

## Applications of Biology

### Introduction

The study of the application of biological principles for the human welfare. The fields incorporated are improvement of domesticated animals and cultivated plants by using the knowledge of genetics; increasing food production by the timely and judicious use of fertilizers and pesticides without ecodegradation; integration of biofertilisers and biological pest control with traditional techniques; protection of grains in stores with suitable insecticides; control of cancers' organic diseases (cardiovascular, brain, joints), congenital defects and metabolic disorders by eliminating their causes; checking the increasing menace of drug addiction.

## Pesticides

A pest may be defined as any organism that cause damages to economic and physical well-being of humans. Pesticides are the substances used to kill or repel pests (*cide* meaning 'killer'). About 30% of agricultural products in India are lost every year due to pests and diseases. Chemical pesticides are toxic chemicals used in killing pests.

### 20.1.1 Classification of pesticides

On the basis of chemical structure, major pesticides are grouped into Organochlorines, Organophosphates, Carbamates, Pyrethroids and Triazines.

(i) **Organochlorines** : Important examples of organochlorines are (a) DDT (b) BHC (c) Aldrin and (d) Endosulphan.

(a) **DDT (Dichloro di-phenyl trichloro ethane)  $C_{14}H_9Cl_5$**  : DDT has become ineffective for killing mosquitoes because of the development of adaptive resistance. Spraying of DDT on crops produces pollution of air, soil and water. In India, as a result of prolonged use of DDT, 13-31 ppm of DDT can be detected in the body fat of the people, highest in the world. DDT was first synthesised by German chemist Othnar Zeidler in 1874 and its insecticidal value was discovered by Paul Muller in 1939. DDT is the most famous pesticide of the world and is a nonbiodegradable pollutant.

(b) **BHC (Benzenehexachloride)  $C_6H_6Cl_6$**  : BHC was first synthesized by Michael Faraday in 1825 and its insecticidal value was independently discovered by Dupire (1941) in France and Leicester (1942) in England. The most common pesticide used in India is BHC; it represents about 50% of total volume of pesticides used in India.

(c) **Endosulphan (Thiodan)  $C_9H_6Cl_6O_2S$**  : Endosulphan is a pesticide and is useful in the control of aphids, caterpillars, plant bugs and borers.

(d) **Aldrin (Octalene)  $C_{12}H_8Cl_6$**

(1) Aldrin is an insecticide applied to foundations of buildings to prevent termites.

(2) Aldrin has been successfully used in control of locusts and grasshoppers in India.

(3) Aldrin, Dieldrin and Endrin are very poisonous pesticides.

(ii) **Organophosphates** : Organophosphates inhibit cholinesterase, an enzyme essential for transmission of nerve impulse across synapse. Major organophosphates used in India are Malathion, Parathion and Fenitrothion.

(iii) **Malathion** : It is one of the two active ingredients in Flit, the second being Pyrethrin.

(iv) **Carbamates** : Some commonly used carbamates are Carbofuran (Furadan), Propoxur (Baygon) and Aldicarb (Temik).

Methyl isocyanate gas which caused **Bhopal gas tragedy** on 3rd Dec. 1984. is used as a raw material for synthesizing Carbaryl (trade name Selvin). The ingredient which killed hundreds of people in Bhopal gas tragedy was Methyl isocyanate (MIC). Derivatives of carbamates are also used as herbicides (phenylcarbamates, thiocarbomates) and fungicides (dithiocarbamates).

(v) **Pyrethroids** : Examples of pyrethroids are Allethrin, Cyalethrin and Barthrin which are quick-acting broad spectrum insecticides. Pyrethroids are highly toxic and quite expensive, not used on a large scale in India at present. Pyrethroids are synthetic derivatives of pyrethrin, a chemical produced by grinding of flowers of the plant *Chrysanthemum cinerarifolium*.

(vi) **Triazines** : Triazines are used for controlling weeds in tea, tobacco and cotton. Triazines (Simazine, Atrazine, etc.) are a group of herbicides derived from urea.

(vii) **Bordeaux mixture** : Bordeaux mixture is used primarily as a fungicide, it was first used to control downy mildew disease of grape-vine caused by a fungus, *Plasmopara viticola*. The first pesticide to be used commercially was Bordeaux mixture. Bordeaux mixture was discovered by Millardet in France in 1882. Bordeaux mixture is prepared by dissolving 40 g. of copper sulphate and 40 g. of calcium hydroxide in a litres of water. Most herbicides attack the photosystem II (photolysis of water and oxygen evolution) in photosynthesis and also translocation of organic substances in plants. Pesticides also enter the food chain; their concentration goes up as they move up in the food chain. This is called biomagnification or bioconcentration.

### 20.1.2 Bioherbicides and Bioinsecticides

The first bioherbicide was mycoherbicide, based on the fungus *Phytophthora palmivora*, and was developed in 1981. In India and Australia, the overgrowth of cacti was checked by the introduction of cochineal insect (*Cactoblastis cactorum*). Introduction of juvenile hormones at inappropriate time results in the early death of insect pests. Natural insecticides are obtained mostly from plant and occasionally from microbes. One of the earliest pesticides employed by human was Margosa (neem) leaves. Aphids have been controlled by the use of ladybugs or praying mantis. Screw-worm was eradicated by releasing sterile males (sterilized by irradiation) at the time of mating to compete with natural fertile population. Sporeine was the first bioinsecticide developed on commercial scale in Germany. Sporeine kills insects by inhibiting ion transport in the midgut. Transgenic plants of tomato showing resistance to hornworm larvae have been obtained. Genes for

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some of these toxins have been isolated and transferred to host through recombinant DNA technology (transgenic plants).

