Common Drugs

(i) **Antipyretics:** Those drugs which are used to bring down body temperature during fever. e.g., Paracetamol, Aspirin etc.

(ii) **Antacids:** Those substances which neutralize the excess acid and raise the pH to an appropriate level in stomach are called antacids. e.g., magnesium hydroxide, aluminium hydroxide gel etc.

(iii) **Antihistamines:** Antihistamine is the drug which combate the effect of histamine released by certain cells of the body (most cell) during allergic reaction. These are widely used for treatment of hay fever, conjuctivitis, snoozing, itching of eyes, nose and throat etc. e.g., diphenylhydramine, promethazine etc.

(iv) **Tranquillizers:** Drugs which are used for the treatment of stress, fatigue, mild and severe mental diseases are called tranquillizers. e.g., equanil, valium, serotonin, barbituric acid, luminal, seconal etc. They form an important component of sleeping pills. They are also called Psychotherapeutic drugs.

(v) **Analgesics:** Drugs which reduce pain without reducing consciousness, mental confusion, paralysis or some other disturbance of the nervous system are called analgesics. e.g., aspirin, paracetamol, morphine diacetate etc. Certain narcotics (which induce sleep and unconsciousness) like morphine and its derivatives codeine and heroine are used in severe pain as analgesic.

(vi) **Antimicrobials:** Drugs used to cure diseases caused by microorganisms such as bacteria, viruses, fungi etc., are called antimicrobials. e.g., sulphanilamide

(vii) **Antibiotics:** These are chemical substances which are produced by some microorganism and can be used to either inhibit the growth or even kill other microorganism which cause infections. e.g., penicillin, chloramphenicol, erythromycin etc. The first antibiotic was discovered by Alexander Flemming in 1929 from the mould Penicillium notatum, was penicillin. The antibiotics can be either bactericidal or bacteriostatic. The range of micro-organisms attacked by an antibiotic is called its spectrum.

(viii) **Antiseptics :** Those chemical substances which prevent the growth of micro-organism or may even kill them. They are safe to be applied on living tissues. e.g., furacin, soframycin, boric acid, iodine, bithional etc.

(ix) **Disinfectants:** Those chemical substances which kill microorganisms but are not safe to be applied on the living tissues. These are generally used to kill the micro-organism present in the drains, toilets, floors etc. e.g., 0.2% solution of phenol acts as an antiseptic whereas 1% solution acts as a disinfectant.

(x) **Antifertility drugs :** Chemical substances used to check pregnancy in women are known as anti-fertility drugs or oral contraceptives. e.g., Norethindrone, Mifepristone etc.

RADIO PHARMACEUTICALS

The use of specific radiotracers called radio pharmaceuticals for imaging organ function and disease states is a unique capability of nuclear medicine. Radio pharmaceuticals are used in the field of nuclear medicine as tracers in the diagnosis and treatment of many diseases. Radio pharmaceuticals should have a short half-life so that they should minimize the radiation dose to patients and at the same time be long enough to perform the diagnosis procedure.

Some common examples of radio pharmaceuticals are :

(i) 99mTc-MDP (methyldiphosphate) used for bone scan.

(ii) I131 for thyroid imaging.

(iii) C14-PABA (para-amino benzoic acid) used for pancreatic studies

(iv) Co-60 for treatment of cancer

FOOD CHEMISTRY

Chemicals in Food

Food additives : All those chemicals which are added to food to improve its keeping qualities, appearance, taste, odour and nutritive (food) value are called food additives. Some important food additives are :

(i) Food colours

(ii) Flavours and sweetness

(iii) Fat emulsifiers and stabilising agents

(iv) Flour improvers – antistaling agents and bleaches

(v) Antioxidants

(vi) Preservatives

(vii) Nutritional supplements such as minerals, vitamins and amino acids

Except for chemicals of category (vii), none of the above additives have nutritive value. These are added either to increase the shelf life of stored food or for cosmetic values, i.e., taste, appearance, etc.

Food preservatives: Chemical substances which are used to protect food against bacteria, yeasts and moulds are called preservatives. Preservatives are classified into two groups – Class-I and Class-II. Class-I preservatives include table salts, sugar and vegetable oils. Some common preservatives of Class-II are :

1. Sodium benzoate and
2. Sodium metabisulphite

Advantages and Disadvantages of Beverages and Tobacco

Tea

It stimulates the nervous and muscular system and is a tonic for the heart and lungs. It causes indigestion, nervousness and burns on stomach walls.

Alcohol

In the body it is metabolized to other substances, affecting the central nervous system in particular. The effect varies between individuals, and can be worse when applied in addition to certain drugs. When applied to open wounds (as for disinfection) it produces a strong stinging sensation. Pure or highly concentrated

ethanol may permanently damage living tissue on contact. When large quantities of ethanol are consumed, it tends to slow metabolic processes and to depress the central nervous system. This results in lack of coordination, mental confusion, drowsiness, lowering of the normal inhibitions, and finally stupour.

Tobacco

There is no much use of inhaling tobacco whereas its effects are sleeplessness, irregularity of heart beats, dyspepsia and blindness.

Portland Cement

It was first discovered in England. It is essentially a mixture of lime stone and clay. It was called Portland cement because in presence of water it sets to a hard stone-like mass resembling with the famous Portland rock. The approximate composition of Portland cement is

Calcium oxide (CaO)	62%
Silica (SiO2)	22%
Alumina (Al2O3)	7.5%
Magnesia (MgO)	2.5%
Ferric oxide (Fe2O3)	2.5%

In cement, almost entire amount of lime in present in the combined state as calcium silicate (2CaO. SiO2 and 3CaO. SiO2) and calcium aluminates (3CaO. Al2O3 and 4 CaO. Al2O3).

(i) Cement containing excess amount of lime cracks during setting; while cement containing less amount of lime is weak in strength.

(ii) Cement with excess of silica is slow-setting and that having an excess of alumina is quick-setting.

(iii) Cement containing no iron is white but hard to burn.

Note : Cement is manufactured by two processes, viz. wet and dry. A small amount (2–3%) of gypsum is added to slow down the setting of the cement so that it gets sufficiently hardened. Setting of cement is an exothermic process and involves hydration of calcium aluminates and calcium silicates.

Glass

It consists of a mixture of two or more silicates.

Physical Properties of Glass

Hard, rigid, high viscosity, bad conductor of heat and electricity, brittle, etc.

Chemical Properties of Glass

(i) It is resistant to action of air and acids except hydroflouric acid.

(ii) It is alkaline in nature.

(iii) It slowly reacts with water to form alkaline solution.

Types of Glass :

(i) Silica glass: For this type of glass the raw material used is 100% pure form of quartz. It is quite expensive. It is used in the manufacture of laboratory apparatus. It has low thermal expansion.

(ii) Alkali silicate glass: For it the raw materials used are sand and soda. It is also called water glass because it is soluble in water and used only as a solution. It is generally used to make gums and adhesives.

(iii) Lead glass: For this type of glass lead oxide is added to ordinary glass. The addition of lead oxide increases the density and also the refractive index. This type of glass is used for the manufacture of ornamental glass ware, decorative articles, etc.

(iv) Optical glass: This type of glass is used in the manufacture of optical instruments like binoculars, spectacles, lenses, prisons, tellescopes, microscopes etc. It generally contains phosphorus, lead silicates with little cerium oxide which absorbs UV radiations.

(v) Borosilicate glass: It contains silica and Boron oxide and small amount of oxides of sodium and aluminium. It is resistant to a wide variety of chemicals due to this property it is used in the manufacture of laboratory ware.

Polymers

A polymer may by defined as a high molecular weight compound formed by the combination of a large number of one or more types of small molecules of low molecular weight. The small unit (or units) of which the polymer is made is known as monomer (or monomers). Many polymeric substances occur in nature such as cellulose, starch, rubber, proteins, and resins. Polymerisation may be defined as a chemical combination of a number of similar or different molecules to form a single large molecule.

The monomers can unite in two different manners to form large molecules, in other words we can say that the polymerisation can be achieved by two methods, viz., condensation and addition polymerisation. In the former the two monomers (same or different) link with each other by the elimination of a small molecule, such as water or methyl alcohol, as a by product to form the dimer, which again condenses with another molecule of monomer in the same way by the elimination of a small molecule to form trimer, which forms tetramer, and so on until a large molecule is formed.

Plastics, Resins and Rubber

(i) Thermoplastics : Those substances which soften on heating. Examples : Polyethene, PVC, nylon, teflon, etc.

(ii) Thermosetting resins or thermosetting plastics : Those substances which are converted to an infusible material on heating and thus they are not subjected to heat-softening. Examples : Bakelite, urea-formaldehyde resin, etc.

(iii) Rubber : Natural and synthetic rubbers are examples of polymers, 'Raw' rubber is obtained from the latex of the rubber tree. Natural rubber is a linear polymer of isoprene. It is very soft and, to make it hard, is cross-linked by heating under high pressure with sulphur. This process is called vulcanisation. Synthetic rubbers are made by polymerisation of chloroprene, styrene and butadiene mixtures.

DYES

Dyes are chemical substances used to impart colour to the textiles, silk, wool, food stuffs, etc.

Conditions For a Substance to Behave Like Dye

(1) It must have a suitable colour.
(2) It must be able to fix itself on fabric.
(3) When fixed, it must be fast to light.
(4) Resistant to action of water, soap, detergents etc.

Different dyes in our daily life

(i) Acid dyes:
Dyes which are sodium salt of azo dyes containing sulphonic acid (– SO3H) and carboxylic acid (– COOH) groups are called acid dyes. These dyes are applied to the fabric like wool, silk, nylon and acrylic fibres. E.g., orange-I, orange-II and congo red.

(ii) Basic dyes:
These dyes are the salts of the colored bases containing amino groups (–NH2 or –NR2) as the auxochromes. Modified nylons and polyesters can be dyed with these dyes. E.g., Aniline yellow, butter yellow and malachite green.

(iii) Direct dyes
These dyes can be directly applied to the fabric in the form of aqueous solution. These are most useful for fabrics which can form hydrogen bonds with the dyes like cotton, wool, silk, rayon and nylon. E.g., Congo red and Martius yellow.

(iv) Disperse dyes:
These are water insoluble dyes and are applied to the fabric in form of a dispersion of the finely divided dye in a soap solution in the presence of some stabilizing agents such as phenol, cresol or benzoic acid. These dyes are used to dye synthetic fibres such as nylons, polyesters and polyacrylonitrile fibres. E.g., Celliton fast pink B and Celliton fast blue B.

(v) Fibre reactive dyes:
These are those dyes which contain a reactive group which combines directly with hydroxyl or amino group of the fibre. E.g., Derivatives of 2, 4-dichloro-3, 5-triazine.

(vi) Ingrain dyes :
These are water insoluble azo dyes which are produced in situ on the surface of the fabric by means of coupling reactions. E.g., para red.

(vii) Vat dyes :
These are insoluble dyes which are first reduced (via alkaline sodium hyposulphite) to a colourless soluble form in large vats and then applied to the fabric. E.g., Indigo.

(viii) Mordant dyes :
These dyes do not dye the fabric directly but require a mordant. The mordant, infact, acts as a binding agent between the fibre and the dye. For acid dyes, metal ions are used as mordants but for basic dyes, tannic acid is used as the mordant. E.g., alizarin.

ENVIRONMENTAL POLLUTION

Pollution

Pollutant :- Any material affecting the life is known as pollutant and the phenomenon is known as pollution. The pollutants may be inorganic, biological or radiological in nature.

(i) Primary pollutants : These are emitted directly from the sources. eg. inorganic gases such as H_2S, SO_2, CO, NO, HF, NH_3 radioactive substancs or particulates such as smoke, ash, dust, fumes.

(ii) Secondary pollutants : These are formed in the atmosphere by chemical interactions among primary polluntants eg. SO_3, NO_2, CH_4, aldehydes, ketones, nitrates, sulphates, phenols.

(iii) Bio-degradable pollutants : These are domestic wastes which are rapidly decomposed by micro-organisms.

(iv) Non-degradable pollutants : These include chemicals, mercuric salts, lead compounds, pesticides etc.

(v) Natural pollution : It is caused by radioactive substances, volcanic eruptions, forests and mines fires, floods etc.

(vi) Artificial pollution : It is caused by industries, thermal plants, automobile exhausts, sewage etc.

