Human Health and Disease

1 HEALTH

- As per **'Good humor' hypothesis** arrived at by reflective thought and asserted by **Hippocrates** along with **Indian Ayurveda System,**

  Health is a state of body and mind where there was a balance of certain 'humors' *e.g.*, persons with black bile belonged to hot personality and had fevers.
- **William Harvey** (discovered blood circulation experimentally) disproved this 'good humor' hypothesis of health by demonstrating normal body temperature in persons with black bile using thermometer.

View of biologists in later years:

- Mind influences our immune system through neural and endocrine systems, and that our immune system maintains our health *i.e.*, state of complete physical, mental and social and psychological well being.
- Health is not simply 'absence of disease' or 'physical fitness'.

- **Factors affecting health:**
  Mental state, genetic disorders, infections and life style (habits, rest and exercise)
- **Healthy conditions** → Increase → Productivity, longevity; Bring economic prosperity
  Healthy conditions → Decrease → Infant and maternal mortality

2 DISEASE

- It is state of the body when functioning of one or more organ/systems is adversely affected, characterized by various signs and symptoms.

Types of diseases

Parameters	Non-infectious	Infectious
Transmission from one person to another	×	✓
Example	Cancer	AIDS

- **Pathogens**: are disease causing organisms
  - **Most parasites are pathogens** living in (or on) the host multiply and interfere with normal vital activities resulting in morphological and functional damage.
  - Gut pathogens can survive harsh pH & digestive enzymes.

3 CLASSIFICATION OF DISEASES ON THE BASIS OF TRANSMISSION

Mode of transmission	Bacterial	Viral	Protozoan	Helminthic
Air (droplet/aerosol) or **object borne** (pens, knobs *etc.*)	Pneumonia, diphtheria	Common cold, Smallpox	–	–
Direct contact	Tetanus	Smallpox	–	–
Contaminated food and water	Typhoid, dysentery	Polio	Amoebiasis	Ascariasis
Insect vector/vector borne	Plague	Chikungunya, Dengue	Malaria	Filariasis
Body fluids	Syphilis	AIDS	Trichomoniasis	–

- **Vector:** Transmits disease from one organism to another *e.g.* female *Aedes* mosquito is the vector for dengue and chikungunya, while, *Anopheles* spreads malaria.

4 MEASURES FOR PREVENTING SPREAD OF INFECTIOUS DISEASES

Parameters	Measures
Personal Hygiene	Keeping the body clean Consumption of clean drinking water, food, vegetables, fruits etc.
Public Hygiene	Proper disposal of waste and excreta Periodic cleaning and disinfection of water reservoirs, pools, cesspools and tanks. Decontamination of drinking water
Avoid close contact	Contact with infected persons and belongings should be avoided.
Control vectors and their breeding places	Avoid stagnation of water in and around residential areas. Regular cleaning of house old coolers Use of mosquito nets Introducing **larvicidal fishes** like *Gambusia* in ponds that feed on mosquito larvae Spraying of insecticides in ditches, drainage areas and swamps Doors and windows should be provided with wire mesh.

- Balanced diet, yoga and regular exercise, personal hygiene, awareness about diseases and vaccination are very important to **maintain good health**.
- Use of vaccines and immunisation programmes have enabled us to **completely eradicate a deadly disease like smallpox**. Large number of infectious diseases like polio, diphtheria, pneumonia and tetanus have been controlled to a large extent by the use of vaccines.
- Biotechnology is at the verge of making available newer and safer vaccines.
- Discovery of antibiotics and various drugs have enabled us to effectively treat infections

5 BACTERIAL DISEASES

Disease	Pathogen	Organ affected	Common symptoms
Typhoid	*Salmonella typhi* **Diagnostic test: Widal test**	Small intestine and other organs by migrating through blood	**Sustained high fever (39-40°C)** Stomach pain ○ Weakness Constipation ○ Headache Loss of appetite **In severe cases, intestinal perforation and death** may occur.
Pneumonia	*Streptococcus pneumoniae*, *Haemophilus influenzae*	Alveoli of lungs	Problem in respiration due to fluid filled alveoli Fever, chills, cough, headache **In severe cases, lips and finger nails turn gray to bluish**

Typhoid Mary (Mary Mallon), a cook by profession was a **typhoid carrier** who spread typhoid through the food she prepared.