S. No.	Insecticide	Source
(1)	Nicotine	Tobacco ( <i>Nicotiana tabacum</i> )
(2)	Pyrethroids	<i>Chrysanthemum cinerarifolium</i>
(3)	Rotenone	Roots of <i>Derris elliptica</i>
(4)	Sabadilla	Seeds of <i>Schoenocaulon officinale</i>
(5)	Ryania	Roots and stem of <i>Ryania speciosa</i>
(6)	Azadirachtin	Seeds of <i>Azadirachta indica</i> (Neem or Margosa)

### 20.1.3 Integrated pest management

IPM is based on the assumption that no single safe pest control method will be successful. IPM, therefore, seeks to use a variety of biological, physical and chemical methods integrated into a cohesive scheme designed to provide long-term protection. Biological methods include using natural predators of pests, using resistant varieties, crop rotation, intercropping, etc. Mechanical methods include manual destruction of eggs of pests, removing weeds, etc. Use of chemical pesticides is carefully timed. Integrated pest management is the selection, integration and implementation of pest control based on predicted economic, ecological and sociological consequences.

## Immune System and Immune Response

### 20.2.1 Immunity

The ability of an individual to resist the development of diseases and allergy is called Immunity.

#### Differences between active and passive immunity.

Active immunity	Passive immunity
(1) Immunity is said to be active when person's own cells produce antibodies in response to infection or vaccination.	(1) Immunity is said to be passive when antibodies produced in other organisms are injected into a person to counteract antigen such as snake venom.
(2) It takes time in the formation of antibodies.	(2) It provides immediate relief.
(3) It is harmless.	(3) It may create problems. Foreign antibodies may cause reaction and body may destroy them by forming its own antibodies.
(4) Active immunity is long lasting.	(4) Passive immunity is not long lasting.

### 20.2.2 Components of immune system

#### Differences between humoral immune system and cell-mediated immune system

Humoral immune system	Cell-mediated immune system
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(1) It is made up of B-lymphocytes.	(1) It is made up of T-lymphocytes.
(2) It defends against the pathogens that invade the body fluids.	(2) It defends against the pathogens as well as fungi or protists that invade the host cells.
(3) It does not react against transplants and cancerous cells.	(3) It reacts against transplants and the cancerous cells.

### 20.2.3 Cells of the Immune system

#### Cells of the Immune system

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 and help 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.

### 20.2.4 Antibody and antigen

#### Difference between antibody and antigen

	Antibody	Antigen
(1)	Antibody is a molecule synthesised by an animal to combat foreign material.	Antigen is usually a foreign material that elicits antibody formation.
(2)	Each antibody is a protein molecule.	Antigen is a protein or polysaccharide molecule.
(3)	Antibody occurs on the surface of plasma cell and also in body fluids.	Antigen may occur on the surface of a microbe or in a free molecule.
(4)	Antibody directly joins an antigen to destroy the antigen.	Antigen binds to a macrophage to reach a helper T-cell to initiate immune response.

### 20.2.5 Immunoglobulin classes

#### Types and functions of different immunoglobulin classes

S. No.	Immunoglobulin class	Functions
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(1)	Ig A	Called secretory immunoglobulin because it is present in all body secretions including colostrum and mother's milk. Functions as first line of defence against inhaled and ingested pathogens by activating alternate pathway of complement system.
(2)	Ig D	Alongwith IgM occurs over B-lymphocytes as antigen receptors, activation of B-cells, also present in serum tissue and effective against toxins and allergens.
(3)	Ig E	Present in mucous membranes, skin and lungs. Attaches to mast cells and basophils for relcasing histamine and other substances that mediate hypersensitive response to allergens.
(4)	Ig G	Constitute 75% of the total Ig, present in all body parts, can pass through placenta providing passive immunity to neonates, stimulate complement system and phagocytes against toxins, viruses, bacteria and fungi.
(5)	Ig M	Largest Ig with 10 binding sites, activates B-cells over which it is present along with IgD, also first to reach site of infection and activate classical pathway of complement system.

## 20.2.6 Interferons and antibodies

### Differences between interferons and antibodies

Interferons		Antibodies	
(1)	Interferons are produced by any microbe-infected cell.	(1)	Antibodies are produced by plasma B-cell only.
(2)	They leave the infected cell and enter a nearby healthy cell to dispose off the microbes.	(2)	They pass into and circulate in blood and lymph to dispose off the antigens.
(3)	They induce the healthy cell to synthesise the antimicrobial proteins that check microbial multiplication.	(3)	They selectively bind to the antigens that are immobilised for easy attack by phagocytes.
(4)	They are quick in action but give a temporary protection against microbes.	(4)	They are slow in action but give a long-lasting protection against antigens.
(5)	They act inside the cell.	(5)	They act outside the cells
(6)	They form the body's second line of defence.	(6)	They form the body's third line of defence.

