Human Health and Disease

Health is a state of complete **physical, mental & social well-being.** Health is affected by genetic disorders, infections, change in life style (food, water, rest, exercise, habits etc). Mind influences immune system (through neural and endocrine systems).
When the functioning of organs or systems of the body is adversely affected, it is called a **disease**. Diseases may be **infectious** (transmits from one person to another) or **non-infectious**.
Disease causing organisms are called **Pathogens.** Parasites are pathogens as they harm the host.

COMMON INFECTIOUS DISEASES IN MAN

1. BACTERIAL DISEASES

a. **Typhoid:** Pathogen is **Salmonella typhi.**
- **Mode of transmission:** It enters small intestine through food & water and migrates to other organs via blood.
- **Symptoms:** Sustained high fever (39°-40° C), weakness, stomach pain, constipation, headache & loss of appetite. Intestinal perforation and death may occur. **Widal test** is used for confirmation of the disease.

b. **Pneumonia:** Pathogen is **Streptococcus pneumoniae & Haemophilus influenzae.**
It infects lung alveoli. The alveoli get filled with fluid leading to respiratory problems.
- **Mode of transmission:** Inhaling the droplets/aerosols released by an infected person. Sharing glasses and utensils with an infected person.
- **Symptoms:** Respiratory problems, fever, chills, cough, headache. In severe cases, lips and finger nails turn gray to bluish colour.

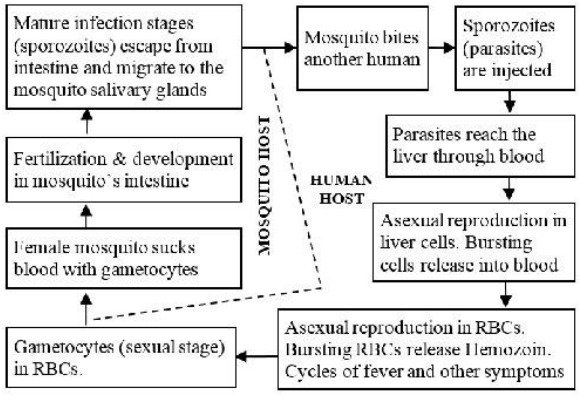
2. VIRAL DISEASES

a. **Common cold:** Pathogen is **Rhinoviruses.**
It infects nose & respiratory passage but not lungs.
- **Mode of transmission:** Inhaling droplets resulting from cough or sneezes. Through contaminated objects.
- **Symptoms:** Nasal congestion & discharge, sore throat, cough, hoarseness, headache, tiredness etc. Last for 3-7 days.

3. PROTOZOAN DISEASES

a. **Malaria:** Pathogen is **Plasmodium sp.** (P. vivax, P. malariae & P. falciparum). Most serious (malignant) malaria is caused by P. falciparum.
- **Mode of transmission:** By female Anopheles mosquito.
- **Symptoms:** Haemozoin (toxin released by Plasmodium) causes chill and high fever recurring every 3-4 days.

Life cycle of Plasmodium



b. **Amoebiasis (Amoebic dysentery):** Pathogen is **Entamoeba histolytica.**
- **Mode of transmission:** Houseflies (mechanical carriers) transmit parasites from faeces to food & water.
- **Symptoms:** Constipation, abdominal pain and cramps, stools with excess mucous and blood clots.

4. HELMINTH DISEASES

a. **Ascariasis:** Pathogen is **Ascaris** (Intestinal parasite).
- **Mode of transmission:** Soil, water, vegetables, fruits etc. contaminated with faeces containing eggs of parasites.
- **Symptoms:** Internal bleeding, muscular pain, fever, anaemia and blockage of intestinal passage.

b. **Filariasis (Elephantiasis):** Pathogen is **Filarial worms or Wuchereria** (W. bancrofti & W. malayi).
- **Mode of transmission:** Bite of female Culex mosquito.
- **Symptoms:** Filarial worms live in lymphatic vessels (usually of lower limbs). It causes chronic inflammation of the organs in which they live for many years. Limbs and genital organs may be deformed.

5. FUNGAL DISEASES

a. **Ring worms:** Pathogens are **Microsporum, Trichophyton & Epidermophyton.** They are seen in groin, b/w toes etc.
- **Mode of transmission:** From soil or by using towels, cloths, comb etc. Heat and moisture help fungi to grow.
- **Symptoms:** Dry, scaly lesions on skin, nails, scalp etc. Intense itching.