Environment :

The conditions existing around animal or human life. It is further classified as

(a) Atmosphere :- The gaseous envelop surrounding the earth.
- **(i) Stratosphere :** The layer of the earth's atmosphere above the troposphere and below the mesosphere.
- **(ii) Troposphere :** The lowest region of the atmosphere extending from earth's surface to the lower boundary of the stratosphere. It contains water vapour and is greatly affected by air pollution.
- **(iii) Thermosphere :** The upper region of the atmosphere above the mesosphere. It is the hottest region (temp upto 1200°C).
- **(iv) Mesosphere :** The region of the earth's atmosphere above the stratosphere and below the thermosphere. It is the coldest region (temp. –2 to –92°C) of atmosphere.
- **(v) Exosphere :** The uppermost region of atmosphere. It contains atomic and ionic O_2, H_2 and He.

(b) Hydrosphere :- The aqueous envelop of the earth eg. oceans, lakes etc.

(c) Lithosphere :- The solid rocky portion of the earth.

(d) Biosphere :- The biological envelop which supports the life.

Air Pollution :

(I) Major air pollutants: The major air pollutants are following:-

(a) Carbon monoxide (CO) :- It is produced by incomplete combustion of gasoline in motor vehicles, wood, coal, inceneration and forest fires. It is treacherous and deadly poisonous gas. It induces headache, visual difficulty coma and death. It blocks the normal transport of oxygen from the lungs to other parts of the body.

(b) Sulphur dioxide (SO_2) :- It is produced by petrol combustion, coal combustion, petrol refining and smelting operations. It hinders the movement of air in

and out of lungs. It is particularly poisonous to trees causing chlorosis and dwarfing. In presence of air it is oxidised to SO_3 which is also irritant.

$$2\,SO_2 + O_2\ (air) \longrightarrow 2\,SO_3$$

In presence of moisture SO_3 is converted into highly corrosive sulphuric acid.

$$SO_3 + H_2O\,(moisture) \longrightarrow H_2SO_4$$

It attacks marble, limestone, vegetation, paper and textiles and injurious to human beings.

(c) **Oxides of nitrogen :-** NO_2 and NO

(Source - combustion of coal, gasoline, natural gas, petroleum refining, chemical plants manufacturing explosives and fertilizers, tobacco smoke. Breathing NO_2 causes chlorosis to plants and chronic lung conditions leading to death. NO_2 reacts with moisture to form acids.

$$2NO_2 + H_2O \longrightarrow HNO_2 + HNO_3$$

$$3\,HNO_2 \longrightarrow 2\,NO + HNO_3 + H_2O$$

(d) **Smoke, dust :-** Sources foundries, cement works, iron and steel works, gas works, power generating stations.

(e) **Ammonia :** Ammonia works

(f) **Chlorine and hydrogen chloride :** Chlorine works

(g) **Chlorinated hydrocarbons :** Dry cleaning works

(h) **Mercaptans :** Oil refineries, coke ovens

(i) **Zn and Cd :** Zinc industries

(j) **Freon :** Refrigeration works.

(II) **Photochemical pollutants :-** The nitrogen dioxide by absorbing sunlight in blue and U. V. region decomposes into nitric oxide and atomic oxygen followed by a series of other reactions producing O_3 formaldehyde, acrolein and peroxyacylnitrates.

Ozone causes bronchial irritation even at 1 ppm level. Ozone affects tobacco plants, spinach, tomato, potato etc. The photochemical pollutants are powerful eye irritants. The reactions are as follows

$$NO_2 + h\upsilon \longrightarrow NO + O, \qquad O + O_2 \longrightarrow O_3$$

$$RH + O \longrightarrow RO^{\bullet}, \qquad RO^{\bullet} + O_2 \longrightarrow RO_3^{\bullet}$$

$$RO_3^{\bullet} + RH \longrightarrow \text{Aldehydes} + \text{Ketones}$$

$$RO_3^{\bullet} + NO \longrightarrow RO_2^{\bullet} + NO_2$$

$$RO_2^{\bullet} + NO_2 \longrightarrow \text{Peroxyacylnitrate}$$

(III) **Smog :** It is a mixture of smoke (composed to tiny particles of carbon, ash and oil etc. from coal combustion) and fog in suspended droplet form. It is of two types :

(a) ***London smog or classical smog :*** It is coal smoke plus fog. The fog part is mainly SO_2 and SO_3. It has sulphuric acid aerosol. It causes bronchial irritation and acid rain. It is reducing in nature.

(b) ***Photochemical smog or Los Angeles smog :*** The oxidised hydrocarbons and ozone in presence of humidity cause photochemical smog.

Hydrocarbons + O_2, NO_2, NO, O, O_3 → Peroxides, formaldehyde, peroxyacetylnitrate (PAN), acrolein etc. It is oxidising in nature and causes irritation to eyes, lungs, nose, asthamatic attack and damage plants.

(IV) **Acid rain :-** The oxides of C, N and S present in the atmosphere, dissolve in water and produce acids and lower the pH of water to below 5.5.

$$H_2O + CO_2 \longrightarrow H_2CO_3 \rightleftharpoons 2\,H^+ + CO_3^{2-}$$

$$2\,H_2O + 2\,SO_2 + O_2 \rightarrow 2\,H_2SO_4 \rightleftharpoons 2\,H^+ + SO_4^{2-}$$

$$2\,H_2O + 4\,NO_2 + O_2 \rightarrow 4\,HNO_3 \rightleftharpoons 4H^+ + 4NO_3^-$$

The acids are toxic to vegetation, react with marble and damage buildings.

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2$$

Acids corrode water pipes and produce salts with heavy metals ions viz Cu, Pb, Hg and Al toxic in nature.

(V) **Green House effect :-** The retention of heat by the earth and atmosphere from the sun and its prevention to escape into the outer space is known as green house effect. Green house gases such as CO_2, ozone, methane, the chlorofluoro carbon compounds and water vapour form a thick cover around the earth which prevents the IR rays emitted by the earth to escape. It gradually leads to increase in temperature of atmosphere.

(VI) **Ozone layer and its depletion :-** The ozone layer, existing between 20 to 35 km above the earth's surface, shield the earth from the harmful U. V. radiations from the sun. The U. V. radiations cause skin cancer, cataract of eye, and harmful to vegetation.

Depletion of ozone is caused by oxides of nitrogen

$$N_2O + h\upsilon \longrightarrow NO + N$$

reactive nitric oxide

$$NO + O_3 \longrightarrow NO_2 + O_2$$

$$O_3 + h\upsilon \longrightarrow O_2 + O$$

$$NO_2 + O \longrightarrow NO + O_2$$

$$2\,O_3 + h\upsilon \longrightarrow 3\,O_2 \text{ (Net reaction)}$$

The presence of oxides of nitrogen increase the decomposition of O_3. Depletion of ozone by chlorofluoro carbons.

$$CF_2Cl_2 + h\upsilon \longrightarrow CF_2Cl + Cl$$

$$CFCl_3 + h\upsilon \longrightarrow CFCl_2 + Cl$$

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow Cl + O_2$$

$$O_3 + O \longrightarrow 2O_2 \text{ (Net reaction)}$$

(VII) Control of air pollution :- It can be controlled by

1. Dissolving HCl, HF, SiF_4 in water and SO_2, Cl_2, H_2S in alkaline solution.
2. Adsorbing gas and liquids molecules over activated charcoal and silica gel.
3. Chemical reactions

$$2CuO + O_2 + 2SO_2 \longrightarrow 2CuSO_4$$

$$2CaCO_3 + O_2 + 2SO_2 \longrightarrow 2CaSO_4 + 2CO_2$$

$$4NO + 4NH_3 + O_2 \longrightarrow 2N_2 + 6H_2O$$

4. Use of precipitators to settle charge particles
5. Use of settling chambers under the action of gravity
6. Use of natural gas in place of diesel, petrol etc.

WATER POLLUTION

The contamination of water by foreign substances which would constitute a health hazard and make it harmful for all purposes (domestic, industrial or agriculture etc.) is known as water pollution. The polluted water may have affensive odour, bad taste, unpleasant colour, murky oily etc.

Sources of water pollution :

(i) Domestic sewage : Discharges from kitchens, baths, lavatories etc.

(ii) Industrial waters : Wastes from manufacturing processes which includes acids, alkalies, pesticides, insecticides, metals like copper, Zinc, lead, mercury, fungicides etc.

(iii) Oil : from oil spills or washings of automobiles

(iv) Atomic explosion and processing of radioactive materials

(v) Suspended particles (organic or inorganic) viruses, bacterials algae protozoa etc.

(vi) Wastes from fertilizer plants such as phosphates, nitrates ammonia etc.

(vii) Clay : Ores, minerals, fine particles of soil.

Effects of impurities in water : Dissolved substances

(i) Hardness : Corrossive effect on boils, alkalinity, laxative effect

(ii) Fluorides : Motting of teeth enamel, nervous and skeleton disorders, above 1 mg/litre causes fluorosis.

(iii) Sulphates : Sulphates of Na, K, Mg cause **diarrihoea**

(iv) Sodium chloride : It imparts bad taste to water

(v) Iron and manganese : Stain fabrics, bad taste, modify colours

(vi) Lead : It damages kidney, liver, brain and central nervous system

(vii) Cadmium and Mercury : Cause kidney damage

(viii) Zn : Causes vomitting, dizziness and diarrhoea

(ix) Arsenic can cause cramps, paralysis and death

(x) Phosphates from fertilizers : They promote algae growth and reduce D.O. concentration of water. This process is known as eutrophication.

(xi) Anionic detergents (eg. alkyl benzene sulphonates, ABS) : They produce stable foam, stabilise colloidal impurities and inhibit oxidation of organic compounds like phenol. ABS is not bio-degradable.

(xii) Hydrogen sulphide : Acidic, rotten-egg odour and corrosive to metals.

(xiii) Polychlorinated biphenyls : They are resistant to oxidation and cause skin disorders and are carcinogenic.

(xiv) Acid polluted water (pH < 3) : H_2SO_4 produced by oxidation of Iron pyrites (FeS_2) harmful to life.

Suspended impurites :

(i) Parasitic worms : They cause infections

(ii) Bacterias : Cause dysentery, typhoid, cholera

(iii) Viruses : Cause entroviral infections

(iv) Algae : Cause foul odour, taste, turbidity

International standards for drinking water :

S.No.	*Characteristics (mg/l)*	*Acceptable limit*	*Rejection limit*
1.	pH value	7 - 8.5	6.5 - 9.5
2.	Total dissolved solids	500	1500
3.	Total hardness (as $CaCO_3$)	200	600
4.	Fluorides	1.0	1.5
5.	Chlorides	200	1000
6.	Sulphates	200	400
7.	Nitrates	45	45
8.	Magnesium	30	150
9.	Calcium	75	200
10.	Zinc	5.0	15.0
11.	Anionic detergents	0.2	1.0
12.	Iron	0.1	1.0
13.	Manganese / Copper	0.05	0.5
14.	Phenolic compounds	0.001	0.002
15.	Toxic Materials eg. As, Cd, Cr, CN^-, Pb, Se	0.05 - 0.001	0.05 - 0.001

Aerobic and anaerobic oxidation :

The oxidation of organic compounds present in sewage in presence of good amount of dissolved or free oxygen (approx. 8.5 ml/l) by aerobic bacterials is called aerobic oxidation. When dissolved or free oxygen is below a certain value the sewage is called *stale* anaerobic bacterias bring out purification producing H_2S, NH_3, CH_4, $(NH_4)_2S$ etc. This type of oxidation is called anaerobic oxidation. The optimum value of D.O. for good quality of water is 4-6 ppm (4-6 mg/l). The lower the concentration of D.O., the more polluted is the water.

Biological Oxygen demand (BOD) :

It is defined as the amount of free oxygen required for biological oxidation of the organic matter by aerobic conditions at 20°C for a period of five days. Its unit is mg/l or ppm. An average sewage has BOD of 100 to 150 mg/l.

Chemical Oxygen Demand (COD) :

It is a measure of all types of oxidisable impurities (biologically oxidisable and biologically inert organic matter such as cellulose) present in the sewage. COD values are higher than BOD values.

COD Determination :

A known volume of sample is refluxed with known volume of standard $K_2Cr_2O_7$ + dil. H_2SO_4 in presence of Ag_2SO_4 (catalyst) for 1½ hours. The unreacted $K_2Cr_2O_7$ is then titrated against $FeSO_4.(NH_4)_2SO_4.6H_2O$ solution. The oxygen equivalent of $K_2Cr_2O_7$ consumed is taken as a measure of COD.