## Diseases

A condition of the body or a part of it in which functions are disturbed or damaged. A wide variety of diseases attack human beings. These diseases are the three main types: communicable or infectious diseases, noncommunicable diseases and genetic disorders.

### 20.3.1 Communicable diseases

Communicable diseases are caused by pathogens and readily spread from the infected to the healthy persons. The pathogens may be bacteria, viruses, protozoans and Helminthes.

#### (i) Diseases caused by bacteria

## Some common bacterial diseases

Disease	Pathogen or causative organism	Habitat	Mode of infection	Incubation period	Main symptoms
(1) Tuberculosis	<i>Mycobacterium tuberculosis</i>	Lungs	By patient's sputum and throat and nose discharges from persons suffering from active stage of disease.	3 to 6 weeks	Fever, cough, sputum containing blood, pain in chest and loss of body weight
(2) Typhoid	<i>Salmonella typhi</i>	Intestine	By contaminated food and water; by intestinal discharges.	10 to 14 days	Continued fever often with delirium, slow pulse, rose-coloured eruption or rash.
(3) Leprosy	<i>Mycobacterium leprae</i>	Skin, mucous membranes, peripheral nerves.	Spreads through long and close contact with the infected person.	3 to 5 years or more.	Skin lesions, ulcers, nodules, scaly scabs, deformities of fingers and toes and wasting of body parts.
(4) Cholera	<i>Vibrio cholerae</i>	Intestine	By contaminated food and water	From few hours up to 5 days but commonly 1 to 2 days.	Vomiting, acute diarrhoea and muscular cramps.
(5) Diphtheria	<i>Corynebacterium diphtheriae</i>	Mucous membrane of the wall of throat	By discharges from throat of an infected person.	2 to 6 days.	Early symptoms mild fever, sore throat; late symptoms difficulty in breathing due to obstruction in the throat.
(6) Tetanus	<i>Clostridium tetani</i>	Body tissues	Through wounds and cuts in the body.	6 to 10 days. It may be as short as one day or as long as several months.	Painful contraction of muscles, usually of neck and jaw, followed by paralysis of thoracic muscles.
(7) Plague	<i>Pasteurella pestis</i>	Blood and lymph	By rat flea bite	2 to 7 days	High fever, extreme weakness and painful enlargement of lymph nodes, generally in the groin or armpit.
(8) Whooping cough (Pertussis)	<i>Bordetella pertussis</i>	Respiratory tract	By discharges from throat of infected person and also by direct contact.	7 to 14 days, but not more than 3 weeks.	Mild fever and irritating cough called whooping
(9) Gonorrhoea	<i>Neisseria gonorrhoeae</i>	Urogenital mucosa	By sexual contact (Sexually transmitted disease)	2 to 14 days in males, and 7 to 21 days in females.	Inflammation of mucous membranes of urogenital tract, arthritis and female sterility.
(10) Syphilis	<i>Treponema pallidum</i>	Oral, genital, rectal mucosa	By sexual contact (Sexually transmitted disease)	3 weeks	Lesions in the oral, genital and rectal regions
(11) Scarlet	<i>Streptococcus</i>	Upper	Discharges from nose.	12-24 hours	Rash develops as

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<b>fever</b>	<i>pyogenes</i>	respiratory tract			small "goose pimples" on the skin.
(12) <b>Meningitis</b>	<i>Neisseria meningitidis</i>	CNS			Inflammation of the meninges of central nervous system.
(13) <b>Anthrax</b>	<i>Bacillus anthracis</i>		Contact with spore containing animals.		High fever, rapid breathing, painful swelling in different body parts.
(14) <b>Botulism (Food poisoning)</b>	<i>Clostridium botulinum</i>				Swollen tongue, double vision, vomiting, diarrhoea, fatigue and respiratory failure.
(15) <b>Pneumonia (pneumococcal)</b>	<i>Streptococcus pneumoniae</i>	Lungs	By patient's sputum	1-3 days	Fever, chills, shortness of breath and cough that produces sputum and occasionally blood.
(16) <b>Bacterial dysentery (Shigellosis)</b>	<i>Shigella sonnei</i> , <i>Sh.dysenteriae</i>	Intestine	By contaminated food, water, hands and fomite.		Diarrhoea
(17) <b>Typhus fever</b>	<i>Rickettsia prowazekii</i>	Endothelial cells of small blood vessels	By contact with the faecal matter of head and body lice.	10-12 days	High fever, uneasiness, loss of strength, skin rash, severe headache, inflammation and rupture of blood vessels.
(18) <b>Q fever</b>	<i>Coxiella burnetti</i>		By airborne dust particles and droplets	9-28 days	Fever, severe headache, chilliness and muscular pain
(19) <b>Trench fever</b>	<i>Rochalimaea quintana</i>	Blood	By head and body lice.	14 – 30 days	Fever, weakness, dizziness, headache, severe back and leg pains, skin rash and occasionally enlargement of liver and spleen.
(20) <b>Rocky mountain spotted fever</b>	<i>Rickettsia rickettsii</i>	Endothelial cells	By ticks	3-12 days	Sever headache, chills, skin rash, muscular pain and loss of strength.