PREVENTION AND CONTROL OF DISEASES

Personal hygiene

Keep the body clean. Use clean drinking water, food etc.

Public hygiene

a. Proper disposal of wastes and excreta.
b. Periodic cleaning and disinfection of water reservoirs, pools, cesspools and tanks.
c. Avoid contact with infected persons or their belongings (to control air-borne diseases).
d. Standard practices of hygiene in public catering.
e. Control and eliminate the vectors (e.g. mosquitoes).
- Avoid stagnation of water.
- Regular cleaning of household coolers.
- Use of mosquito nets.
- Introduce larvivorous fishes like Gambusia in ponds.
- Spraying insecticides in ditches, drainage and swamps.
- Provide doors and windows with wire mesh.

These precautions can avoid vector borne diseases like Malaria, Filariasis, Dengue & Chikungunya.

IMMUNE SYSTEM

- It is the system that gives immunity to the body.
- It plays role in allergic reaction, auto-immune disease and organ transplantation.
- It includes **lymphoid organs, tissues, cells & antibodies.**

LYMPHOID ORGANS

These are the organs where origin, maturation & proliferation of lymphocytes occur. 2 types: Primary & Secondary.

a. Primary lymphoid organs

- Here, immature lymphocytes differentiate into antigen-sensitive lymphocytes. E.g. **Bone marrow & thymus.**
- Bone marrow is the site of formation of blood cells.
- Thymus is large during birth but gradually reduces in size and becomes very small size in puberty.

b. Secondary lymphoid organs

- The organs, to which matured lymphocytes migrate, interact with antigens and then proliferate to become **effector cells.** E.g. Spleen, lymph nodes, tonsils, Peyer's patches, Mucosal associated lymphoid tissue (MALT) & appendix.
- **Spleen:** Bean-shaped organ. Contains lymphocytes and phagocytes. It removes worn-out RBCs & microorganisms from blood. It is a reservoir of erythrocytes in foetus.
- **Lymph nodes:** Found in lymphatic system. They trap microorganisms or other antigens. Trapped antigens activate lymphocytes and cause immune response.
- **MALT:** Located within the lining of respiratory, digestive & urinogenital tracts. It constitutes 50% of lymphoid tissue.

IMMUNITY

It is the ability of the immune system to fight the pathogens. It is 2 types: Innate and Acquired.

1. Innate (inborn) immunity

- It is the *non-specific* immunity present at the time of birth.
- It includes 4 types of **Barriers:**

a. **Physical barriers:** E.g. ***Skin*** (Prevent entry of foreign bodies), ***Mucus coating*** of the respiratory, gastro-intestinal and urino-genital tracts to trap microbes.

b. **Physiological barriers:** E.g. gastric HCl, saliva, tear etc.

c. **Cellular barriers:** ***Phagocytes*** like *WBC* [e.g. *neutrophils* or *Polymorphonuclear leukocytes (PMNL), monocytes* and natural killer *lymphocytes], macrophages* etc.

d. **Cytokine barriers:** Virus infected cells secrete proteins called ***interferon*** which protect non-infected cells from further viral infection.

2. Acquired immunity

- It is *pathogen specific* immunity developed during lifetime.
- It is characterized by *memory*, i.e. during first encounter of a pathogen, body produces *primary response* in low intensity. Second encounter of the same pathogen causes a *secondary (anamnestic) response* in high intensity.
- Primary and secondary immune responses are carried out with *B-lymphocytes (B-cells)* and *T-lymphocytes (T-cells)*.

a. **B-lymphocytes:** Produce *antibodies*.

b. **T-lymphocytes:** Help B-cells to produce antibodies.

Structure of an antibody molecule

An antibody has **4 polypeptide chains:** 2 **light chains** and 2 **heavy chains (H_2L_2).**

Types of antibodies:

IgG, IgA, IgM, IgE & IgD.

Types of Acquired immune response

1. **Humoral immune response/ Antibody mediated immunity (AMI):** It is the immune response mediated by ***antibodies.*** Antibodies are found in blood plasma. So called as Humoral immune response.
2. **Cell-mediated response / cell-mediated immunity (CMI):** It is the immune response mediated by ***T-lymphocytes (T-cells).*** The body can differentiate 'self' and 'non-self' and the CMI causes Graft rejection.

   Tissue matching & blood group matching are essential before undertaking any graft/ transplant. After this , the patient should take immuno-suppressants all his life.

Types of Acquired immunity

Acquired immunity is 2 types: Active and passive.

