on external characters only.It is the **easiest and quickest** method of crop improvement.
  - **Clonal selection :** This method is used for vegetatively propagated crop plants, e.g., sugarcane, banana and potato etc. The progeny of vegetatively propagated parent is known as clone which are similar to their parent plants. Therefore, selection in between clones is done in this method on the basis of phenotypic characters. There are certain limitations of clonal selection, these are :
    a. This method can be used for vegetatively propagating crop plants only.
    b. New variations are not observed.

HYBRIDIZATION

- When new variety of a crop plant is developed by the cross of 2 genetically different plants, then it is known as hybridization.
- The plants which are crossed may be of same or different species or genera.
- The progeny obtained due to cross between two genetically different parents, appeared to be more robust, vigorous and of higher yield in comparison to its parents, this phenomenon is known as hybrid vigour or "heterosis". It is developed due to heterozygosity.
- Heterosis gets disappeared due to inbreeding. Hybrid vigour remains maintained in vegetatively propagated plants.
- **Basic steps of hybridization** are as follows –
  - **Selection of parents**
  - **Self pollinatio**n in parents which induces homozygosity.

- **Emasculation :** Removal of anthers or male reproductive structures before maturation of flower.
- **Bagging :** To avoid contamination by unwanted pollen, the female and male flowers are covered with cellophane or parchment or paper bags. This process is called **bagging**. Female flower is covered by a bag. Bagging is mainly done to check undesired cross pollination.
- Cross is made between selected parents with desired characters.

POLYPLOID BREEDING

- The plants which have more than 2 sets of chromosomes are known as **polyploids.**
- There are various types of plants on the basis of chromosome set numbers. E.g., monoploid, diploid, triploid, pentaploid (e.g., wheat) and hexaploid and so on.
- Triploidy is of general occurrence in various crop plants. These triploids are usually seedless or parthenocarpic, e.g., most of the banana species are triploid hence, their fruits are seedless (parthenocarpic).
- In sexually reproducing members, polyploidy is generally evolved due to fusion of egg with more than one male gametes. Besides this, polyploidy can be artificially induced by the treatment of colchicine (an alkaloid obtained from Colchicum-autumnale.) Some triploid plants have got more vigour and large sized fruits. E.g., Apple and pear.

MUTATION BREEDING

- Various important varieties of numerous crop plants have been developed by mutation breeding. E.g., "Sharbati Sonora" and "Pusa lerma" varieties of wheat have been evolved by gamma radiation mutation treatment of dwarf varieties "Sonara" and "Lerma rojo".
- "Sharbati Sonora" is responsible for "Green revolution".
- Similarly, Remei and Atomita-2 varieties of rice have also been developed by mutation breeding. Erectoides and Erectiferum varieties of Barley were also developed by mutation breeding.
- The world fame Aruna variety of castor well known for its disease resistance and high yield of oil is also obtained by mutation breeding only.
- By U.V. Rays treatment of P. chrysogenum and P. notatum, the production of penicillin is enhanced.
- **Some important limitations of mutation breeding are :**
  - Most of the mutations are recessive.
  - Rate of mutations is quite meagre.
  - Most of the induced mutations are useless for the plant breeders because these are lethal.
  - Sometimes stability of mutants is doubtful. Some mutants get back their normal type once again.

TISSUE CULTURE

- Tissue culture is a modern method of crop improvement. It is based on totipotent nature of plant cell or phenomenon.
i.e. every type of totipotency plant cell has got the capability to develop into a new plant.
- The principle of totipotency was put forward by **Haberlandt**, but elaborated by **Steward** through his experiments. He developed a completely natural wild carrot plant by tissue culture of a single cell from root apex.
- A single cell or a group of cells used in tissue culture method, is known as explant. As a result of **explant** culture in culture medium, an irregular group of cells is formed which is known as **callus.**

- Later on necessary concentrations of auxins and cytokinins are added in culture media and root and shoot formation is stimulated. This process is known as **organogenesis**. In this manner, a complete plantlet is developed by single cell culture. Later on, it is grown in soil or flower pots for further growth.
- **Practical applications of tissue culture for crop improvement are :**
  - **Micropropagation,** by which numerous plantlets are developed in a limited space which can be later utilized for agriculture or horticulture, or forestry.
  - **Androgenic haploids :** Haploid plants are developed by anther culture technique. These are known as androgenic haploids. **Guha and Maheshwari** first of all obtained androgenoic haploids by anther culture of Datura innoxia. Androgenic haploids are very much useful in plant breeding because –
    - Only one set of chromosomes is found in haploid plants. Therefore, slightest variations can also be easily detected.
    - These haploid plants are used for the production of homozygous diploids (by colchicine treatment) and later on these homozygous diploids may be used as parents.
  - **Production of disease free plants :** These can be developed by shoot tip culture. Because "shoot apex" does not get effected by virus.
  - **Culture of rare hybrids :** The hybrid plants obtained by interspecific or intergeneric cross are mostly sterile, because their embryo becomes abortive in earlier or later stages. These rare hybrids can be preserved by embryo culture.
  - **Somatic or protoplast hybridization:** In this method, protoplasts from cells of two genetically different species are made to fuse. With the help of cellulase or pectinase enzymes, cell wall of the cells is separated as a result of which walless cells or protoplasts are formed. Fusion of protoplasts is done. Pomato and Bromato hybrids have been developed by this method.