### (ii) Diseases caused by virus

## Some common viral diseases

Disease	Pathogen causative organism or	Habitat	Mode of infection	Incubation period	Main symptoms
(1) Chicken pox	<i>Varicella zoster</i>	Skin sores	By contact with sores or by skin of an infected person.	Usually 14 to 16 days, but it may be as long as 7 to 21 days.	Rise in temperature, general discomfort such as fever, pain in back, shivering and malaise and rash. skin sores that open and emit fluid.
(2) Measles (Rubeola)	<i>Rubeola virus</i>	Respiratory mucosa.	By droplets from nose and throat and respiratory tract of a case of measles.	10 days from exposure to onset of fever and 14 days to appearance of rash.	Fever, inflammation of respiratory mucous membranes, sensitivity of the eyes to the light and rash eruption of the skin.
(3) Mumps	<i>Myxovirus parotidis</i>	Salivary glands.	By droplet infection (discharges from the throat of an infected person) and after direct contact with an infected person	Varies from 2 to 3 weeks, usually 18 days.	Pain and swelling in parotid glands, difficulty in opening the mouth Mumps may also affect testes, pancreas, central nervous system, ovaries and prostate, etc.
(4) Poliomyelitis (Polio)	<i>Polio virus</i>	Nerve cells.	By contaminated food and water.	7 to 14 days. (Range 3 to 35 days).	Stiffness and pain in the neck and back. As the virus invades central nervous system, it causes varying degrees of paralysis such as limb paralysis.
(5) Rabies (Hydrophobia)	<i>Lyssavirus type I or street virus</i>	Brain and spinal cord cells	By the bite of rabid dog.	Commonly 3 to 8 weeks but may vary from 4 days to many years.	Damage in the cells of spinal cord and brain, high fever, severe pain, difficulty in swallowing, extreme salivation, biting behaviour, fear of water, etc.
(6) Smallpox	<i>Variola virus</i>	Mucous membrane of respiratory tract and pustules on the skin of infected persons.	By droplet infection of oral and nasal discharges and by contact with the clothes of an infected person.	12 days	Sudden onset of fever, headache, backache, vomiting and sometimes convulsions. On third day skin rash appears. the rash gradually changes into pustules containing clear fluid, then scabs. Scabs leave permanent pitted scars, the pockmarks.
(7) Trachoma	<i>Chlamydia trachomatis</i>	Eyelids, conjunctiva and cornea of eye	By direct contact, use of towels, pillow, and handkerchiefs of an infected person and by flies.	5 to 12 days	Inflammation, discomfort and discharge from the eyes and corneal ulceration.
(8) Influenza	<i>Influenza virus (A, B and C types of influenza virus)</i>	Mucous membrane of nose, throat and upper respiratory tract.	By contact and droplet infection (discharges from nose and throat) of an infected person	18 to 72 hours	Discharges from nose sneezing, fever, headache, muscular pains, coughing, inflammation of respiratory mucosa and general weakness.
(9) Viral hepatitis (i) Hepatitis A	<i>Hepatitis A virus (HAV)</i>	Liver	By ingestion, by direct contact (person to person), indirectly by contaminated food, water or milk.	15 to 45 days (usually 25 to 30 days)	Fever, chills, headache, fatigue, general weakness, aches and pains, followed by anorexia, vomiting, dark urine and jaundice.
(ii) Hepatitis B	<i>Hepatitis B virus (HBV)</i>	Liver	By infected blood inoculation, from mothers to their babies	45 to 180 days (usually less than 100 days)	Progressive liver disease, chronic active hepatitis and hepatocellular carcinoma
(10) Common cold	<i>Rhino virus</i>	Mucous membrane of respiratory tract	Droplet infection		Headache, watery eyes, sneezing, excessive nasal secretions and cough.
(11) Dengue fever	<i>Dengue virus</i>		Mosquito bite	3 to 8 days	Classical dengue – Fever, headache, pain in joints, vomiting. dengue Haemorrhagic fever – Bleeding of skin, GI tract, excessive thirst, restlessness and difficulty in breathing.
(12) Yellow	<i>Arbovirus</i>		Mosquito bite	6 days	Fever, headache, backache,



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<b>fever</b>					vomiting, rupture of veins in kidneys, spleen, liver etc. and yellowing of eyes and skin
(13) AIDS	HIV		By contact with blood	28 months average	Infections, cancer, brain damage, WBC destruction.