VIRAL DISEASES

Disease	Pathogen	Organ affected	Symptoms
Common cold	Rhino virus	Nose and respiratory passage	Nasal congestion and discharge Sore throat Hoarseness, cough Headache, tiredness

Common cold does not infect lungs and its symptoms usually lasts for 3-7 days

HELMINTHIC DISEASES

Disease	Pathogen	Organ/structure affected	Symptoms
Ascariasis	*Ascaris* **(Roundworm)**	Intestine	Internal bleeding, fever, muscular pain, anemia, **blockage of intestinal passage**
Elephantiasis /Filariasis	*Wuchereria bancrofti/ W. malayi* **(Filarial worm)**	Lymphatic vessels	**Chronic inflammation** of organs in which they live for many years resulting in gross deformities *e.g.*, limbs, genital organs etc.

FUNGAL DISEASE

Disease	Pathogen	Body parts affected	Symptoms
Ringworm	*Microsporum*, *Trichophyton*, *Epidermo-phyton*	Skin, nails, scalp	Dry, scaly lesions Intense itching

Heat and moisture makes the fungi thrive in **skin folds** such as in groin and between toes

Acquired from soil or belongings of infected individuals such as towels, combs, clothes *etc.*

6 PROTOZOAN DISEASES

Disease	Pathogen	Area affected	Symptoms
Amoebiasis /Amoebic dysentery	*Entamoeba histolytica*	Large Intestine	Constipation Abdominal pain Cramps **Stool with excess mucous and blood clots**
Malaria	*Plasmodium* *P. vivax* *P. malariae* *P. falciparum*	RBCs	Chills High fever recurring every 3-4 days If not treated, can prove to be fatal

House flies act as mechanical carrier for amoebiasis

***P. falciparum* causes malignant malaria (Most serious form)**

LIFE CYCLE OF *PLASMODIUM*

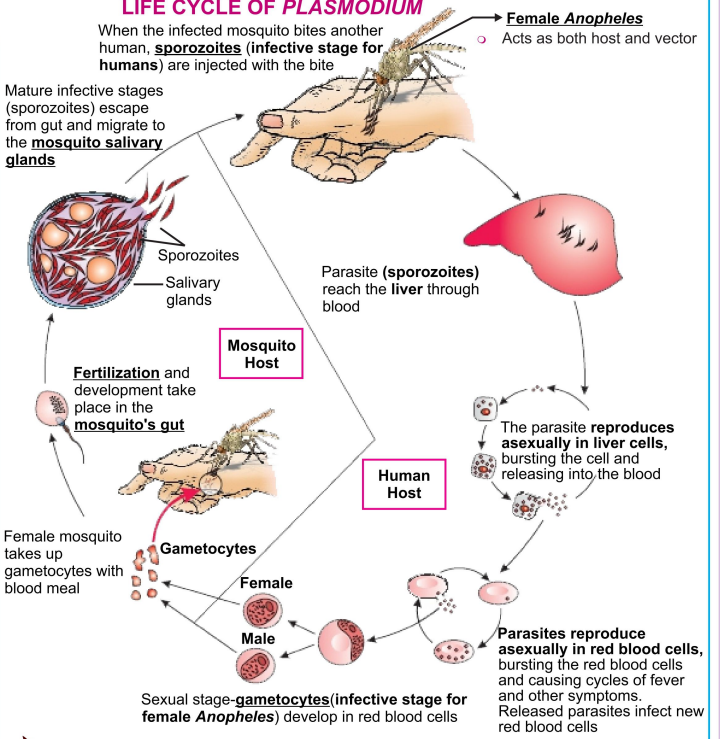


Fig: Stages in the life cycle of *Plasmodium*

Rupturing of RBCs releases the toxic substance, **haemozoin** responsible for symptoms of disease