1 ml. of 1 N $K_2Cr_2O_7 \equiv 0.008$ g oxygen

SOIL OR LAND POLLUTION :

The addition of substances in an indefinite proportion changing the productivity of the soil is known as soil or land pollution.

Sources of soil pollution :

(i) ***Agricultural pollutants :*** Chemicals like pesticides, fertilizers, fumigants, insecticides, herbicides, fungicides.

(ii) ***Domestic refuge*** and industrial wastes

(iii) ***Radioactive wastes*** from research centres, and hospitals

(iv) ***Soil conditioners*** containing toxic metals like Hg, Pb, As, Cd etc.

(v) ***Farm wastes*** from poultries, dairies and piggery forms

(vi) ***Improper disposal*** of human and animal excreta.

(vii) ***Pollutants*** present in air from chemical works

Control of water pollution :

The water pollution can be reduced by following techniques

(i) **Recycling of waste water** : by aeration and use of trickling filter

(ii) **Use of chemicals :** Effective filtration and chlorination

(iii) **Special techniques** : Such as adsorption, ion-exchangers, reverse osomosis, electrodialysis etc.

(iv) **Waste-water reclamation :** Sewage water can be directly used for irrigation and fish farms. Since it contains N, P and K.

Sewage treatment :

The artificial treatment is called sewarage and involves the following steps :

(i) **Preliminary process :** Passing sewage through screens to remove large suspended matter and then through mesh screens to remove solids, gravels, silt etc.

(ii) **Settling process (sedimentation) :** The residual water when allowed to stand in tanks, the oils and grease float on the surface and skimmed off and solids settle down. The colloidal meterial is removed by adding alum, ferrous sulphate etc. and we get *primary sludge*.

(iii) **Secondary treatment or Biological treatment :** It is aerobic chemical oxidation or aeration which converts carbon of the organic matter to CO_2, nitrogen into NH_3 and finally into nitrites and nitrates, dissolved bases form salts such as NH_4NO_2, NH_4NO_3 and $Ca(NO_3)_2$ etc. and *secondary* sludge is obtained. The primary and secondary sludge (combined) is subjected to anaerobic digestion to CO_2 and CH_4

$$2[CH_2O] \longrightarrow CO_2 + CH_4$$

(iv) **Tertiary treatment :** It is treatment of waste water with lime for removal of phosphate which is coagulated by adding alum and ferric chloride and removed by filtration. Water is disinfected by adding chlorine. Secondarty sludge forms a good fertilizer for soil as it contains nitrogen and phosphorous compounds.

PESTICIDES :

The chemical substances used to kill or stop the growth of unwanted organisms are called pesticides. They are further classified as

(a) ***Insecticides :*** They are used to kill insects. The most common insecticides are D.D.T, BHC, gamexane

(b) ***Herbicides :*** They are used to kill weeds e.g. Solium chlorate, Sodium arsenite
The (iii) and (iv) are not used now a days.

(c) ***Fungicides :*** They are used to stop or kill fungus e.g. coppersupphate, 2,4,6-trichlorophenol

(d) ***Rodenticides :*** They are used to kill rodents e.g. Zincphosphide, thalium sulphate

Biology

CELL

All organisms are composed of cells. Cell is the basic unit of all organisms. Every living organism is made up of either a single cell, called unicellular organisms. Such as, *Amoeba,* blue green algae etc; or a multiple number of cells, called multicellular organisms. Such as, all higher plants and animals.

Cell Theory : proposed by two biologists, Schleiden and Schwann in 1838.

Cell Renewal : proposed by Rudolf virchow (1855) – according to him cells divided and new cells are formed from pre-existing cells. (*Omnis cellula-e-cellula*)

Anton Von Leeuwenhoek (1674) first saw and described a live cell. In 1838, two biologists, Schleiden and Schwann proposed the **"Cell Theory".**

Cell theory, therefore, states that

(i) All living organisms are composed of one or more cells.

(ii) The cell is the basic unit of life.

(iii) Cells develop from pre-existing cells.

Fundamental Unit of Life, Structural organization of Cell and Cell wall.

THE FUNDAMENTAL UNIT OF LIFE

Each cell is amazing world into itself. It can take in nutrients, convert them into energy, carry out specialized function and reproduce as necessary. Amazing is that each cell stores into its own set of instruction for carrying out each of its activities. Cells are of two types.

- Plant Cell
- Animal Cell

Difference between plant and animal cell:

Plant Cell	Animal Cell
Plant Cell are larger in size	Animal cell is comparatively smaller in size
Cell wall is present around the cell membrane made up of cellulose and other polysaccharides	Cell wall is totally absent
Plastids are present	Plastids are absent (except Euglena)
One or two large vacuole is present	Vacuole are present of small size and very few in number
Golgi body are present in the form of unit known as dictyosome	Golgi body is well developed
Nucleus lies on one side in the peripheral cytoplasm	Nucleus lies in the centre of the cell.
Centrosomes and centrioles are absent	Centrosome and centrioles is present

STRUCTURAL ORGANIZATION OF CELL

1. Cell Membrane/Plasma Membrane

The cell membrane was discovered by Swiss Botanist Carl Nuegeli and C. Camerin 1855.

It is the outermost, extremely delicate elastic membranous covering of each cell. It is a living, selectively permeable membrane. It is made up of lipoproteins, that is lipids and proteins. Carbohydrate are attached at some protein at outer surface, forming cell-coat.

Cell-Coat – On the basis of cell coat one can differentiate that from which organ the cell belong to, e.g., the given cell belongs to liver cells or kidney cells can be distinguished on the basis of cell-coat.

Cell coat is present only in animal cells.

Functions of Cell Membrane

(i) It provides definite shape to the cell.

(ii) It functions as a mechanical barrier between external and internal environment of the cells.

2. Cell Wall

Robert Hooke in 1678 discovered cell wall while observing thin section of cork. Cell walls made of three different types of carbohydrates namely cellulose, hemicelluloses and pectin. Cellulose is a specialized sugar that is classified as a structural carbohydrate and not used for energy. There are small holes in cell wall known as plasmodesmata through which materials are transported from one cell to another .Cell wall is made up of three layers.

Primary cell wall : It is a thin and flexible layer formed when cell is in a growing phase.

Secondary cell wall : It is present below the primary wall and is fully grown

Middle lamella : This outermost layer forms the interface between adjacent plant cells and glues them together. It is made of pectin.

Function : Gives plant cells their characteristic shapes, and provides protection. Cell walls of plant cells have sufficient tensile strength to withstand internal osmotic pressures.

Cytoplasm

Cytoplasm occupies the major part of the cell. It is a living component of cell, consisting of transparent, semi-fluid granular substance.

(i) **Cytosol :** Cytosol is the fluid part of cytoplasm. It is viscous, and contains a number of substances like water, ions, enzymes, vitamins, carbohydrates, lipids and proteins.

(ii) **Cell organelles:** Cell organelles are tiny, sub-microscopic structures that are specialized to perform specific functions.

3. Protoplasm

In 1846 Hugo von Mohl described the "tough, slimy, granular, semi-fluid" substance within plant cells, to distinguish this from the cell wall, cell nucleus and the cell sap within the vacuole.

Mitochondria

Richard Altman in 1894 considered mitochondria as a cell organelle and called them as 'bioblaet'. The term mitochondrian was coined by Carl Bonda in 1898.

Mitochondria are commonly known as *"Powerhouse of the cell".* They have the ability to make their own protein, as they contain their own DNA and ribosome.

Functions of Mitochondria

(i) Mitochondria are the site of cellular respiration. They use molecular oxygen from air to oxidize the carbohydrates and fats present in the cell to carbon dioxide and water vapour.
(ii) Mitochondria provide energy in the form of ATP for various metabolic activities of living cells.

Plastids

Plastids are found only in plant cells. They are absent in animal cells. On the basis of pigments present in them, plastids are of following three types:

(i) Leucoplasts : They are colourless plastids. They are found in storage cells of roots, seeds and underground stems.
(ii) Chromoplasts : They are coloured plastids. The colour varies from red, orange, yellow etc. due to the presence of carotenoids.
(iii) Chloroplasts : Chloroplasts are green colour plastids, found in leaves. The green colour is due to the presence of chlorophyll. Chlorophyll traps the solar energy which is used for manufacturing food. They are the sites of photosynthesis.

Structure of chloroplasts : A chloroplast is bounded by two membranes i.e. outer membrane and inner membrane. The inside of chloroplast is clearly marked into a colourless ground matrix called **stroma**. It contains a variety of photosynthetic enzymes, DNA and ribosomes. It is the site where all chemical reaction occurs and starch (sugar) is synthesized. **Grana** are stacks of membrane bound, flattened sacs containing the molecules of chlorophyll. Each thylakoid have chlorophyll molecules on their surface that trap sunlight and take part in process of photosynthesis.

Endoplasmic Reticulum

It is a complex network of membrane bound structure which runs through the cytoplasm. Cisternae are spaces within the folds of the ER membranes. It is connected to both the outer nuclear membrane as well as cell membrane. Depending on presence or absence of ribosome on the surface of ER, it is divided into two types:

(i) Rough Endoplasmic Reticulum (RER): It is lined with ribosomes and is rough in appearance, hence, named as rough endoplasmic reticulum. It is the site of protein synthesis.
(ii) Smooth Endoplasmic Reticulum (SER): It contains no ribosomes and hence is smooth in appearance. It helps in lipid and steroid synthesis.

Functions of Endoplasmic Reticulum

(i) It helps in intracellular and intercellular transport of materials.
(ii) It provides large surface area for various metabolic reactions.

Golgi Bodies

It was discovered by 1898 by Italian Physician Camillo Golgi during on investigation of the nervous system.
It consists of smooth, flattened, membrane bound, sac-like structures called cisternae. It is frequently surrounded by vesicles, which are discharged from the cisternae.

Functions of Golgi Bodies

(i) It is involved in the synthesis and repair of cell membrane.
(ii) Golgi apparatus also takes part in storage, modification and packaging of various biochemical products produced by different components of the cell.

Lysosomes

It was discovered by 1898 by Dr. Dure.
Lysosomes are small, spherical vesicle covered by a single membrane. It is scattered all over the cytoplasm. The digestive enzymes contained in lysosomes are synthesized by RER, and are packed into lysosomes by Golgi bodies. Lysosomes are also called *suicidal bags* as enzymes contained in them can digest the cell's own material when damaged or dead.

Functions of Lysosomes

(i) Lysosome helps in intracellular digestion of food particles as they are rich in various digestive enzymes.
(ii) They help in destruction of foreign particles, as in white blood cells.

Nucleus

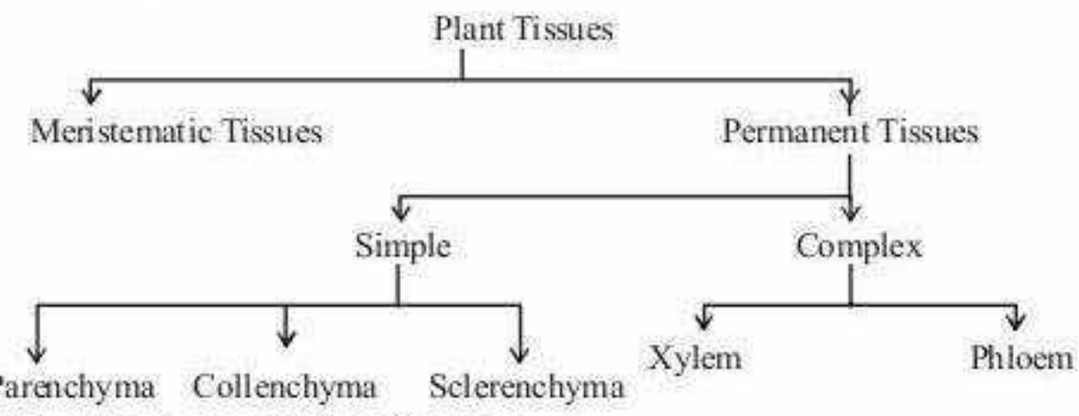
It is the prominent spherical structure found at the centre of the cell. It is the largest organelle present in cell. In plant cell nucleus lies at the periphery of the cell due to presence of central large vacuole while in animal cell, nucleus lies in central position. Nucleus is made up of four parts:

(i) Nuclear envelope : It is double membrane structure that separates nucleus from the cytoplasm. The membrane is perforated with several nuclear pore which allows exchange of materials between cytoplasm and nucleus.
(ii) Nucleoplasm : It is colourless cytoplasm within nuclear membrane in which chromatin and nucleoli are suspended.
(iii) Nucleolus : It is a dense spherical granular structure found inside the nucleus. It is membrane less structure rich in protein and RNA. Synthesis of ribosome takes place in nucleolus.
(iv) Chromatin Material : Chromatin is network of fine thread like coiled filaments uniformly present in nucleoplasm made up of DNA and protein. During cell division chromatin materials changes into chromosomes.