1. **Active immunity:** It is the immunity in which antibodies are produced in a host body when the host is exposed to *antigens* (e.g. living or dead microbes or other proteins). It is a slow process. It is produced by 2 ways:
   a. **Natural Active Immunity:** It is developed during natural infection by microbes.
   b. **Artificial Active Immunity:** It is developed by injecting the microbes deliberately during immunization.
2. **Passive immunity:** Here, readymade antibodies are directly given to the body. It is 2 types:
   a. **Natural Passive Immunity: E.g.**
      - Antibodies (IgG) from mother → Placenta → Foetus
      - Antibodies (IgA) in colostrum → infants
   b. **Artificial Passive Immunity: E.g.**
      - Anti-tetanus serum (ATS)

Immunization

This is based on 'memory' of the immune system. 2 types:

1. Active Immunization (Vaccinati on)

- In this, a preparation of **vaccine** (antigenic proteins of pathogen or inactivated pathogen) is introduced into the body. It results in the development of antibodies.
- During actual infection, the antibodies neutralize antigens.
- The vaccines also generate memory B and T-cells. They recognize the pathogen quickly.
- E.g. Polio vaccine, Hepatitis B vaccine, DPT vaccine etc.
- Vaccines are produced using DNA recombinant technology (E.g. Hepatitis B vaccine produced from Yeast).

2. Passive Immunizati on

- It is the direct injection of pre-formed antibodies or antitoxin. It requires for quick immune response.
- E.g. Immunization against Tetanus, snake venom etc.

Allergies

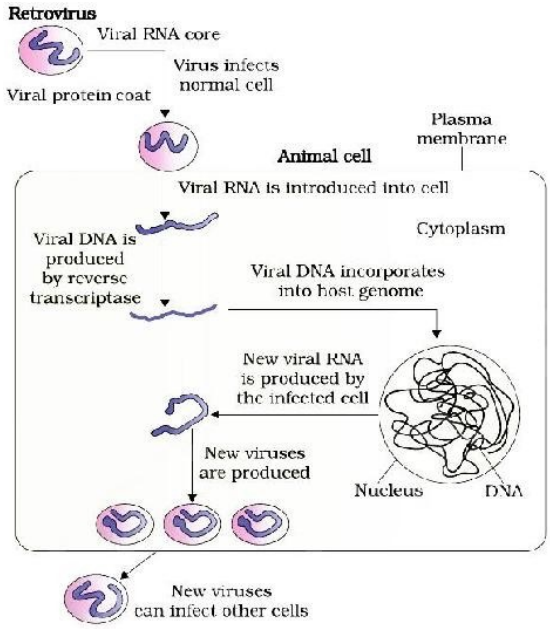
- It is the exaggerated response of the immune system to certain antigens present in the environment.
- **Allergens:** Substances causing allergy. E.g. mites in dust, pollens, animal dander, fur etc.
- Antibodies produced against the **allergens** are of **IgEtype.**
- Allergy is due to the release of chemicals like ***histamine*** and ***serotonin*** from the ***mast cells.***
- **Symptoms:** Sneezing, watery eyes, running nose, difficulty in breathing, skin rashes etc.
- **Determination of cause of allergy:** The patient is exposed to or injected with very small doses of possible allergens, and the reactions studied.
- **Treatment:** Drugs like *anti-histamine*, *adrenaline* and *steroids* quickly reduce the symptoms of allergy.
- **Asthma** is a respiratory disease due to allergy.
- Modern-day life style results lowering of immunity and more sensitivity to allergens.

Autoimmunity

- It is the condition in which the body attacks self-cells due to genetic and other unknown reasons.
- It leads to ***auto-immune disease***. E.g. *Rheumatoid arthritis.*

AIDS (Acquired Immuno Deficiency Syndrome)

- It is the deficiency of immune system.
- It is caused by **HIV (Human Immunodeficiency Virus),** a **retrovirus** having RNA genome.
- AIDS was first reported in America (1981).
- **Transmission:**
  - Sexual contact with infected person.
  - Transfusion of contaminated blood & blood products.
  - Sharing of infected needles.
  - From infected mother to her child through placenta.
- **High risk people of getting HIV:**
  - Individuals with multiple sexual partners.
  - Drug addicts who take drugs intravenously.
  - Individuals who require repeated blood transfusion.
  - Children born to an HIV infected mother.
- HIV does not spread by touch or physical contact. It spreads only through body fluids.
- There is a time-lag (from few months to 5-10 years) between the infection and appearance of symptoms.
- **Replication of retrovirus:**



- **Life cycle:**

HIV enters body → To macrophages (acts as HIV factory) → RNA genome replicates in presence of *Reverse transcriptase* to form viral DNA → Viral DNA incorporates into host DNA→ Infected cells produce virus particles → HIV enters into helper T-cells (T_H) → Replicates & produce progeny viruses → Attack other helper T-cells → T-cells decrease → Weaken immunity.