### (iii) Diseases caused by protozoa.

#### Some common protozoan diseases

Diseases	Pathogen	Transmission	Affected organ	Incubation period	Main symptoms
(1) Amoebiasis	Entamoeba histolytica	Water and food contamination	Digestive System	About 2 to 4 weeks or longer	Mild diarrhoea, alternating with constipation. In severe cases, there may be dysentery with mucus and blood in stool. Abscesses may be formed in liver.
(2) Giardiasis	Giardia lamblia	Water and contact	Digestive System		Epigastric pain, abdominal discomfort, diarrhoea, headache and sometimes fever.
(3) Trichomoniasis (Leucorrhoea)	Trichomonas vaginalis	Sexual contact	Vagina		Discharge of whitish fluid from vagina
(4) Sleeping sickness	Trypanosoma	Bite of tsetse fly	Plasma, Nervous fluid		When in blood → causes high fever. When in lymph → swelling of neck and armpit. When in cerebrospinal fluid → weakness, anaemia, lethargy, unconsciousness and death.
(5) Kala- azar	Leishmania donovani	Bite of sandfly	Blood and lymph	2 weeks to 18 months	Infection occurs chiefly in spleen and liver, secondarily in bone marrow and intestinal villi, characterized by fever and enlargement of visceral organs.
(6) Balantidiosis	Balantidium coli	Water and food contamination	Digestive System		Ulcers in human colon, diarrhoea and dysentery.
(7) Malaria	Plasmodium	Bite of female Anopheles mosquito	Circulatory System and Liver		

### (iv) Diseases caused by helminthes

#### Some Common helminthes diseases

Diseases	Pathogen	Transmission	Affected organ
(1) Bilharzia	Schistosoma	Water and food contamination	Circulatory System
(2) Taeniasis	Taenia solium	By eating infected park	Intestine
(3) Ascariasis	Ascaris	Water and contact	Intestine
(4) Ancylostomiasis	Ancylostoma		Intestine
(5) Elephantiasis or Filariasis	Filaria or Wuchereria banerofti	Bite of tsetse fly	Lumph
(6) Trichinosis	Trichinella	Bite of sandfly	Intestine
(7) Guinea worm disease	Dracunculus	Water and food contamination	Periphery muscles
(8) Eyeworm disease	Loa loa	Bite of female Anophele mosquito	Eye

## 20.3.2 Non-communicable diseases

The noncommunicable diseases remain confined to the person who develops them and are not transmitted to other persons.

(i) **Diabetes mellitus**

- (a) Caused due to relative or complete lack of insulin secretion by B-cells of islets of Langerhans.
- (b) Causes chronic hyperglycemia.

(ii) **Arthritis**

- (a) Characterized by pain and swelling of joints.
- (b) Rheumatoid arthritis - inflammation of synovial membrane.
- (c) Osteoarthritis - due to erosion of articular cartilage.
- (iii) **Gout** : Due to accumulation of uric acid crystals in synovial joints.

(iv) **Cardio-vascular diseases**

- (a) Rheumatic heart disease is an auto immune disease.
- (b) Hypertension i.e. increased blood pressure.
- (c) Angina pectoris - chest pain caused by myocardial anoxia.
- (d) Myocardial infarction - commonly called coronary or heart attack.
- (e) Arteriosclerosis - Hardening of arteries.

(v) **Cancer**

(a) Characterized by uncontrolled growth and division of cells. Cancer leads to a mass of cells termed as '**Neoplasm**' or tumor - referred to as malignant tumor.

- (b) Spread of cancerous cell to distant sites is termed '**Metastasis**'.
- (c) Study of cancer cells - oncology.
- (d) Agent causing cancer - Carcinogenic or oncogenic agent.

(vi) **Types of cancer**

- (a) **Carcinomas** : Malignant growth of epithelial tissue.
- (b) **Sarcomas** : Malignant growth of connective tissue.
- (c) **Leukemia** : Unchecked proliferation of blood cell type (Leucocytes)
- (d) **Lymphoma** : Cancer of lymphatic tissue
- (e) **Lipoma** : Tumor that originate from adipose or fatty tissue.
- (vii) **Diagnosis of cancer by** : (a) Biopsy (b) X-ray and (c) Microscopic examination of body fluids.

(viii) **Treatment of cancer**

- (a) Surgical removal of tumor.
- (b) Radiotherapy
- (c) Chemotherapy

(d) A common weed *Catharanthus roseus* is the source of two anti cancer drugs, Vincristine and vinblastin used in the treatment of Leukemia

<b>Carcinomas</b>	<b>Sarcomas</b>
Breast cancer	Bone tumor
Lung cancer	Muscle tumor

Cancer of pancreas	Cancer of lymph nodes
Cancer of stomach	

### Some Cancer-causing Agents and their targets

Carcinogen	Target tissue
Soot	Skin and lungs
Coal tar (3,4-benzopyrene)	Skin and lungs
Cadmium oxide	Prostate glands
Aflatoxin (a mould metabolite)	Liver
Mustard gas	Lungs
Nickel and chromium compounds	Lungs
Asbestos	Lungs
Diethylstilbestrol (DES)	Vagina
Vinylchloride	Liver
Cigarette smoke	Lungs

### Oncogenic Viruses and Associated Cancers

Virus	Type of Cancer
Rous sarcoma virus	Sarcoma in chicken
Murine Sarcoma virus	Sarcoma in mice
Avian Sarcoma virus	Sarcoma in birds
Luck's disease virus	Adenocarcinoma (Renal tumor in frogs)
Epstein-Barr	Burkitt's lymphoma (common in Africans)
Herpes Simplex II	Cancer of uterus cervix in women

### 20.3.3 Genetic disorders

Genetic Disorder arise in man in the following ways

(i) By numerical changes in chromosomes.