TISSUE

Plant Tissue

On the basis of their ability to divide, plant tissues are divided into two types:



(A) Meristematic Tissues

The meristematic cells are spherical, or polygonal in shape. The cells are compactly arranged without inter-cellular spaces. The cell wall is thin, elastic and is made of cellulose.
Functions : Meristematic tissue divides continuously to form a number of new cells and help in growth of tissue.
On the basis of position in the plant body, meristematic tissues are divided into three types:

(i) **Apical Meristem:** It is found at the growing tips of roots and stems. It brings about growth in length of root and stem.

(ii) **Lateral Meristem:** It occurs on the sides almost parallel to the long axis of the root and stem. It increases the width or girth of the stem and root.

(iii) **Intercalary Meristem:** It occurs at the base of the leaves or at the base of internodes. It increases the length of the internode.

(B) Permanent Tissue

The cells of permanent tissues normally do not divide. The cells may be thin walled (living) or thick walled (dead). Permanent cells are specialized to perform a particular function. Depending on the type of cells, permanent tissues are divided into two types : Simple tissue and Complex tissue.

Simple Tissue

Simple tissue is made up of only one kind of cells forming a uniform mass. The cells are similar in structure, origin and function. Simple permanent tissues are of three types :

(A) Parenchyma : Parenchyma is widely distributed in plant body such as stem, roots, leaves and flower. They are found in the cortex of root, ground tissue in stems and mesophyll of leaves.

Characteristic Features

(i) Cells are isodiametric i.e. equally expanded on all sides.
(ii) Nucleus is present and hence, living.
(iii) The cell walls are thin and made of cellulose.
(iv) Cells are loosely packed with large intercellular spaces between the cells.

Functions

(i) Parenchyma store and assimilate food.
(ii) They give mechanical support to the plant body by maintaining turgidity.

(B) Collenchyma : They are found below the epidermis in leaf stalks, leaf mid-ribs, and herbaceous dicot stems.

Characteristic Features

(i) Collenchyma cells are elongated cells with thick primary walls.
(ii) Intercellular spaces are absent.
(iii) Nucleus is present and hence the tissue is living.

Functions

(i) Collenchyma provides mechanical support to the stem.
(ii) It provides flexibility to soft aerial parts so that they can bend without breaking.

(C) Sclerenchyma : It is found in and around the vascular tissue, under the skin i.e. the epidermis in dicot stems.

Characteristic Features

(i) Cells are long, narrow, thick and lignified usually pointed at both ends.
(ii) The cell wall is evenly thickened with lignin.
(iii) Nucleus is absent and hence the tissue is made up of dead cells.

Complex Tissue

Complex tissue is made up of more than one type of cells that work together to perform a particular function.
Complex tissues are of two types: Xylem and Phloem.

(A) Xylem

It is a complex permanent tissue that conducts water and mineral upward from root to the plant. Xylem consists of four types of elements:

(i) **Tracheids:** Tracheids are long, tubular dead cells with wide lumen and tapering ends. The cell wall is thick with lignin.

(ii) **Vessels:** Vessel is a cylindrical tube like structure that are placed one above the other end to end. It is a non-living cell with lignified walls. Tracheids and vessels both are main conducting elements in the xylem.

(iii) **Xylem fibers :** They are long, non-living cells with very thick lignin deposition on the walls. They have narrow lumen and tapering ends. They provide mechanical support to the plant.

(iv) **Xylem parenchyma:** They are living cells with cellulosic cell wall. They help in storage of starch and other materials. They also help in lateral conduction of water.

(B) Phloem

It is a complex permanent tissue that conducts food synthesized in the leaves to different parts of the plant body. Unlike, xylem, conduction of food occur both in upward and downward directions. Phloem consists of four types of elements :

(i) **Sieve tubes :** They are elongated, cylindrical tubes with perforated end walls between adjacent sieve tube cells. Sieve tube cells are placed end to end in a linear row. Sieve tube cells have vacuolated cytoplasm and lacks nucleus.

(ii) **Companion cells :** They are thin walled cells which lie on the sides of sieve tube cells. They have dense cytoplasm and prominent nucleus. They help sieve tubes in the conduction of food material by maintaining a proper pressure gradient in the sieve tube cells.

(iii) **Phloem parenchyma :** The phloem parenchyma cells are thin-walled and living. They help in storage and show lateral conduction of food.

(iv) **Phloem fibers :** They are the only non-living (dead) component of phloem. They are thick-walled elongated and spindle shaped cells with narrow lumen. They provide mechanical support to the tissue. They are source of commercial fibers. E.g. jute, hemp, flax, etc.

Vascular bundles – The elements of Xylem and phloem are always organised in groups are called vascular.

Protective Tissue

Protective tissues are outer layer of cells that protects the plant parts like stem, roots, leaves, flowers and fruits.

(A) Epidermis

It is the outermost protective layer of plant body. It is usually single layer. The cells are elongated and closely packed without any intercellular spaces between them. At places the epidermis is not continuous and bears minute pores called stomata. Stomata consist of an opening called stomata opening which is surrounded by two specialized kidney-shaped cells called guard cells.

Functions of Epidermis

(i) The main function of epidermis is to protect the plant body from entry of pathogens and pest.
(ii) The stomata regulate the exchange of gases and also help in transpiration.

(B) Cork

Cork is the outer protective tissue of older stems and roots. They are dead cells and lack intercellular spaces. Suberin makes the cork cells impermeable to water and gases. At places, cork possesses small aerating pores called lenticels.

Functions of Cork

(i) Cork protects plant body against mechanical injury, extreme temperature and infections.

(ii) Though cork is light, impervious, non-reacting and insulating, it is commercial used in manufacture of stoppers for bottles, shock absorbers, sports good, insulation board etc.

ANIMAL TISSUES

(A) Epithelial Tissue

Epithelial Tissue is the simplest animal tissue that forms the continuous sheet of closely packed cells that covers all external and internal surface of the animal body. It occurs over the skin, lining of mouth and other parts of alimentary canal, lung alveoli, lining of respiratory tract, kidney tubules, urinary tract, reproductive tract, blood vessels, etc.

Functions

(i) It protects the underlying tissues against mechanical injury, dehydration and against infection by micro-organisms.

(ii) Epithelium lining the lung alveoli allows exchange of gases between blood and alveolar air.

Stratified squamous epithelium : The basal layer lies in contact with basement membrane, so that new cells can be added on older surface cells as they are torn away. They are found in skin and cover the external dry surface of the skin.

Keratinized epithelium – protects the epidermis of skin, hair, horn, nail. etc.

Squamous Epithelium : It is made of thin, flat, irregular shaped cells that fit together to form a compact tissue. The margins may be smooth or wavy. It is found in lung alveoli, Bowman's capsule, blood capillaries etc. Squamous epithelium can be single layered (simple) or multilayered (stratified).

Functions

(i) As squamous epithelium lines the Bowman's capsule, it helps in ultrafiltration.

(ii) In blood capillaries, the epithelium helps in exchange of materials between blood and tissue.

Cuboidal Epithelium : It is made up of cube like cells, which are square in section but polygonal in surface view. The nucleus is centrally placed and round in structure. Microvilli may be present on the free surface which increases the surface area of absorption.

They are found in the uriniferous tubules, thyroid vesicles, salivary and pancreatic ducts.

Functions

(i) The cuboidal epithelium helps in secretion, excretion and absorption.

(ii) It also provides mechanical support to the part where they are found.

Columnar epithelium : It is tall and pillar-like. The nucleus is oval and lies at the base. The free surface bears a number of tiny finger like projections called microvilli. They are found in the lining layer of stomach, intestine and their glands. They are also present in the salivary glands, sweat glands, tear glands, and covering of epiglottis.

Functions

(i) Columnar epithelium lines the intestine and is specialized to absorb nutrients.

(ii) Goblet cell is a modified columnar cell, which produces mucus.

On the basis of specific functions, the epithelial tissue is classified into ciliated and glandular epithelium.

Ciliated Epithelium

It is cuboidal or columnar cells that bear cilia at their free surface. It is found in sperm ducts and uriniferous tubules and the inner lining of respiratory tract (trachea or wind pipe) and oviducts.

Functions

(i) The beating of cilia helps to keep the unwanted particles from entering into the lungs.

(ii) Cilia also help in pushing the ovum in oviduct.

Glandular Epithelium

It is actually a modification of columnar epithelium. The epithelium is infolded to form multicellular glands. It is found in the lining of the intestine and glands.

Functions

The glands secrete sweat from sweat glands, oil from oil glands, enzymes from digestive glands, hormones from endocrine glands, mucus from mucus glands, etc.

(B) Connecting Tissue

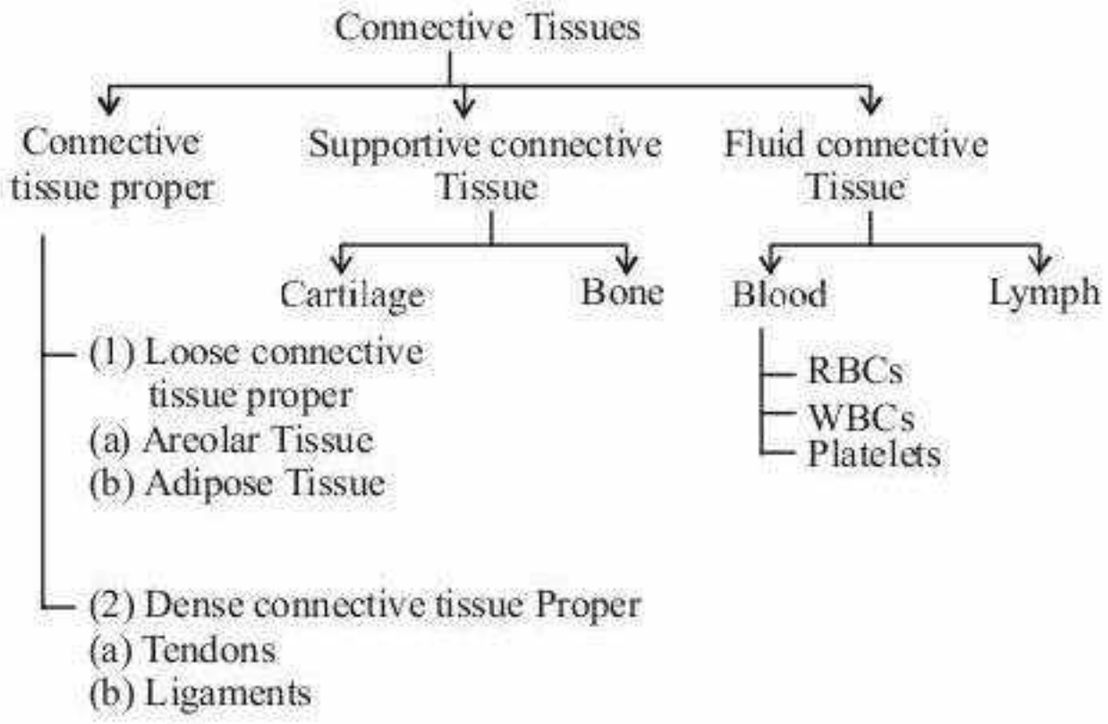
Connective tissue is a fundamental animal tissue that has scattered living cells embedded in matrix.

Functions of Connective Tissue

(i) It helps in binding the different structures of the body. For example, muscle with bone, bone with bone, and muscle with skin.

(ii) It also forms shock absorbing cushions around organs like eye, heart and kidneys.