7 AIDS/ACQUIRED IMMUNO DEFICIENCY SYNDROME

- 1st reported - 1981, Killed – Approximately 25 million people in last 25 years
- It is deficiency of immune system, acquired during the lifetime of an individual
- **Syndrome** means 'group of symptoms'
- **Non congenital, fatal infectious disease**
- **Causative agent** – HIV / Human Immuno deficiency virus
  - ↳ **Enveloped virus enclosing RNA genome**

Life cycle	**Mode of Transmission**	**High Risk Individuals**
Entry of virus in body	Sexual contact	Multiple sexual partners
	Placenta	Mother to foetus
	Blood transfusion	Repeated blood transfusion,
	Infected needles	Drug addicts **(intravenous)**

Entry into body cells **(Macrophages, helper T-cells)**

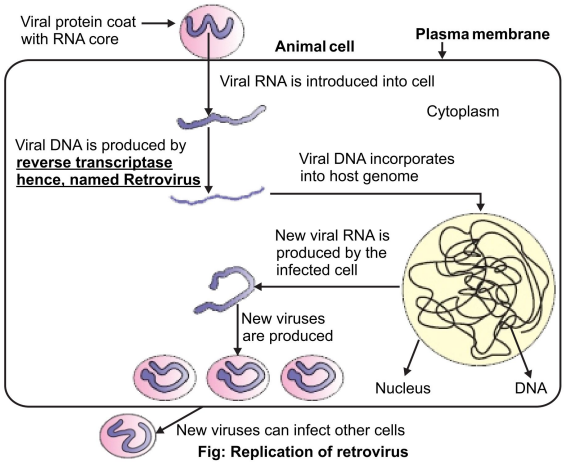


Fig: Replication of retrovirus

Sequence of events:

- Infected cells, **(Macrophages)** can survive while viruses are being replicated and released **hence called HIV factory**
- HIV enters into macrophages and T-helper cells (T_H) simultaneously
- There is progressive decrease in number of helper T-cells.
- **Initial symptoms:** Bouts of fever, diarrhoea, weight loss
- **Later the immuno-deficient patient** is prone to infections especially *Mycobacterium,* viruses, fungi, *Toxoplasma* etc.

There is always a time-lag between infection and appearance of AIDS symptoms. This may vary from a few months to many years (usually 5-10 years)

Diagnostic Test

- **ELISA** (Enzyme Linked Immuno Sorbent Assay)

Treatment

- **Anti-retroviral drugs**, can only prolong life but cannot prevent death

8 CANCER

- A dreaded **non-infectious** disease; major cause of death all across the globe.

Parameters	**Normal cells**	**Cancerous cells/Neoplastic cells**
Cell growth and differentiation	Highly controlled and regulated	Uncontrolled & non-regulated
Contact inhibition	**Present**, virtue of which contact with other cells inhibits their growth	**Lost**, so these cells keep on dividing and form mass of cells called **Tumor/Neoplasm**

Types of Tumor

Parameters	**Benign**	**Malignant tumor/cancer**
Location	Confined to original place	Grow rapidly and spread to other parts
Damage	Little damage	Invade and damage other cells starving normal cells by competing for vital nutrients.
Metastasis	**No**	**Yes**, Cells sloughed from such tumors reach distant sites through blood and start new tumor called **Metastasis (Most feared property)**.