(a) In autosomes, *e.g.*, Down's syndrome.

(b) In sex chromosomes, *e.g.*, Turner's and klinefelter's syndromes.

(ii) By gene mutation in chromosomes.

(a) In autosomes, *e.g.*, Alkaptonuria, phenylketonuria, sickle-cell anaemia, albinism, infantile amaurotic idiocy.

(b) In sex chromosomes, *e.g.*, Haemophilia, red-green colour blindness, night blindness, muscular dystrophy.

### Common human genetic disorders.

Name of disorder	Type of disorder	Effect of disorder	Symptoms of disorder
(1) <b>Albinism</b>	Autosomal gene mutation.	Lack of enzyme tyrosinase.	absence of dark pigment in the skin, hair and iris.
(2) <b>Phenylketonuria (PKU)</b>	Autosomal gene mutation.	Lack of enzyme phenylalanine hydroxylase.	Extreme mental retardation.

(3) <b>Tay-Sach's disease</b>	Autosomal gene mutation.	Lack of enzyme hexosaminidase A.	Mental retardation, blindness, muscular weakness.
(4) <b>Alkaptonuria</b>	Autosomal gene mutation.	Lack or inactivity of enzyme homogentisate oxidase.	Blackening of urine on exposure to air, darkening of cartilage.
(5) <b>Colour blindness (Red-green colour blindness)</b>	Sex-chromosomal gene mutation.	Lack of red and green colour vision pigments in cone cells of retina.	Inability to distinguish red from green colour.
(6) <b>Haemophilia</b>	Sex-chromosomal gene mutation.	Lack of blood coagulant.	Blood does not clot, more common in males.
(7) <b>Muscular dystrophy</b>	Sex-chromosomal gene mutation.	Lack of protein dystrophin.	Muscle degeneration, most sufferers are males.
(8) <b>Erythroblastosis foetalis</b>	Incompatibility of genes.	Anti-Rh factor of mother's blood	Anaemia of baby, damage to brain.
(9) <b>Down's syndrome</b>	Autosomal aneuploidy.	Trisomy of chromosome 21.	Mongolian eyelid fold, ever open mouth, protruding tongue, short neck, projecting lower lip.
(10) <b>Klinefelter's syndrome</b>	Sex-chromosomal aneuploidy.	XXY sex-chromosomes.	Sterile male, usually long limbs, obesity, sparse body hair, enlarged breasts, mental retardation.
(11) <b>Turner's syndrome</b>	Sex-chromosomal aneuploidy.	XO-sex-chromosomes.	Sterile female, under developed breasts, short stature, neck with heavy muscles and loose skin, narrow lips.

### 20.3.4 Sexually transmitted diseases

Venereal Diseases (VD) or sexually transmitted diseases (STD) represent group of infection diseases that are spread primarily through sexual intercourse. The term 'venereal' comes from **Venus**, goddess of love. Unlike syphilis and gonorrhoea, genital herpes is incurable. **Herpes simplex** causes painful blisters on the prepuce, glans penis and penile shaft in males, and on the vulva or high up in the vagina in females. The blisters disappear and reappear, but the disease itself is still present in the body.

#### Some STD and their Pathogens

Disease	Pathogen
(1) Syphilis	Treponema pallidum
(2) Gonorrhoea	Neisseria gonorrhoeae
(3) Chancroid	Haemophilus ducreyi
(4) Vaginitis	Gardnerella vaginalis
<b>Viral</b>	
(5) Herpes genitalis	HSV – 2 (DNA) virus
(6) Condyloma acuminatum	Papova (DNA) virus
<b>Protozoan</b>	
(7) Trichomoniasis	Trichomonas vaginalis

#### Some Immunological tests and Disease

Test	Disease
(1) Amest test	Carcinogenicity
(2) Dick test	Scarlet fever
(3) Mantoux test	Tuberculosis

(4) Rose-Waaler test	Rheumatoid fever
(5) Schick test	Diphtheria
(6) Wassermann test	Syphilis
(7) Widal test	Typhoid
(8) Watson stain test	Plague
(9) Tourniquet test	Dengue fever
(10) ELISA	AIDS

### 20.3.5 Diseases spread through blood transfusion

#### (i) Hepatitis

(a) It is a viral disease

(b) Types are Hepatitis A hepatitis B, C, D, E and Hepatitis F have also been discovered now.

(c) Hepatitis A virus mainly attack children and young adult. No vaccine.

(d) Hepatitis B causes serum hepatitis. Only adult is susceptible but vaccines are available.

(e) High risk of cancer.

#### (ii) AIDS (Acquired Immuno deficiency Syndrome)

(a) Caused by human immuno deficiency virus (HIV)

(b) There are two types of HIV namely HIV-1 and HIV-2.

(c) The most common virus currently associated with AIDS is HIV-1

(d) HIV is a retrovirus containing RNA as genetic material.

(e) HIV progressively destroys T- lymphocytes.

(f) AIDS related complex (ARC) is milder form of AIDS. World AIDS day is celebrated on 1st December on the basis of number of patients in world South Africa is in first position and India is second.

(g) Test for HIV - ELISA (enzyme linked immunosorbent assay). A positive ELISA should be confirmed using another test called the **western blot test**.