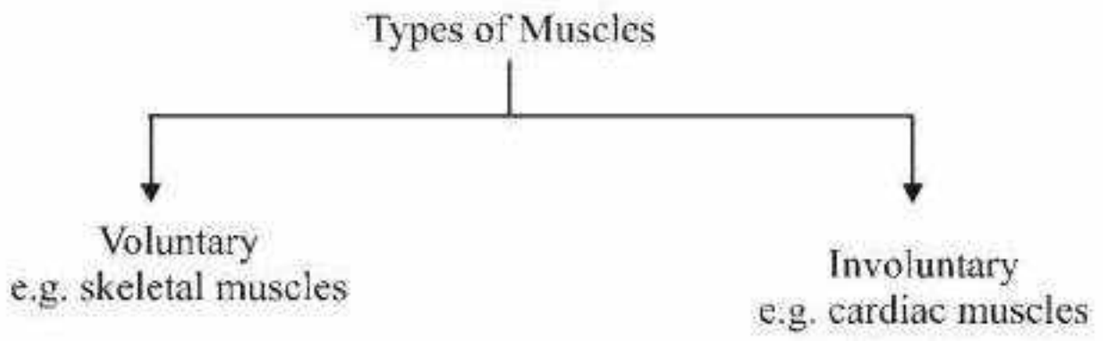
Based on the nature of matrix, connective tissue is divided into three types:



(C) Muscular Tissue

Muscular tissue is composed of contractile proteins inside cells. Cells of muscular tissue are elongated and are known as muscle fibers. The muscle fiber is covered by a sheath of membrane called sarcolemma. The actin and myosin filaments slide past each other to shorten the fibrils causing the whole muscle to contract. The cytoplasm is called the sarcoplasm.

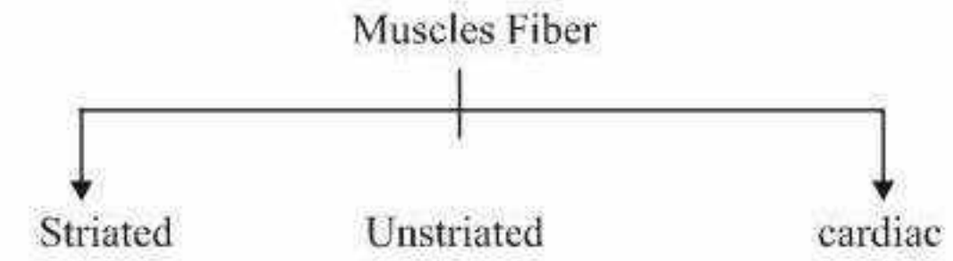
There are two kinds of muscles.



(i) **Voluntary Muscles** are those muscles, which function as per direction of conscious will. For examples, skeletal muscles that come into use when we walk.

(ii) **Involuntary muscles** are those muscles, which function on their own, independent of conscious will. For example, breathing in and out of air.

Types of Muscle Fibers



On the basis of their location, structure and function, there are three types of muscle fibers.

(i) Striated muscle fiber

(ii) Unstriated muscle fiber

(iii) Cardiac muscle fiber

S. No.	Striated muscle fibers	Smooth muscle fibers	Cardiac muscle fibers
On the basis of structure			
1.	Cells are long and cylindrical in shape.	Cells are elongated and spindle shaped.	Cells are small and cylindrical.
2.	Cells are multinucleated.	Cells are uni-nucleated.	Cells are uni-nucleated.
3.	Fibers possess striations.	Striations are absent.	Striations are present but they are fainter than those of striated muscle fiber.
4.	Intercalated discs are absent.	Intercalated discs are absent.	Intercalated discs are present.
5.	They are voluntary in nature.	They are involuntary in nature.	They are involuntary in nature.
On the basis of location			
6.	They are found in limbs, hands, feet, tongue, pharynx etc.	They are found in urinogenital tracts, digestive tract, lungs, iris, blood vessel etc.	They are found only in the wall of heart.
On the basis of function			
7.	They are able to perform fast and powerful contractions. Hence, get fatigued soon.	They perform slow but prolonged contractions.	They perform powerful and rhythmic contraction and seldom get fatigued.

(D) Nervous Tissue

Nervous tissue is specialized to transmit messages in our body. They can receive, integrate and transmit stimuli to various parts of the body. Neuron is the functional unit of nervous tissue. It is also known as nerve cells.

Each neuron is made of three parts:

(i) **Cell body (Cyton) :** It is a broader nucleated part of neuron. Its cytoplasm is called Neuroplasm.

(ii) **Dendrons :** Dendrons are small, branched protoplasmic outgrowths of cell body. Dendrites receive impulses and transmit the same towards cyton.

(iii) **Axon :** Axon is a single, long, fiber like process generally arising singly from the cell body of a neuron. Axon carries impulses towards the cell body. The transmission of impulse is usually carried out with the help of a neurotransmitter like acetylcholine.

LIFE PROCESSES IN PLANTS AND ANIMALS

Nutrition

It is the intake of nutrients lie carbohydrates, fats, proteins, minerals, vitamins and water by an organism and assimilates to get energy.

Food Components

Our food consists of organic and inorganic components. Different components have different roles in the body of organism. Following are the major components of food:

1. Carbohydrates

This nutrient comes under energy providing food. It is carbon, hydrogen and oxygen containing compound. Starch and sugar are the major source of carbohydrates. Glucose is a carbohydrates act as a instant energy source. Carbohydrates can be categorized into the following:

(i) Monosaccharide:

(ii) Disaccharide:

(iii) Polysaccharide:

2. Fats

This nutrient also comes under energy providing food. They are also made up of carbon hydrogen and oxygen but with low oxygen content. Fats produce much energy than carbohydrates but it takes time for digestion and assimilation. Common food rich in fats include milk, cheese, butter, cream, ghee, vegetable oils, meat, and fish liver oils.

All fatty acids are chains of carbon atoms with hydrogen atoms attached to the carbon atom. There are three main types of fatty acids depending upon the bonds.

Fatty acids are said to be saturated if all the carbon atom are single bonded and are called unsaturated if one or more double bond is present in the carbon atom. Saturated fat is found mostly in foods from animals and some plants. Saturated fats are usually solid at room temperature. Unsaturated fats are of two types monounsaturated and polyunsaturated. Monounsaturated fats include canola, olive and peanut oils. These fats remain liquid at room temperature but may start to solidify in the refrigerator. Polyunsaturated fats include safflower, sesame and sunflower seeds, corn and soybeans, many nuts and seeds, and their oils. These fats are usually liquid at room temperature and in the refrigerator.

Monounsaturated fat and polyunsaturated fat are considered more "heart-healthy" fats, which we should include in our diet. Saturated fat has been shown to increase blood cholesterol levels and low-density lipoprotein (LDL) levels, which can increase the risk for heart disease. Trans fat is considered as bad cholesterol as it suppresses levels high density lipoprotein (HDL), which is a good fat and increases the level of LDL which is a bad cholesterol.

3. Proteins

Proteins are formed by carbon, hydrogen, oxygen and nitrogen. Nitrogen is the most essential element in proteins. Some proteins contain sulphur and phosphorus also. Proteins on digestion form simple molecules called as amino acids. Proteins act as building blocks and serve as materials helping in growth and repair of the body cells and tissues. Proteins on digestion form simple molecules called as amino acids. Amino acids polymerizes by the formation of peptide bond between two adjacent amino acids.

Protein deficiency causes severe disease which is common in children known as "Kwashiorkor". The common symptoms of this disease are distended abdomen, enlarged liver with fatty infilterates, thinning of hair and loss of teath.

4. Vitamins

Vitamins are the chemical substances that help in maintaining a healthy body. It is required in minute quantities for normal metabolisms but cannot be synthesized in adequate amount by humans and animals. Vitamins are synthesized by plants and bacteria. Vitamins A, D, E, and K are fat soluble and can be stored in the body. Vitamin B complexes and Vitamin C are water soluble forms. They cannot be stored for a long period of time in the body.

Vitamin required by the body

Vitamin	Chemical Name	Function in Body	Deficiency Disease	Sources
B_1	Thiamine pyrophosphate	Part of coenzyme for respiration	**Beri-beri:** nerve and heart disorders	Found in whole grain cereals, legumes, beans, nuts, brewer's yeast, wheat germ, pork, ham, and liver.
B_2	Riboflavin	Part of coenzyme FAD needed for respiration	**Ariboflavinosis:** skin and eye disorders	Milk, yogurt, other dairy, meat, leafy greens, whole grains.
B_{12}	Cyanoco-balamin	Coenzyme needed for making red blood cells, bone, blood and nerve changes	**Pernicious anaemia**	Animal products (meat, fish, poultry, shellfish, eggs, cheese, milk).
B_5	Nicotinic acid ('niacin')	Part of coenzymes NAD, NADP used in respiration	**Pellagra:** skin, gut and nerve disorders	Widespread in foods.
C	Ascorbic acid	Not precisely known skin teeth and blood vessels.	**Scurvy:** degeneration of	
A	Retinol	Not fully known but forms part of visual pigment, rhodopsin	**Xeropthalmia:** 'dry eyes'	Milk, eggs, meat, fish liver oilsz: Green leafy vegetables - kale, spinach, broccoli Yellow Vegetables - carrots, sweet potatoes Fruits- mango, papaya and apricot
D	Cholecalciferol	Stimulates calcium absorption by small intestine, needed for proper bone growth	**Rickets:** bone deformity fish liver oils, oysters, yeast.	Formed in skin when exposed to sunlight. Also found in dairy products, egg yolk,
E	Tocopherol	Not precisely known	**Infertility**	Found primarily in plant oils, green, leafy vegetables, wheat germ, whole grains, egg yolk, nuts, seeds, and liver.
K	Phylloquinone	Involved in blood clotting	**Possible haemorrage**	Bacterial synthesis in the digestive tract. Diet generally supplies remaining need. Green, leafy vegetables, cabbage-type vegetables and milk

5. Minerals

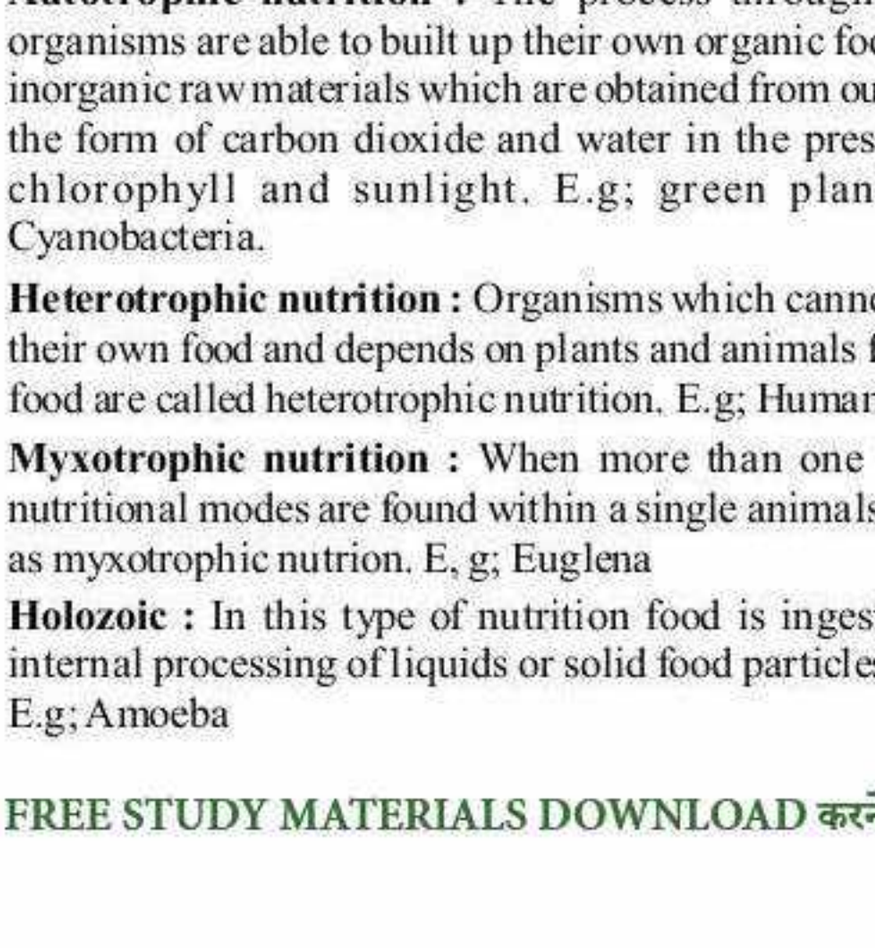
Mineral nutrient are the chemical elements required by the living organisms other than four elements C (carbon), H (hydrogen), O (oxygen) and N (nitrogen) present in organic molecules. Major minerals of the living organisms are calcium, phosphorus, sodium, chlorine, magnesium and sulphur.