Cause: **Normal cell** Proto/cellular oncogene (*c-onc*) —Neoplastic transformation (causative agents called **carcinogens**)→ **Cancerous cell** Oncogene

- **Ionising radiations**-X-rays, γ - rays • **Non-ionising radiations**-UV rays • **Physical agents**
- **Chemical agents**-in tobacco smoke • **Biological agents**-Oncogenic viruses **(carry viral oncogenes)**
- **Diagnosis/Detection:** Early detection allows the disease to be treated successfully in many cases.

Technique	**Basis**	**Detect**
Biopsy	Histopathological studies	Changes in tissue
Blood and bone marrow test	Cell counts	Leukemias
Radiography	X-rays	Internal organ cancers
Computed tomography **(CT)**	X-rays	Internal organ cancers **(3D image)**
Magnetic resonance Imaging **(MRI)**	Strong magnetic fields and non-ionising radiations	Accurately detect pathological and physiological changes in living tissue
Molecular techniques	Identification of genes responsible for susceptibility to certain cancers	
Antibodies based	Against cancer specific antigens	Certain cancers

- **Tumor cells have ability to avoid detection and destruction by immune system.**
- **Approaches for treatment:**
  - Surgery
  - Radiotherapy: Tumor cells irradiated lethally
  - Chemotherapy: Side effects like hair loss, anemia
  - Immunotherapy: α-**Interferons** (Biological response modifiers) activate immune system and helps in destroying the tumor.

Prevention

- Different agencies like NGOs, NACO, WHO started number of programmes to educate/make people aware of AIDS **(Don't die of ignorance)** and some of the measures preventing spreading of HIV infection.
- **Making blood banks safe** from HIV
- **Use of only disposable needles and syringes** in public and private hospitals and clinics
- **Free distribution of condoms,** advocating safe sex
- **Controlling drug abuse**

Human Health and Disease

1 IMMUNITY

- The ability of the host to fight the disease causing organisms, conferred by the immune system is called **Immunity**

Types

Parameters	Innate	Acquired
Observed from	Time of birth	After birth
Exposure to infection	Not required	Required
Defence	Non specific	Specific
Memory record	×	✓

Memory based immunity evolved in higher vertebrates

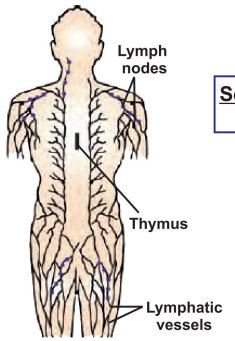
2 INNATE IMMUNITY

- This immunity is accomplished by providing different types of barriers to the entry of the foreign agents.

Types of Barrier	Structures involved/Barrier	Basic function
Physical	○ Skin ○ Mucus coating of the epithelium lining the respiratory, gastrointestinal and urogenital tracts	○ Prevent entry of microbes ○ Trap microbes entering our body
Physiological	○ Saliva in the mouth ○ Acid in stomach ○ Tears from eyes	○ Prevent microbial growth
Cellular	○ Neutrophils/PMNL ○ Monocytes ○ Macrophages ○ Natural killer cells (type of lymphocytes)	○ Phagocytose microbes ○ Destroy microbes
Cytokine	○ Interferons	○ Produced by virus infected cells that protect **non-infected cells** from further infection

3 ACQUIRED IMMUNITY

- The human immune system consists of lymphoid organs, tissues, cells and soluble molecules like antibodies. This response is carried out by two special types of lymphocytes present in our blood *i.e.*, **B and T-lymphocytes.**



Primary lymphoid organs: Thymus, Bone marrow

Matured lymphocytes migrate → T-cells, B-cells

Secondary lymphoid organs: Spleen, lymph nodes, tonsils, appendix, MALT, Peyer's patches

T-cells mediated response → Help → B-cells produce antibodies/Army of proteins in blood

- Origin and/or maturation of lymphocytes
- **lymphocytes become antigen sensitive**
- Provide micro-environments for development and maturation of lymphocytes
- Provide sites for interaction of lymphocytes with antigen which proliferate to become **effector cells**.