Potato × Tomato → Pomato
Brinjal × Tomato → Bromato

  - **Somaclonal variations :** The variations amongst the plants developed by tissue culture method are known as somaclonal variations. These variations are stable and useful for agriculture, e.g., pest and disease resistance.

INTERNATIONAL EFFORTS FOR UTILIZATION OF CROP GERMPLASM

- Cereals, e.g., wheat, rice, barley, sorghum, maize and pearl millet are basic food sources for human population. Out of this, rice is the main food source for more than 50% of the population.
- **Improvement in rice :** For the enhancement in crop yield in rice, a dwarf variety gene "De-Geo-Woo-Gene" was brought from Taiwan.
- **IRRI (International Rice Research Institute, Los Banos, Philippines)** utilized this gene in developing early ripening varieties IR-8 and IR-24 of rice with higher crop yield.

NOTES

Under supervision and direction of Dr. Gurdev Singh Khush, 13 varieties of rice (brought from 6 countries) were crossed with a wild species Oryza nivara and a new improved variety IR-36 was developed in IRRI Manila. This variety is resistant against grossy, stunt virus. IR-36 variety of rice is well known for higher crop yield, and has been helpful in solving major food problem of Asia.

PLANT BREEDING FOR DISEASE RESISTANCE

- Diseases are the main enemies of the crops and they cause enormous loss to the agricultural production of the country.
- Breeding for disease resistance is carried out by the conventional breeding techniques or by mutation breeding.
- The conventional method of breeding for disease resistance is that of hybridization and selection.

- **Disease resistance** is the ability of plants to withstand, oppose or overcome the attack of pathogens.

Table : Some crop varieties developed by hybridization and selection, for disease resistance against fungi, bacteria and viral diseases

S. No.	Crop	Variety	Resistance to diseases
1.	Wheat	Himgiri	Leaf and stripe rust, hill bunt
2.	*Brassica*	Pusa swarnim (Karan rai)	White rust
3.	Cauliflower	Pusa Shubhra, Pusa Snowball K-1	Black rot and Curl blight black rot
4.	Cowpea	Pusa Komal	Bacterial blight
5.	Chilli	Pusa Sadabahar	*Chilly mosaic* virus, *Tobacco mosaic virus* and Leaf curl

Table : Some crop varieties developed by hybridization and selection against insect pest resistance :

S.No.	Crop	Variety	Insect Pests
1.	*Brassica* (rapeseed mustard)	Pusa gaurav	Aphids
2.	Flat bean	Pusa sem 2, Pusa sem 3	Jassids, aphids and fruit borer
3.	Okra (Bhindi)	Pusa sawani Pusa A-4	Shoot and Fruit borer

PLANT BREEDING FOR IMPROVED FOOD QUALITY

- Improved food quality is an important aspect for plant breeders because it determines the suitability of plant product for various uses.

- Breeding for improved food quality is undertaken with objectives of improving-
  - Protein content and quality
  - Oil content and quality
  - Vitamin content
  - Micronutrient and mineral content.
- **Biofortification** is the process of breeding crops with higher levels of vitamins and minerals or higher protein and healthier fats is the most practical means to improve public health.
- Through biofortification , scientists can provide farmers with crop varieties that naturally reduce anaemia, cognitive impairment and other nutritionally related health problems.

SINGLE CELL PROTEIN

- Single cell protein is a microbial biomass. This biomass is obtained from both unicellular and multicellular microorganisms. Single cell protein can be produced using algae, fungi, yeast and bacteria.
- Commercial production of S.C.P. is mostly based on yeasts and some other fungi, e.g., Fusarium graminearum.
- Production of SCP requires carbon source as well as nitrogen, phosphorus and other nutrients needed to support optimal growth of the selected micro-organism. SCP process are highly aerobic (except those using algae). Therefore, aeration must be provided.

ADVANTAGES OF SCP

- The SCP is rich in high quality protein and is rather poor in fats, which is rather desirable.
- They can be produced all year round and are not dependent of the climate (except the algal processes).
- SCP may be used directly as human food supplement, or else it may be used in animal feed to at least partially replace the currently used protein-rich soyabean meal and fish proteins, and even cereals, which can be diverted for human consumption.
- The microbes are very fast growing and produce large quantities of SCP from relatively small area of land. For example, 250 gm of Methylophilus methylotrophus, a microorganism, can produce 25 ton protein.
- These use low cost substrates and in some cases, such substrates which are being wasted and causing pollution to the environment.
- When the substrate used for SCP process is a source of pollution, SCP production helps reduce pollution.
- Strains having high biomass yields and a desirable amino acid composition can be easily selected or produced by genetic engineering.
- Some SCPs are good sources of vitamins, particularly B-group of vitamins e.g., yeasts and mushrooms.
- At present, SCP appears to be the only feasible approach to bridge the gap between requirement and supply of proteins.