ADD table from year book at page B-396 and page B-397 Inorganic elements in human diet

Minerals	Source	Function
Sodium (Na)	Table salt large amounts is present in processed foods, small amounts in milk, breads, vegetables, and meats	Needed for proper fluid balance, nerve transmission, and muscle contraction
Chloride	Table salt, large amounts is present in processed foods, small amounts in milk, meats, breads, and vegetables	Needed for proper fluid balance, stomach acid
Potassium	Meats, milk, fresh fruits and vegetables, whole grains, legumes	Needed for proper fluid balance, nerve transmission, and muscle contraction
Calcium	Milk and milk products, canned fish with bones (salmon, sardines), fortified tofu and fortified soy milk, greens (broccoli, mustard green), legumes	Important for healthy bones and teeth, helps muscles relax and contract, important in nerve functioning, blood clotting, blood pressure regulation, immune system health
Phosphorus	Meat, fish, poultry, eggs, milk, processed foods	Important for healthy bones and teeth, found in every cell, part of the system that maintains acid-base balance
Magnesium	Nuts and seeds; legumes, leafy, green vegetables, seafood, and chocolate	Found in bones, needed for making protein, muscle contraction, nerve transmission, immune system health
Sulfur	Occurs in foods as part of protein, meats, poultry, fish, eggs, milk, legumes, nuts	Found in protein molecules
Iron	Organ meats; red meats, fish, poultry, shellfish (especially clams), egg yolks, legumes; dried fruits dark, leafy greens, iron-enriched breads and cereals, and fortified cereals	Part of a molecule hemoglobin found in red blood cells that carries oxygen in the body, needed for energy metabolism
Iodine	Seafood, foods grown in iodine-rich soil, iodized salt, bread, dairy products	Found in thyroid hormone, which helps regulate growth, development, and metabolism

NUTRITION IN ANIMALS

The mechanism by which organisms obtain food is referred to as the modes of nutrition. The organisms either synthesize their own food or obtain food prepared by other organisms in various ways.



- **Autotrophic nutrition :** The process through which organisms are able to built up their own organic food from inorganic raw materials which are obtained from outside in the form of carbon dioxide and water in the presence of chlorophyll and sunlight. E.g; green plants and Cyanobacteria.
- **Heterotrophic nutrition :** Organisms which cannot make their own food and depends on plants and animals for their food are called heterotrophic nutrition. E.g; Human
- **Myxotrophic nutrition :** When more than one type of nutritional modes are found within a single animals, called as myxotrophic nutrion. E, g; Euglena
- **Holozoic :** In this type of nutrition food is ingested and internal processing of liquids or solid food particles occur. E.g; Amoeba
- **Saprozoic :** Organism gets its nourishment from the dead and decaying matter in the form of solid food. E.g; Spiders, houseflies.
- **Saprophytic :** Organism gets its nourishment from the dead and decaying matter in the liquid form. E.g; Fungi
- **Osmotrophic :** food is taken as dissolved organic substances by the process of osmosis.
- **Parasitic :** It is a type of heterotrophic mode of nutrition in which organism take food from the host on which it lives. E.g; leech, tapeworm

Nutrition in Human beings

Mouth : It is the uppermost opening of the human digestive track which gives passage for ingestion of food. The full dental formula of humans is represented as I 2/2, C 1/1, PM 2/2, M 3/3.

Pharynx : It is a common passage for both food and air. A flap, **epiglottis** closes over the trachea when food is swallowed to prevent choking.

Oesophagus : The chewed food is pushed down the oesophagus to the stomach through peristaltic contraction of the muscular oesophagus.

Stomach : It is a small J-shaped pouch with walls made of thick elastic muscles which stores and helps breakdown of food.

Small Intestine : The small intestine is coiled and narrow tube which can be distinctly divided into three regions.

(i) Duodenum : It is a U-shaped structure, starts from pyloric end of the stomach and receives the secretion of common duct which brings secretion of liver and pancreas.

(ii) Jejunum : It is 2.4 metre long and bears finger likes projections called **villi** which increase the surface area of the inner lining of intestine.

(iii) Ileum : It is 2.4 metre long with club-shaped villi.

Large intestine : It is roughly 1.5 meters long with three parts: the **caecum** at the junction of small intestine, the **colon**, and the **rectum**. Faeces is stored in rectum for a certain time and then eliminated from the body by **peristaltic** movement, through the anus.

Glands Involved in Digestion

Salivary gland : Salivary gland is a exocrine gland which opens in the oral cavity through duct. This gland contains saliva which contains 99% water and rest is mucous. It is slightly acidic in nature (Ph about 6.8) and contains enzyme ptyalin. There are four pairs of salivary glands which are as follows:

- Sublingual gland: present on both the side of tongue.
- Sub-maxillary gland: present in the lower jaw.
- Parotid gland: present below ears.

Liver : It is the largest gland with bilobed structure. Larger right lobe having gall bladder attached to it and small left lobe. There are specialized Kuffer's cells which help in phagocytosis of RBC and bacteria. Bile juice secreted by the liver gets stored in the gall bladder and help in emulsification of fat present in the food. It also helps in deamination process of amino acid and detoxifying the undesired harmful substances.

Pancreas : It is the second largest gland of the body. It is also known as mixed gland as it performs both as exocrine (duct gland) and endocrine (ductless gland) function. It secretes pancreatic juice and hormones. Its endocrine portion has three main types of cells.

- α cells secrets glucagon
- β cells secrets insulin
- δ cells secrets somatostatin

Nutrition in Green Plants

The process of photosynthesis can be defined as the synthesis of organic food from inorganic raw materials using light energy by the green plants.

$$\underset{\text{carbon dioxide}}{6CO_2} + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{water}}{6H_2O} + \underset{\text{oxygen}}{6O_2}$$

Photosynthesis takes place only in the green plants of the plant, mostly in leaves, and some times in green stems are floral parts. Within a leaf photosynthesis occurs particularly in specialised cells, called mesophyll cells. There contain the chloroplast, which are the actual sites for photosynthesis in green plants.

Chloroplast are organelles in the cells of green plants which contain the green pigment chlorophyll. They give the green colour to the plants.

Overall mechanism of photosynthesis occurs in two phases:

(1) Light reaction : It occurs in granum of chloroplast where absorption of radiant energy by two pigment systems lead to the production of three major substances *i.e.* Oxygen, ATP, $NADPH_2$.

(2) Dark reaction : Dark reaction make use of these organic energy molecule (ATP and NADPH) synthesized in process of light reaction. This reaction cycle is also called Calvin Benson cycle and it occur in stroma. ATP provides energy while NADPH provides the electrons required to fix the CO_2 (carbon dioxide) into carbohydrates.

The whole reaction can be studied in three parts.

(i) Acceptance of CO_2 by CO_2 acceptor (RuBP-Ribulose biphosphate)

(ii) Utilisation of ATP and $NADPH_2$

(iii) Regeneration of RuBP (5 Carbon compound)

$$6CO_2 + 12\,NADPH_2 + 18ATP \longrightarrow C_6H_{12}O_6 + 12\,NADP + 18ADP + 18pi + 6H_2O$$

RESPIRATION

Respiration is a process where the body breaks down glucose with the help of oxygen. It is a part of metabolic process where energy molecule is released while carbon dioxide and water are produced. Respiration may be divided into two categories :

(i) Aerobic respiration: It is a process of cellular respiration that uses oxygen in order to break down respiratory substrate which then releases energy.

(ii) Anaerobic respiration: It is a process of cellular respiration that takes place in absence of oxygen, there is incomplete breakdown of respiratory substrate and little energy is released.

Respiratory organs in different animals

	Respiratory organs	Animals/Animals groups
1	Skin	Earthworm, leech, frog.
2	Gill or Bronchin or Ctenidia	Annelids (Arenicola); Crustaceans (Prawn, Crab); Molluses (Pila, Unio); Protochordates, Fishes, Amphibians.
3	Trachas	Insects, Arachnids
4	Bucco-pharynx	Frog
5	Lungs	Ambhibians, Reptiles, Birds and Mammals.

Respiratory System in Human beings

Human Respiratory System consist of nostril, nasal cavity, larynx, trachea, bronchi, branchiole and lungs.

- Ribs form the cage of bones in which lungs resides, the intercostal muscles present ribs between the ribs and diaphragm (a muscular structure up on which lungs rests) take post in muscular movements involved in Respiration.
- Alveoli are air sacs present at the end of bronchioes, and provide large surface area for gaseous exchange.

There are two types of physical movements associated with the gaseous exchange.

Inspiration or Inhalation (breathing in)

Inspiration of air occurs when the volume of the thoracic cavity is increased. When the volume increases, the pressure in the thoracic cavity becomes lower than the outside atmospheric air.

Expiration or Exhalation (breathing out)

When the volume of thoracic cavity is reduced, the pressure of the air inside the thoracic cavity becomes greater than outside atmosphere.

EXCRETORY SYSTEM

Cells produce water and carbon dioxide as by products of metabolic breakdown of sugars, fats and proteins. The continuous production of metabolic wastes establishes a steep concentration gradient across the plasma membrane, causing wastes to diffuse out of cells and into the extra cellular fluid.

Excretion in Animals

There is different specialised organs occurs in different animals. In *amoeba* and other unicellular animals has contractile vacuole serves the function of excretion and osmoregulation. In sponges and cnidaria waste diffuses out through the osculum and the oral opening respectively. In flatworms, excretory units are called flame cells. In earthworm, tubular structures constitute nephridia. In human beings, the microscopic thin tubules nephron participate in excretion.

Excretion in Human beings.

Main excretory organs
- Urinary System - Kidneys filter the blood to form urine, which is excess water, salt, urea and uric acid

Acessory excretory organs
- Lungs - removal of excess carbon dioxide
- Liver - produces urea and uric acid as a by-product of the breakdown or proteins.
- Skin - removal of excess water, salt, urea and uric acid

Organs of Excretory System

The main parts of urinary system are

1. **Kidneys-** These are two bean- shaped purplish brown coloured structures located in the back of the abdominal cavity. It is the main organ of excretion through which the nitrogenous waste are eliminated in the form of urine about 12 cm long, about 6 cm thick and weighs about 150 gm. Kidneys contain millions of nephron which filter 170 to 200 litres blood to produce 1-1.8 litres of urine daily.
2. **Renal Arteries -** Two renal arteries constantly transport blood to each of the kidneys.
3. **Renal vein.** Two renal veins return useful nutrients back into the bloodsstream after filtering the unwanted materials in kidneys.
4. **Ureters.** Two tubes which arise from each kidney and carry urine to the bladder.
5. **Urinary bladder.** This is a muscular sac-like structure where urine is stored till it is thrown out.
6. **Urethra.** This is a short muscular tube that carries urine from the urinary bladder to the outside of the body.

Nephron

Nephron is the structural and functional unit of the kidney. Each nephron functions as an independent unit and produces a miniscule quantity of urine: A nephron can be differentiated into the following regions:

(i) **Malpighian corpuscle.** This consists of two parts:
   (a) ***Bowman's capsule*** - This is a cup shaped structure which is double walled, in the hollow of which is a network of capillaries called glomerulus.
   (b) **Glomerules-** This is a mass of blood capillaries with an incoming and an outgoing arteriole.

(ii) **Renal tubule.** This is the remaining part of the nephron, and is continuous with the Bowman's capsule. It is lined with ciliated epithelium and differentiated into the following regions:

Proxcinal convoluted tubule, Henle's loop and Distal convoluted tubule.

The distal convoluted tubule continues to form the collecting tubule. Several such tubules fuse to form large collecting ducts which pass downwards and pour the urine into pelvis of the kidney. From the pelvis, the urine moves through the uter to the urinary bladder.