- HIV infected person may be infected with *Mycobacterium*, viruses, fungi and parasites like *Toxoplasma.*
- **Diagnosis: ELISA test** (Enzyme-linked immuno-sorbent Assay).
- **Treatment:** Anti-viral drugs partially effective. They can only prolong the life of the patient.
- **Prevention of AIDS:**
  - Educate peoples about AIDS.
  - Making blood (from blood banks) safe from HIV.
  - Use of disposable needles and syringes.
  - Advocating safe sex and free distribution of condoms.
  - Controlling drug abuse.
  - Regular check-ups for HIV in susceptible population.

CANCER

- Cancer is an abnormal and uncontrolled multiplication of cells resulting in the formation of tumour (masses of cells).
- Normal cells show a **contact inhibition** (contact with the other cells inhibits their uncontrolled growth). Cancer cells do not have this property.

Types of Tumours

- **Benign tumours:** Confined to the place of its origin. They do not spread to other parts. Cause little damage.
- **Malignant tumours:** Mass of proliferating cells **(neoplastic or tumour cells)** that grow rapidly, invade and damage the surrounding normal tissues. Due to active division and growth, they starve normal cells by competing for nutrients.

Cells sloughed from tumours reach other sites via blood where they form a new tumour. This is called **metastasis**.

Causes of cancer (Carcinogens)

- **Physical agents:** E.g. Ionizing radiations like X-rays and gamma rays and non-ionizing radiations like UV.
- **Chemical agents:** Tobacco smoke (major cause of lung cancer), vinyl chloride, caffeine, nicotine, mustard gas etc.
- **Biological agents:** E.g. **oncogenic viruses, c-onc (cellular oncogenes or proto oncogenes)** etc. When C-onc in normal cells is activated, the cells become oncogenic.

Cancer detection and diagnosis

- **Biopsy:** A thin piece of the suspected tissue is stained and examined under microscope (histopathological studies). **In case of leukemia:** Biopsy & histopathological studies. Blood & bone marrow tests for increased cell counts.
- **Radiography** (use of X-rays), **CT (Computerized tomography) scan & MRI (Magnetic Resonance Imaging).**
- Use of **Antibodies** against cancer-specific antigens.
- **Molecular biology technique:** To detect cancer related genes. Such individuals should avoid carcinogens (e.g. tobacco smoke).

Treatment of cancer

- **Radiotherapy:** Tumour cells are irradiated lethally, without damaging surrounding normal tissues.
- **Chemotherapy:** Use of chemotherapeutic drugs. Many drugs have side effects like hair loss, anaemia etc.
- **Immunotherapy:** The patients are given **biological response modifiers** (e.g. α- interferon) which activates their immune system and helps in destroying the tumour.
- Surgery.

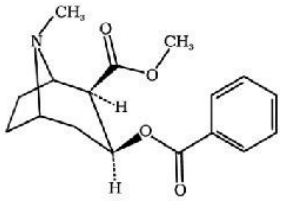
Most cancers are treated by combination of surgery, radiotherapy and chemotherapy.

DRUGS, SMOKING AND ALCOHOL ABUSE

Drugs (opioids, cannabinoids & coca alkaloids)

Opioids:

- They bind to specific **opioid receptors** in CNS and gastrointestinal tract. E.g. morphine, heroin, brown sugar.
- **Morphine** is extracted from the latex of **poppy plant**, ***Papaver som niferum.*** It is a sedative and painkiller, and useful for surgery.

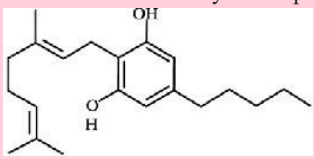


Chemical structure of Morphine

- **Heroin** (*smack* or diacetylmorphine) is a white, odourless, bitter crystalline compound. It is obtained by acetylation of morphine. It is taken by snorting and injection. Heroin is a depressant and slows down body functions.

Cannabinoids:

- They interact with **cannabinoid receptors** in the brain.
- Generally taken by inhalation and oral ingestion.
- Natural cannabinoids are obtained from inflorescences of ***Cannabis sativa*** **(Hemp plant).** Its flower tops, leaves & resin are used to make *marijuana, hashish, charas & ganja.*
- They affect cardiovascular system.
- Cannabinoids are abused by some sportspersons.