(h) Transmission : Intimate sexual contact and contact with blood are common mode. It can be transmitted from mother to foetus.

## Biomedical technologies

### 20.4.1 X-ray radiography

(i) A beam of X-rays is directed at a part of body where the rays are absorbed more by dense structures such as ribs and heart muscles than by less dense structures such as skin or lungs.

(ii) This causes shadows of variable intensity to be cast on a photographic film (radiograph).

(iii) Employed for diagnosing diseases of heart, lungs and detection of fractures and joint injuries.

### 20.4.2 CT scanning

- (i) Developed by Godfrey Hounsfield of Britain in 1968 (Nobel prize in 1979).
- (ii) This technique combines the use of X-rays with computer technology to produce 2-D or 3-D clear cross-sectional image of an area.
- (iii) Useful in diagnosis of disorders in any part of the body.
- (iv) Also known as CAT (Computerised Axial Tomography).

### 20.4.3 Positron emission tomography or PET

- (i) Positron (positive electron) emitting radioisotopes are incorporated in biochemicals which are then injected into the blood stream and get distributed to different parts according to physiological requirements.
- (ii) Provides 3-D images that reflect metabolic and chemical activity of tissues being studied.
- (iii) Useful in measuring regional blood volume and blood flow and for locating the areas of abnormalities.

### 20.4.4 MRI (Magnetic resonance imaging)

- (i) Provides high quality cross-sectioned or 3-D images of organs and structures without using X-rays or other radiations. Uses strong magnetic field for generating resonance and low radio of frequency in protons (from hydrogen atoms in water molecules) present in the body.
- (ii) Reflects differences in water content of tissues, high light pathological changes, especially useful in studying brain and spinal cord.

### 20.4.5 Ultrasound scanning

- (i) It is also known as Sonography
- (ii) Uses ultrasound waves (high frequency, inaudible sound waves) in the range of 1-15 million Hz which are produced due to piezoelectric effect.
- (iii) Transducer which emits these waves, converts them into electrical signals which are displayed on a screen to give 2-D images.
- (iv) Useful in diagnosing diseases of brain, kidney stones, gall stones, cirrhosis etc.

### 20.4.6 Intra-aortic balloon pump

- (i) A special balloon is positioned in descending aorta and connected through a tube to external machine.
- (ii) The balloon is inflated (during diastole) and deflated (during systole) rhythmically with Helium.
- (iii) It is used to improve blood supply to heart wall and other organs.

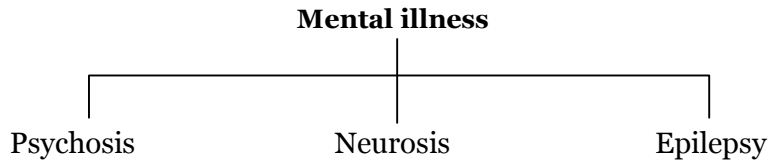
## Mental Health, Addiction and Community Health

" Health is a state of complete physical, mental and social well-being, and not merely an absence of disease or infirmity". Besides the three dimensions (physical, mental and social) of health projected by WHO, a fourth dimension, namely "spiritual health" has also been suggested. Health implies an all-round development of an individual so that it functions optimally without any disease or abnormality.

### 20.5.1 Mental health

Mental illness of a person is characterised by his abnormal behaviour and talk causing distress and suffering both to the person and people around him.

(i) **Types**



(a) **Psychosis** : It is a severe mental disorder in which the individual loses contact with “insane” (madness), not aware of his illness, refuses to take help.

(b) **Neurosis** : It is a mild type of mental illness with excessive or prolonged emotional reactions (anger, fear, sadness, vague aches, etc.)

(c) **Epilepsy** : It is usually characterised by fits of convulsions, the person loses consciousness and falls down.

(ii) **Causes** : The main causes of mental illness are

- (a) Changes in the brain
- (b) Hereditary factors
- (c) Childhood experiences
- (d) Home atmosphere
- (e) Special factors

(iii) **Treatments**

(a) **Shock treatment** (ECT = Electro Convulsive Therapy) : It is suited in some cases and can bring about dramatic improvement in severe depression.

(b) **Psychotherapy** : It also assists a person in adjusting himself to the surroundings.

(c) **Social therapy** (rehabilitation) : It has an important role to play.

A principal reason for psychosis or mental depression is the diminished activity of the norepinephrine and serotonin. Antipsychotic drugs like phenothiazine and lithium are used to calm or sedate the cases of acute psychoses. Most antipsychotic drugs block the action of dopamine, a chemical that stimulates nerve activity in the brain.

**20.5.2 Addiction**

The term ‘**addiction**’ refers to a dependence on and craving for tobacco, alcohol or a particular drug.

(i) **Tobacco Addiction** : Central Tobacco Research Institute is situated at Rajahmundry (A.P.). Anti-tobacco day is celebrated on May 31. Nicotine stimulates passage of nerve impulses, causes muscles to relax, and increased heart rate. Tobacco smoke contains, Carbon monoxide, Polycyclic aromatic hydrocarbons and tar. Polycyclic hydrocarbons are carcinogenic. The main harmful effects of smoking are respiratory diseases (lung cancer, bronchitis and emphysema) and cardiovascular diseases (coronary artery disease and peripheral vascular disease).