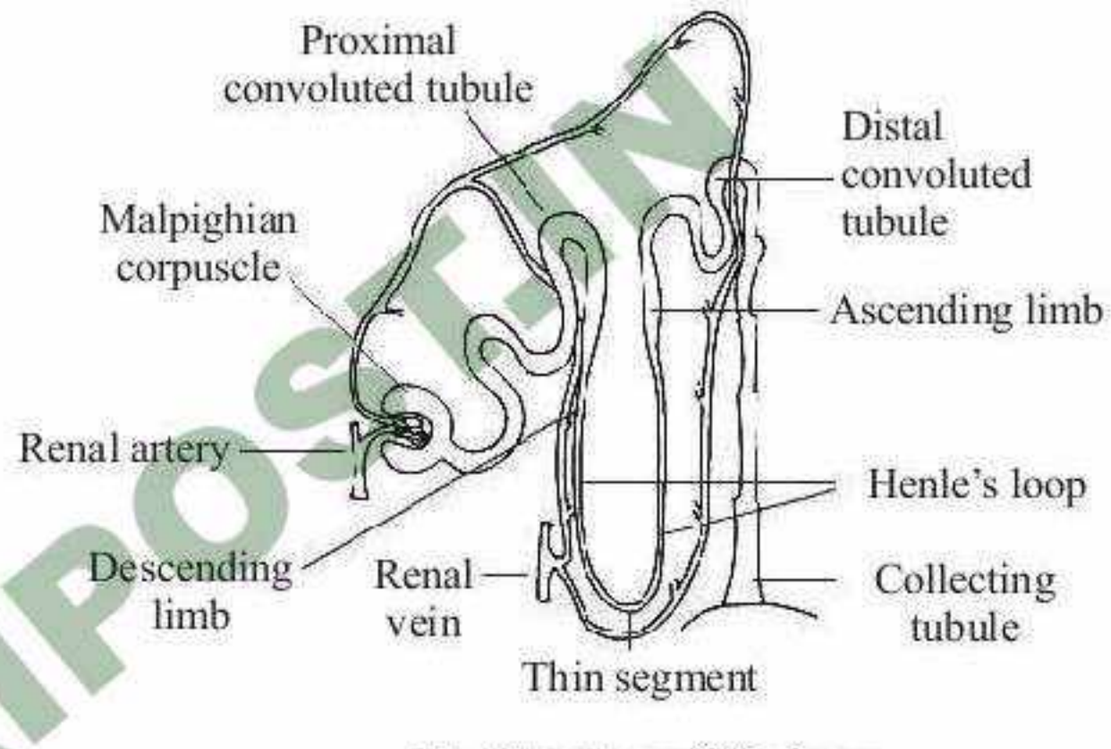


Fig. Structure of Nephron

Process of Excretion

Kidney filters the blood, coming from the heart, forming urine. This process of urine formation happens in the nephrons present in kidneys. This happens in three stages:

1. **Filtration :** This is the first step in clearing the blood. This occurs in the glomeruli. Blood pressure helps plasma of the blood to pass through the capillary walls in the glomerulus. The plasma contains water, glucose, amino acids, and urea.
2. **Reabsorption :** During this stage, the substances considered necessary in the filtrate travel back into the bloodstream and it occurs in the renal tubules.
3. **Tubular secretion:** This is the passage of unwanted substances out of the capillaries directly into the renal tubules. This is an additional way of getting waste material into the urine.

The urine is passed out of the body by urination process. On an average the urine output in a healthy person is 1 to 8 liters per day. Urine contains about 95% water and 5% nitrogenous substances, mostly urea, uric acid, etc.

Renal Failure and Dialysis

Kidneys are a vital organ. Its efficiency gradually declines with age. Sometimes kidney infections, injury to kidney or restricted flow to kidneys may result in damage and malfunctioning. A general term for decline in the performance of kidney is **kidney failure**. In order to clean the blood off metabolic wastes and to maintain normal levels of water and mineral ions in the body fluids, an 'artificial kidney' is employed. The produce used in

artificial kidney in place of the normal one is called **dialysis**. A matching kidney from another person may also be transplanted.

TRANSPORTATION

Transportation in Animals

Transport system in animals is called the circulatory system.

Blood Circulatory System

There are two types of blood circulatory systems:

(i) **Open circulatory system :** The blood enters and circulates in the interstitial spaces (space between the tissues). The blood vessels are open-ended as they open into the common cavities called the **haemocoel**, *e.g.* insects.

(ii) **Closed circulatory System**: The blood always remains inside the blood vessels and never comes in direct contact with the cells. The blood flows in the blood vessels under high pressure such that it reaches all the parts of the body in good time. *e.g.* mammals (including man).

Blood : Blood is a constantly circulating fluid providing the body with nutrition, oxygen, and waste removal. Blood is mostly liquid, with numerous cells and proteins suspended in it, making blood "thicker" than pure water. The average person has about 5 liters (more than a gallon) of blood.

Blood plasma : About 50% of blood is blood plasma which contains 90% water and rest 10% includes protein, inorganic ions and organic substances. It also contain large number of proteins like fibroblast, albumin and globulin. Total volume of blood is 2-3 liters in normal adult. Plasma circulates nutrients like glucose, amino acids and fats and also waste products like carbon dioxide, urea and lactic acid.

Blood cells : There are two types of blood cells:

(i) Erythrocytes (RBC): Red blood cells are colored enucleated living cells. It contain red color pigment called haemoglobin that take part in transport of oxygen. It also carry small amount of carbon dioxide.

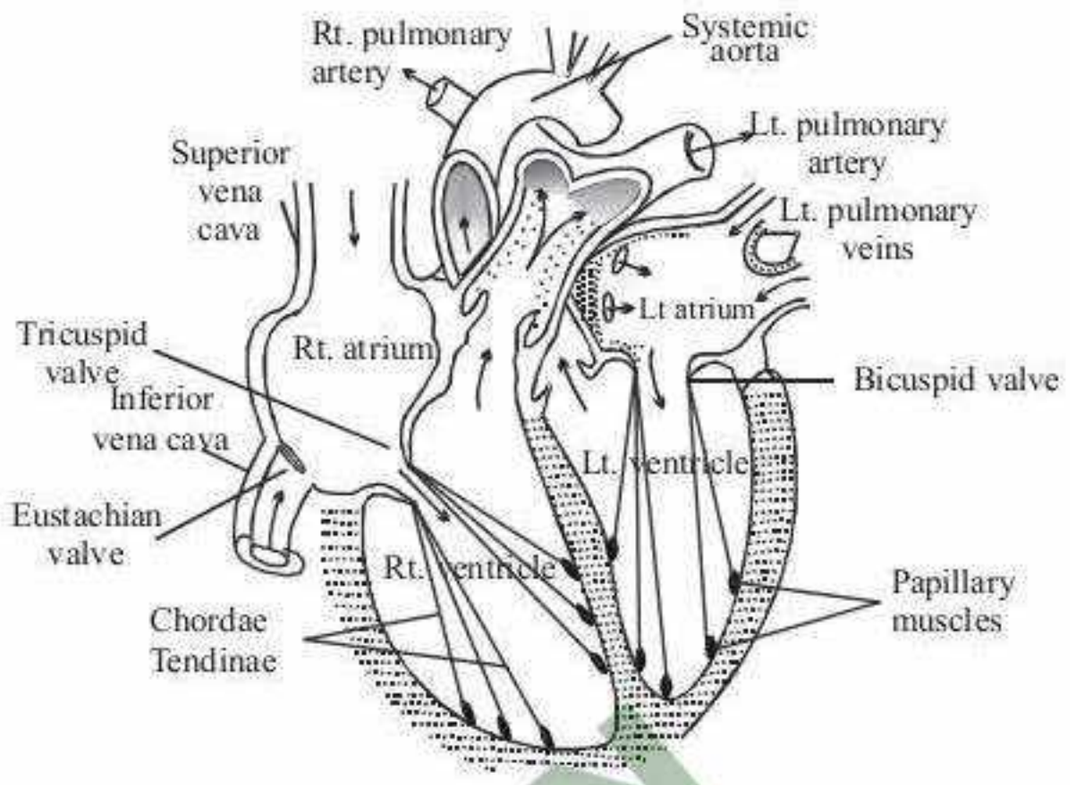
(ii) Leucocytes (White blood cells): They are clolourless nucleated cells that have the ability to change their shape like Amoeba. WBC helps in body protection from diseases and help in healing of wound.

(iii) Thrombocytes (Blood Platelets): Blood platelets are non nucleated, oval clourless cells. It helps in clotting of blood.

Heart

The human heart is a muscular, cone shaped organ about the size of a fist. Heart is situated behind the sternum, between the lungs in the thoracic cavity. The human heart is four chambered.

The right ventricle pumps blood into the pulmonary artery which takes deoxygenated blood to the lungs. The left ventircle receives oxygenated blood from the left and right pulmonary veins coming from the left and right respectively. The aorta branches into vessels which transport blood to the heart and all other body parts, except the air sacs of the lungs. In human beings the blood circulation is called **double circulation** because the blood passes twice through the heart during one round of circulation. The pressure created during ventricular systole is called **systolic pressure** and is equal to that exerted by 120 mm column of mercury. The presence created during ventricular diastole is called **diastolic pressure** and measures 80 mm of mercury.



Schematic diagram of human heart

- between right atrium and right ventricle there is tricuspid value.
- between left atrium and left ventricle there is bicuspid value.
- SA node – is a strip of muscle fibve present at dateral wall of right atrium. Its called pacemaker.

Disorder of Circulatory System

1. **Hypertension :** Increase in the blood pressure. Normal b.p., must be 120/80 mm Hg. A continuous or sustained rise in the arterial blood pressure in known as hypertension
2. **Atherosclerosis :** It refers to the deposition of lipids (especially cholesterol) on the walls lining the lumen of large and medium sized arteries. This results in heart attack or stroke.
3. **Arterio sclerosis :** Calcium salts precipitate with cholesterol to harden the deposition and thickening of arteries. It may lead to rapture of wall, blood clot formation or thrombosis. Thrombosis may lead to heart attack and even death.
4. **Heart failure :** Loose in effective blood pumping by heart. It is also called congestive heart failure.
5. **Cardiac arrest :** Sudden damage of heart muscles, which cause stopping of heart beat. Also known as heart attack.
6. **Angina :** Also called Angina pectoris. It is caused due to unavailability of enough oxygen to the heart muscles.

DIVISION OF HUMAN NERVOUS SYSTEM

The nervous system is concerned with receiving stimuli from the external or internal environment of the body interpreting the stimuli and produing the appropriate response to these stimuli.

Neuron

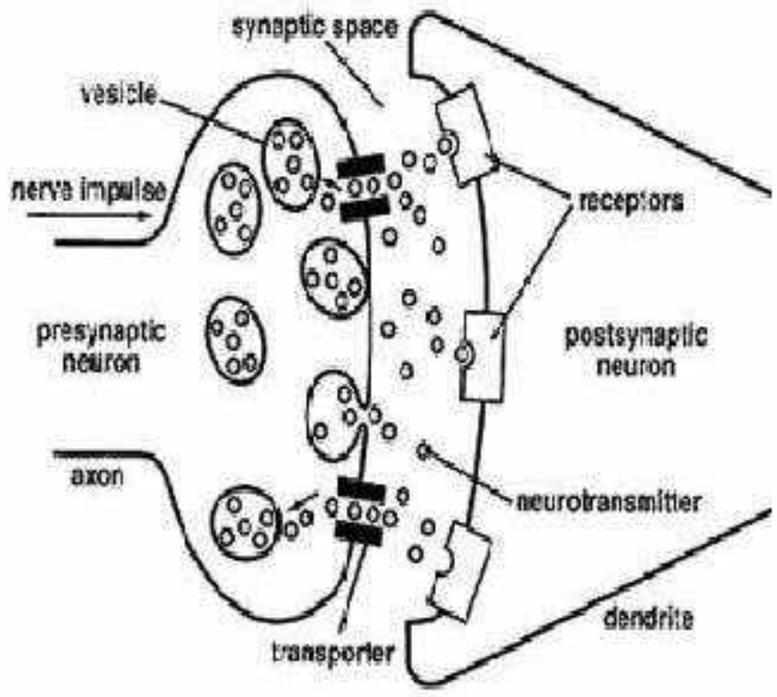
The unit of nervous system. The neutron is a special cells which can receive and conduct impulses.

Cell body : It is also called the cyton. It receives impulses from dendrites and transmits them to axon.

Dendrite : There are short and branched protoplasmic processes stretching out from the cell body of a neuron. Dendrite receive the sensation and pass it to the cyton.

Axon : This is a single, long and cylindrical protoplasmic process of uniform diameter arisin from the cyton. The axon conducts impulses away next neuron is called synapse.

Synapse : It is a point of contact between the terminal branches of axon os a neuron with one dendrites of another neuron. From this gap only nerve impulse jumps into the next neuron. It is total chemical process. At the point of synapse membrane of post and pre synaptic neuron are separated by fluid filled space called as synaptic cleft.



Neurotransmitters

These are the chemicals which allow transmission of signal from one neuron to the other through synapse. They are also present at the axon end of the motor neuron. Vesicles filled with neurotransmitters are secreted into the synaptic gap by a process called exocytosis. Across the gap, the neurotransmitters bind to membrane receptors which are large proteins anchored in the cell membrane of the post-synaptic neuron. Neurotransmitters get accumulated in the synaptic gap and increase the membrane permeability of the next dendrite. This causes influx of the sodium ions and new nerve impulse is generated. Acetylcholine was the first neurotransmitter to be discovered. Its function is to stimulate the muscles including gastro-intestinal system. Another neurotransmitter is serotonin which is an inhibitory neurotransmitter that has been found to be intimately involved in emotion and mood.