- **Cell-mediated immune response/CMI**
- **Humoral immune response/Antibody mediated immune response**

IMMUNE RESPONSE

	Primary	Secondary/Anamnestic
Type		
Exposure to pathogens	First time	Subsequent times
Intensity	Low	High

Based on memory of first encounter

These responses are carried out by B and T lymphocytes.

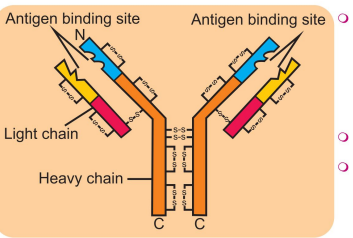


Fig: Structure of an antibody molecule

- Each antibody has 4 peptide chains **(H_2L_2)**
  - 2 long heavy chains
  - 2 short light chains
- Called immunoglobulins (Ig)
- **Types – IgA, IgM, IgE, IgG**

- T-lymphocytes are responsible for graft rejection. Tissue and blood group matching are essential before undertaking any graft/transplant and even after this patient has to take immunosuppressants throughout life.
- If the pathogens succeed in gaining entry to our body, specific antibodies and T-cells serve to kill these pathogens.

4 LYMPHOID STRUCTURES/ORGANS

Structure	Typical
Bone marrow	○ **Main lymphoid organ** where all blood cells are produced including lymphocytes.
Thymus	○ **Lobed** organ located **near the heart** and **beneath the breastbone**. Quite large at the time of birth, **keeps reducing in size** with age and by the time puberty is attained it is reduced to a very small size.
Spleen	○ Large **bean shaped organ**, mainly contains lymphocytes and phagocytes • Acts as a **filter of the blood** by trapping blood borne micro-organisms • **Large reservoir of erythrocytes.**
Lymph nodes	○ Small solid structures located at different points along the lymphatic system ○ Serve to **trap the microbes/antigens** which happen to get into the lymph and tissue fluid. Antigens trapped in the lymph nodes are responsible for the **activation of lymphocytes** present there and cause the immune response.
MALT	○ Mucosa-associated lymphoid tissue is located within the lining of major tracts like respiratory, digestive and urinogenital tracts ○ Constitutes about **50%** of lymphoid tissue in human body.

6 ALLERGIES

Exaggerated response of immune system to certain antigens present in the environment.

Allergens – Substances to which exaggerated immune response is produced e.g. pollens, mites in dust, animal dander, etc.

Antibodies – **IgE type**

Symptoms – Sneezing, watery eyes, running nose, difficulty in breathing

Chemical released – **Histamine** and **serotonin** from mast cells

Diagnosis – Patient is exposed to or injected with very small doses of possible allergens, and reactions studied.

Treatment – Anti-histamine antihistamine, adrenaline and steroids quickly reduce the symptoms of allergy

Effects of modern-day life style

- Protected environment provided early in life has resulted in lowering of immunity and person is more sensitive to allergens
- More and more children in metro cities of India suffer from allergies and asthma due to more sensitivity to the environment

5 VACCINATION AND IMMUNISATION

Types of immunity

	Active	**Passive**
Antibodies	Produced within the host body	Ready-made/preformed antibodies are directly given
Time taken for full/ effective response	Longer	Shorter
Memory cells	✓	✗
Examples	○ Natural infection → Antibody production in host ○ **Vaccination** – Deliberate injection of living/ dead microbes/proteins	○ Mother —Placenta→ Foetus ○ Mother —Colostrum (IgA)→ Infant

Immunisation
(Principle : Property of 'Memory' of immun system)

Active
Preparation of antigenic proteins of pathogen/inactivated /weakened pathogen introduced into body

Passive
Direct preformed antibodies/antitoxin is injected such as antitoxin against snake bites

- The antibodies produced in the host body against antigens would neutralize the pathogenic agents during actual infection.
- The vaccines also generate **memory B-cells and memory T-cells** that recognise the pathogen quickly on subsequent exposure and overwhelm the invaders with a massive production of antibodies.
- **Recombinant DNA technology** has allowed the large scale production of antigenic polypeptides of pathogen in **bacteria/yeast**, hence greater availability for immunisation.
  e.g., **hepatitis B vaccine produced from yeast.**

7 AUTOIMMUNITY

- Memory based acquired immunity evolved in higher vertebrates can **distinguish foreign** molecules as well as foreign organisms (pathogens) **from self-cells**.