Skeletal structure of cannabinoid molecule

Coca alkaloid or cocaine (coke or crack):

- It is obtained from coca plant ***Erythroxylum coca.***
- It interferes with transport of neurotransmitter dopamine.
- Cocaine is usually snorted.
- It stimulates CNS producing euphoria & increased energy.
- Excessive dosage of cocaine causes hallucinations.
- *Atropa belladona* & *Datura* are also hallucinogenic plants.

Drugs like barbiturates, amphetamines, benzodiazepines, lysergic acid diethylamides (LSD), etc. are used as medicines to treat mental illnesses like depression and insomnia. But their abuse results in impairment of physical, physiological or psychological functions.

Smoking

- Tobacco is smoked, chewed or used as a snuff.
- Tobacco contains **nicotine** (an alkaloid). It stimulates adrenal gland to release adrenaline and nor-adrenaline, causing high BP and heart rate.
- Smoking causes cancers of lung, urinary bladder and throat, bronchitis, emphysema, coronary heart disease, gastric ulcer etc. Tobacco chewing causes oral cancer.
- Smoking increases CO content in blood and reduces oxyhaemoglobin. This causes O_2 deficiency in the body.

ADOLESCENCE

- **Adolescence** is 'a period' and 'a process' during which a child becomes mature in terms of his/her attitudes and beliefs for effective participation in society.
- Adolescence is a bridge linking childhood and adulthood (period of 12-18 years of age). It is very vulnerable phase of mental and psychological development.

Causes of drug/alcohol use in Adolescence

- Curiosity and Experimentation.
- Need for adventure and excitement.
- To escape facing problems.
- Stress from pressure to excel in academics or examination.
- Television, movies, newspapers, internet etc.
- Unstable or unsupportive family structures & peer pressure.

Addiction and Dependence

- **Addiction:** It is a psychological attachment (euphoria and a temporary feeling of wellbeing) with drugs and alcohol. With repeated use of drugs, the tolerance level of the receptors increases. Thus the receptors respond only to higher doses leading to greater intake and addiction.
- **Dependence:** It is the tendency of the body to manifest a characteristic and unpleasant ***withdrawal syndrome*** if regular dose of drugs/alcohol is abruptly discontinued. This results in anxiety, shakiness, nausea and sweating. Dependence leads to social adjustment problems.

Effects of Drug/alcohol abuse

- Reckless behaviour, vandalism and violence.
- Coma and death due to respiratory failure, heart failure or cerebral haemorrhage.
- Drugs in combination with alcohol may lead to death.
- Damage of nervous system and liver cirrhosis.
- Mental and social distress to family and friends.

- Social problems like stealing and spread of infectious diseases (e.g. AIDS, hepatitis B).
- Use of drugs and alcohol by pregnant woman affect the foetus (Foetal alcohol syndrome or FAS).
- Loss of sexual drive and necrospermia.
- Misuse of drugs by athletes (e.g. narcotic analgesics, anabolic steroids, diuretics & certain hormones to increase muscle strength and bulk and to promote aggressiveness).

Warning signs of drug/alcohol abuse in Adolescence period

- Drop in academic performance and absence from school.
- Lack of interest in personal hygiene.
- Withdrawal and isolation.
- Depression, fatigue, aggressive and rebellious behaviour.
- Change in sleeping and eating habits.
- Fluctuations in weight, appetite etc.
- Loss of interest in hobbies.
- Deteriorating relationships with family and friends.

Side effects of anabolic steroid abuse

In males:

- Acne.
- Mood swings & depression.
- Increased aggressiveness.
- Reduced testicles.
- Decreased sperm.
- Kidney & liver dysfunction.
- Breast enlargement.
- Premature baldness
- Enlargement of prostate gland.

In females:

- Masculinisation
- Mood swings & depression
- Increased aggressiveness
- Excessive hair growth
- Abnormal menstrual cycle
- Deepening of voice
- Enlargement of clitoris

In adolescent male & female: Severe facial and body acne, premature closure of the growth centres of the long bones resulting in stunted growth.

Prevention and control

1. Avoid undue peer pressure.
2. Education and counselling.
3. Seeking help from parents and peers.
4. Looking for danger signs.
5. Seeking professional and medical help.
    a. Psychologists and psychiatrists.
    b. De-addiction and rehabilitation programs.