(ii) **Alcohol addiction** : Liver synthesises fats from alcohol; the extra fat decreases the production of enzymes and structural proteins. As a result, the liver becomes a storehouse for fat instead of a metabolic centre. The accumulation of fat results in 'fatty liver syndrome' leading to cirrhosis (replacement of liver cells by fibrous tissue). Alcohol addiction lowers blood sugar level, adversely affecting the brain. Ethyl alcohol is a colourless liquid produced from the fermentation of carbohydrates by yeast. Ethanol or ethyl alcohol is the active constituent of alcoholic drinks such as beer (5 percent by volume), wine (10 percent by volume) and whisky (40 percent by volume). In medicine, alcohol is used as an antiseptic and a solvent. Alcohol decreases the activity of CNS, thereby reducing anxiety, tensions and inhibitions. Alcohol decreases the secretion of ADH (antidiuretic hormone) from posterior pituitary causing increased urine output. Alcohol and driving do not go together as alcohol causes.

- (a) Reduced ability to judge distance.
- (b) Reduced co-ordination of limbs, head and eyes.
- (c) Reduced alertness.
- (d) Reduced field of vision (tunnel vision).
- (e) Increased reaction time.
- (f) Changed behaviour

(iii) **Drugs** : Drug can be any chemical substance that alters the function of one or more body organs or changes the process of a disease. Tobacco is the dried leaves of the plant *Nicotiana tabacum* and *N. rustica* (Family Solanaceae). The use of tobacco originated in America, it was smoked by the Red Indians. Nicotine is the substance that causes addiction to tobacco. Nicotine acts as a tranquillizer, but also stimulates the release of adrenaline leading to high blood pressure. Nicotine is highly poisonous; nicotine present in a cigarette is sufficient to kill a person if injected intravenously. Some drugs have a particular risk; the patient becoming totally dependent on them. This is called drug dependence. Psychotropic drugs (Mood-altering drugs) act on the brain and alter the behaviour, consciousness and powers of perception. C.D.R.I. (Central Drug Research Institute) is situated in Lucknow.

(a) **Categories of psychotropic drugs** : Four categories of psychotropic drugs are (1) Sedatives and tranquillisers, (2) Opiate narcotics, (3) Stimulants and (4) Hallucinogens.

(1) **Sedatives and tranquillisers** : Tranquillisers reduce tension and anxiety without inducing sleep. Sedatives and tranquillisers have a depressing (switching off) effect on the activity of the brain. Sedatives may produce a feeling of calmness, relaxation or drowsiness. In higher dose, sedatives induce deep sleep.

(2) **Opiate narcotics** : A common opium derivative is brown sugar, chemically known as diacetylmorphine hydrochloride. Morphine has sleep and dream inducing properties. Codeine is milder than morphine and used in cough syrup. Narcotics induce addiction if used repeatedly and heroin is the most dangerous narcotic. Opium is obtained from the unripe seed pods of the poppy plant *Papaver somniferum*. Opium has an analgesic (pain-killing) effect and may also reduce anxiety and tension, and lowers the blood pressure and breathing rate. Opium and its derivatives, which include morphine, codeine and heroin are among the drugs collectively known as narcotic drugs.

(3) **Stimulants** : Stimulants are also known as '**mood elevators**'. There are two main groups of stimulant drugs : central nervous system stimulants (e.g., amphetamine drugs) and respiratory



stimulants (*e.g.*, analeptic drugs). Mildest among the stimulants is caffeine, commonly taken in the form of tea, coffee and cola drinks. Amphetamines and cocaine are strong stimulants. Cocaine is obtained from the leaves of *Erythroxylon coca*. “Crack” is a purified form of cocaine; it can cause seizures and cardiac arrest.

(4) **Hallucinogens LSD** (lysergic acid diethylamide) : It is one of the most dangerous hallucinogens of modern times derived from Ergot fungus, *Claviceps purpurea*. LSD produces “bad trips” in which a person experiences panic, fear, nausea, dizziness and weakness. The products of hemp plant, *Cannabis sativus*, like bhang, marijuana, ganja, hashish, charas. etc. are other examples of hallucinogens. Hallucinogens include certain drugs of abuse, also called psychedelic drugs, such as LSD, marijuana, mescaline and psilocybin. These drugs have a strong effect on cerebrum and sense organs and take the user to a world of fantasy giving him false and temporary happiness. Hallucinogens can alter a person’s thoughts, feelings and perceptions.

(b) **Effect of simultaneous use of drugs and alcohol**

- (1) Alcohol + Barbiturates – increase depressant effect
- (2) Alcohol + Antihistamines – cause drowsiness
- (3) Alcohol + Valium – increase sedative effect
- (4) Alcohol + Hashish – decrease co-ordination
- (5) Alcohol + Aspirin – damage to gastric mucosa

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### **20.5.3 Community health**

Community health services give special attention to the sanitation of environment, prevention and control of communicable diseases, Maternal and child health, and family welfare and school health services. In India, the community health programme was started as sub programme under Community Development Programme (1952).