If lost this ability

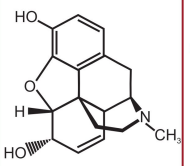
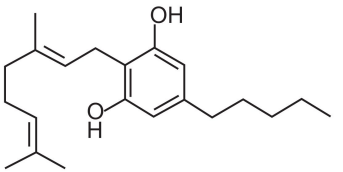
Results – Self **destruction**/body attack self cells

Reason – Genetic/unknown

Example – **Rheumatoid arthritis**

8 DRUG ABUSE

- Chemical when taken for a purpose other than medicinal use or in amounts/ frequency impairs one's physical, physiological or psychological functions and constitutes **drug abuse**.
- **Source** - Majorly from flowering plants and some from fungi.
- Commonly abused drugs are:

Drug	Receptors	Source	Intake	Examples	Action and anything specific
Opioids	CNS, GIT	Latex of poppy plant, *Papaver somniferum*  Opium poppy	Snorting, injection  Chemical structure of Morphine	○ Morphine ○ Heroin/Smack (Diacetylmorphine)	○ Effective sedative and pain killer ○ Useful in patients undergone surgery ○ Depressant and slows down body functions ○ Odourless, white, bitter crystalline compound
Cannabinoids	Principally in brain	Inflorescence, flower tops, leaves and resin of cannabis plant, *Cannabis sativa*  Leaves of *Cannabis sativa*	Inhalation, oral ingestion  Skeletal structure of cannabinoid molecule	○ Charas ○ Hashish ○ Ganja ○ Marijuana	○ Effects on cardiovascular system of the body ○ These days cannabinoids are formating also being abused by some sportspersons
Stimulants	CNS	Coca plant *Erythroxylum coca* (Native of South America)	Snorting	○ Cocaine/coka alkaloid ○ Commonly called (coke/crack)	○ Interferes with transport of neurotransmitter dopamine ○ Potent stimulating action on CNS, producing **sense of euphoria** and increased energy ○ **Excessive dosage causes hallucinations**
Hallucinogens		*Atropa belladona, Datura*  Flowering branch of *Datura*			○ Have been used for hundreds of years in folk-medicine, religious ceremonies and rituals all over the globe.
Other drugs		Synthetic		Barbiturates, Benzodiazepines, Amphetamines	○ Help patients cope with mental illness like **depression insomnia**.

9 DRUGS AND SPORTSPERSON

Why to use?

- Increase muscle strength & bulk
- Promote aggressiveness
- Enhance athletic performance

Commonly abused drugs

- Narcotic analgesics
- Diuretics
- Anabolic steroids
- Certain hormones

Common side effects

- Increased aggressiveness
- Mood swings
- Depression
- Stunted growth because of premature closure of growth centres of long bones
- Severe facial and body acne

Typical side effects

Male

- **Breast enlargement**
- Decreased sperm production
- Reduction in size of testicles
- Acne, premature baldness, enlargement of prostate gland
- Potential for liver and kidney dysfunction

Female

- **Masculinisation** (features like males)
- Abnormal menstrual cycles
- Enlargement of clitoris
- Excessive hair growth on face & body
- Deepening of voice

- These side effects may be permanent with prolonged use.

10 TABACCO/SMOKING-PAVES THE WAY TO HARD DRUGS

Intake	Smoked Chewed Snuff
Chemical substance	**Nicotine, an alkaloid**
Action of nicotine	Stimulates adrenal gland to release adrenaline and non-adrenaline into blood circulation.
Effects	
Respiratory system	Increases carbon monoxide (CO) in blood and reduces concentration of haembound oxygen, causes oxygen deficiency in the body
Circulatory system	Increase heart rate and blood pressure.
Common diseases	Bronchitis Emphysema Coronary heart disease Gastric ulcer
Risk of cancers	Oral cavity Throat Lungs Urinary bladder

- Tobacco has been used by humans for more than 400 years
- Packets of cigarettes, warns against smoking and says how it is injurious to health.

11 ADOLESCENCE AND DRUG/ALCOHOL ABUSE

- **Adolescence** means both "**a period**" and "a **process**" during which a child mature in terms of his/her attitudes and beliefs for effective participation in society.
- Adolescence is a **bridge linking childhood and adulthood.**
- It's a period between **12-18 years of age,** a **vulnerable phase of mental** and **psychological development** of an individual.
- It is accompanied by several biological and behavioural changes.
- Curiosity, need for adventure and excitement, and experimentation, motivate youngsters towards drug and alcohol use.
- First use may be out of curiosity but later used to escape from stress, pressures to excel in academics, perception that it is cool.
- Television, movies, newspapers, internet, **promote** this perception.
- Unstable or unsupportive family structures and peer pressure also promote drug and alcohol abuse.

Use of durgs even once can be **"fore-runner to addiction"** and pull the user into a vicious circle leading to their regular use/abuse.

12 ADDICTION AND DEPENDENCE

Addiction

- Because of perceived benefits, drugs are frequently used repeatedly that leads to **psychological attachment to certain effects** like euphoria and temporary feeling of well being

Dependence

It is the tendency of the body to manifest a characteristic and unpleasant "withdrawal syndrome" if regular dose of drugs/alcohol is abruptly discontinues.

Addiction drive people to take drug even when its use become self-destructive

- **With repeated** use of drug, **tolerance level of receptors increases**
- Receptors respond only to higher doses of drugs leading to greater intake.

Effects of drug/alcohol abuse

- Reckless behaviour. ❍ Vandalism ❍ Violence ❍ Depression ❍ Fatigue ❍ Drop in academic performance
- **Warning signs:**
  - Unexplained absence from school/college
  - Aggressive and rebellious behaviour
  - Change in sleeping and eating habits
  - Deteriorating relationships with family and friends
  - Poor personal hygiene, withdrawal, isolation
  - Loss of interest in hobbies
  - Fluctuations in weight and appetite
- High doses lead to **coma** and **death** due to respiratory failure, heart failure or cerebral hemorrhage
- Chronic use of drugs/alcohol damage **nervous system and liver (cirrhosis)**
- Use of drugs during pregnancy **adversely affect foetus.**

Some far-reaching implications

- Abuser may turn to stealing
- Addict becomes the cause of mental and financial distress to entire family and friends

Withdrawl syndrome

If drug is abruptly discontinued, symptoms include:

- Anxiety ❍ Nausea ❍ Shakiness ❍ Sweating
- In severe cases, can be life threatening, person needs a medical supervision.

Prevention and control

"Prevention is better than cure"

- **Avoid undue peer pressure** on child related to sudies, sports or other activities
- **Education and counselling:** Channelise energy of child into healthy pursuits like sports, yoga, reading, music, etc.
- Sort out problems by **seeking help from parents and peers.**
- **Looking for danger signs** :Alert parents, teachers and close friends need to look for and identify the danger signs of substance (drug/alcohol) abuse and appropriate measures would then be required to diagnose the malady and underlying cause.
- Proper remedial steps or treatment should be taken by **seeking professional and medical help** in the form of highly qualified psychologists, psychiatrists and de-addiction and rehabilitation programmes. This will totally relieve the individual from these evils.