HUMAN NERVOUS SYSTEM

The human nervous system consists of :

(1) Central Nervous System (CNS)

(2) Peripheral Nervous System (PNS)

Central Nervous System

It lies in the mid–dorsal region along the lontudinal axis of the body. It consists of two parts.

(I) Brain (II) Spinal Cord

(I) Brain

This is the highest coordinating centre in the body. It is situated in the head region, in the cranial cavity of the skull. It is soft, whitish organ which weighs 1.2 – 1.4 kg. It forms 98% of the weight of the whole CNS. Brain is surrounded by three protective membranes called **meninges.** The space between these meninges is filled with **cerebrospinal fluid** which protects the brain from mechanical shocks. Brain is divisible into three main regions :

(i) **Fore brain** (ii) **Mid brain** (iii) **Hind brain**

(i) **Fore brain** forms the greatest part of the brain. It consists of three regions:

(A) ***Olfactory lobes*** are a pair of club–shaped small structures present below the cerebral hemisphere. Both lobes are widely separated. Each lobe consists of an olfactory bulb and a narrow olfactory stalk. It is centre of smell.

(B) ***Cerebral hemispheres*** *or* ***cerebrum :*** forms the largest part of the brain. Cerebrum has two cerebral hemispheres which lie side by side and are separated by a deep **cerebral fissure.** The surface of cerebral hemisphere has grooves (**sulci**) and folds **(gyri)** to accomodate larger number of nerve cells.

(C) ***Diencephalon :*** It is smallest and unpaired part of brain. It lies on the lower side of cerebrum. It has a narrow cavity called **third ventricle**. Its roof is called **epithalamus**, side are called thalami and floor is called **hypothalamus.** Pituitary gland is attached by a stalk to the hypothalamus.

(ii) Mid brain : It extends from the pons to the lower portion of the diencephalon. Mid brain is sub divided into (a) Optic Lobes (b) Crura Cerebri

(a) **Optic lobes :** There are four round solid optic lobes called corpora quadrigemina. Anterior optic lobes are centre of vision and posterior lobes are for hearing.

(b) **Crura cerebri : -**These are two ventral bands of nerves connecting diencephalon and medullaoblongata.

Each crura cerebri has two swellings, one in the front called **superior colliculi** and one at the back called **inferior colliculi.** The four swellings together are called **corpora quadrigemina.** The superior colliculi are centres for sight reflexes and the inferior colliculi have centres for hearing reflexes.

(iii) Hind brain consists of three parts :

(a) ***Cerebellum*** is the second largest part of the brain. It is made up of two large lateral **cerebellar hemispheres** and a central **vernis.** It maintains equilibrium posture and tones of muscles.

(b) ***Pons*** **:** It is located in the centre of brain below the cerebellum. It carries impulses from one hemisphere of cerebellum to other co-ordinates muscular movements of body.

(c) **Medulla oblongata** is the posterior most part of the brain which lies below the cerebellum. It continues posteriorly into the spinal cord. It contains a fluid–filled cavity called **fourth ventricle**. It has centre of respiration, heart beat, vomiting, salivation, sneezing, coughing, swallowing etc.

Peripheral Nervous System

All the nerves of the body make up the peripheral nervous system. They all enter or leave the central nervous system. They are grouped into three types:

(a) **Cranial Nerves arise** from the brain except olfactory, optic and auditory nerves and spread to various parts of the head. They are 12 pairs in number.

Cranial Nerves I, II and VIII are sensory nerves.

Cranial Nerves III, IV, VI XI and XII are motor nerves.

Cranial Nerves V, VII, IX and X are mixed (sensory and motor) nerves.

(b) **Spinal Nerves** are 31 pairs in number, arise from the spinal cord along most of its length and spread throughout the body except the head. They are mixed nerves.

(c) **Visceral Nerves** mostly arise from spinal cord and a few from the brain. They regulate the activities of internal organs such as heart, lungs, urinary bladder, blood vessels, etc. besides regulating normal functions of the body. They form the autanomic nervous system.

PNS is further grouped into two :

(i) **Voluntary PNS** is under the control of the will. The nerves arise directly from CNS and connect different body parts for voluntary control of the brain.

(ii) **Involuntary PNS or Autonomic Nervous System (ANS)** is not under the control of human will. It consists of visceral nerves. ANS is subdivided into two :

Organ	Sympathetic System	Parasympathetic System
Heart	Increases heart beat	Decreases heart
Eyes	Dilates pupil	Constricts pupil
Urinary bladder	Relaxation	Contraction

REFLEX ACTION

Reflex action can be defined as an involuntary functioning or movement of any organ or body part in response to a particular stimulus. The function or action occurs immediately, without the involvement of the will or consciousness.

A familiar example of reflex action in man is the withdrawal of hand after pin prick. It is common understanding that if suddenly one is pricked by a sharp object such as a pin, one immediately retracts from the object. In such actions, the impulses are carried by the sensory nerves from the receptor organ to the central nervous system and back to the effector organ. The path or the route through which the impulses travel from the receptor organ, via CNS, is called a **reflex arc** and simple reflex are includes :

Stimulus →Receptor →Sensory nerve →CNS →Motor nerve → Effect

If the controlling centre of the reflex arc is located in the brain, it is called **cerebral reflex;** if it is located in the spinal cord, it is called **spinal reflex.**

The reflex arcs are of two types :

(i) **Somatic reflex** arc involves effector organs located in body (soma) structures e.g. skeletal muscles.

(ii) **Visceral reflex** arc involves effectors located in the visceral organs e.g. gonads,

A simple reflex arc consists of only one sensory neuron and one motor neuron. But, in majority of reflexes, a sensory neuron influences several motor neurons through intermediate neurons of the spinal cord. This forms a complex reflex arc.

Some common examples of reflex actions are knee jerk, blinking of eye when aimed at, withdrawl of hand on pin prick, sneezing, and secretion of saliva at the sight or smell of food.

Significance of reflex action :

(i) It checks overloading and overtaxing of brain

(ii) It results in quick response to a harmful stimuli without the processing done by the coordinating centres of CNS

(iii) It has a survival value.

Some common nervous disorders:

S. No.	Disorders	
1.	Alzimer's	Alzimer's is the loss of ability to think due to the impairment of memory. Generally used to describe an abnormal part of the ageing process. There are many different types of dementia, and many different causes.
2.	Parkinson	Pariinson disease involves the malfunction and death of the vital nerve cell in the brain called neuron. Parkinson is chronic and progressive movement disorder so the affected neuron produces dopamine which control movement and coordination. Symptoms are tremors and shake in the limbs, slowing of voluntary muscles and feeling of depression.
3.	Meningitis	Acute inflammation of protective brain meninges. Symptoms are headache, fever and neck stiffness.
4.	Multiple Sclerosis	It is one of the autoimmune diseases in which myelin sheath of neuron cell of brain and spinal cord get impared.
5.	Poliomyelitis	It is an infectious diseases caused by the poliovirus which causes muscle weakness resulting in an inability to move.

ENDOCRINE SYSTEM IN HUMAN BEINGS

In human beings the message is communicated in form of nerve impulse from receptor to CNS and from latter to effector . This communication through the nervous system is very quick but has certain limitations such as the nerve impulse can reach only those cells which are connected by nerves and the nerve cells cannot continuously generate and transmit impulses. **This is the reason why**? in multicellular organisms another means of communication-chemical communication is also present. The stimulated cells release a chemical into the blood stream, the other body cells detect this chemical and the effect is produced. This is a slower means of communication as compared to the nervous system but it reaches all the cells of the body. **The chemical carrying the message is called hormone and the group of specialised cells which secrete these hormones is called endocrine glands**. These are ductless glands i.e. the hormones are secreted directly into the blood stream and transported to others parts of the body to the target organ, where they are needed.

Difference between Nervous System and Endocrine System

	Nervous System	Endocrine System
1	It is made up of nerve cells or neurons	It is made up of ductless glands
2	Message is transmitted along nerve fibres	Message is spread throughout the body by blood
3	Message is transmitted in the form of electric impulses	Message is transmitted in form of chemicals called hormones.
4	Message is directed to a specific receptor	Message is spread throughout the body and the target cells or orgons pick it up.
5	Message travels very fast	Message travels slowly
6	The response is immediate	The response is usually slow
7	The effects are short-lived	The effects are prolonged

There are some basic differences between the two systems, still they operate in a coordinated manner. Many important functions of the endocrine system are under the control of nervous system. Hence, the two systems are collectively termed as **Neuroendocrine system.**

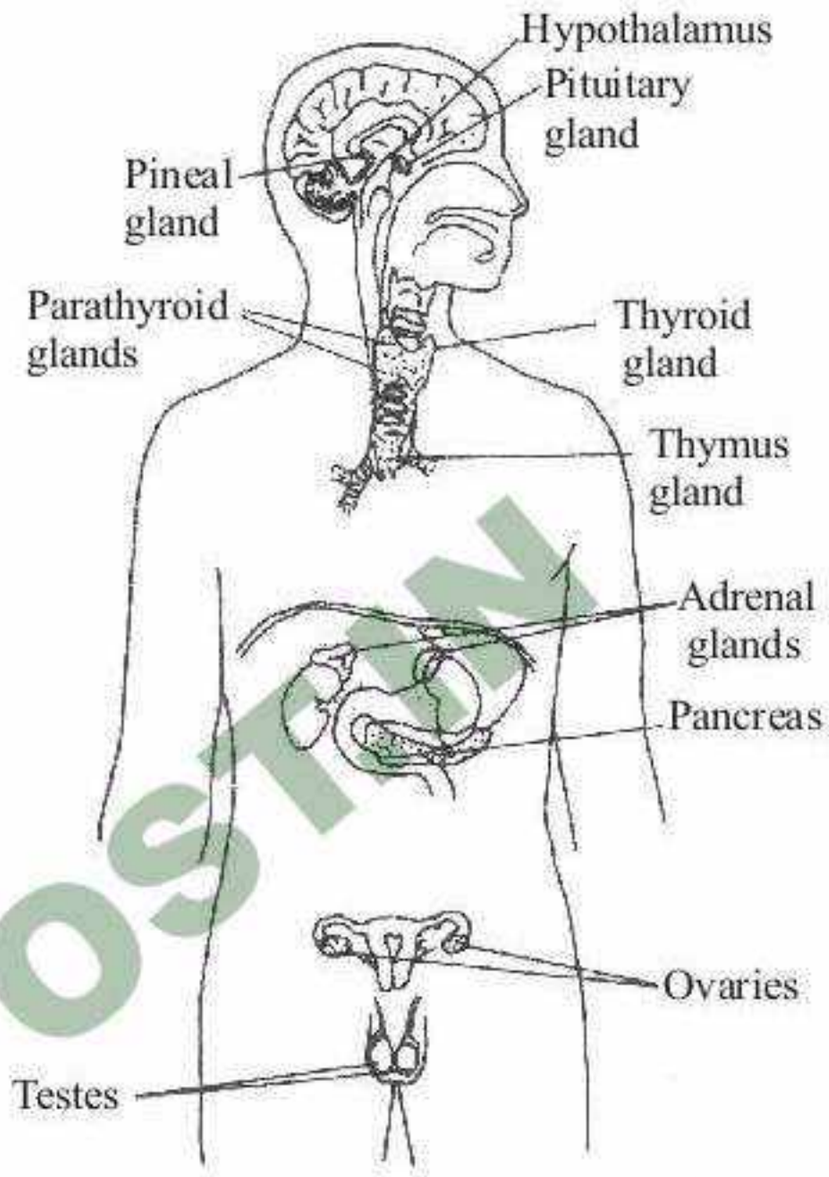


Fig. Endocrine Glands in Male and Female

Table – Endocrine System : Hormones and their action

S. No.	Endocrine gland	Location	Hormone	Action
1	Pituitary (Master gland)	Base of fore brain, pea shaped	Growth hormones, Anti-diluetic hormone A deno Corticottrophic hormone	Regulates the growth of bone and tissue. Controls the amount of water reabsorbed by the water. Defending the body against physiological stress e.g. exposure to cold. Follicle stimulating hormone stimulates ovary to produce female hormone.
2	Pineal	In the brain	Melatonin	Regulates sexual cycle
3	Thyroid	Neck of the lower extremity of larynx, butterfly shaped	Thyroxine	Regulates rate of growth and metabolism. Too little-over weight and sluggishness. Too much-thin and over active.
4	Thymus	Behind breast bone	Thymosin	Helps in production of lymphocytes
5	Adrenal	A pair of cap shaped organs above each kidney.	Cortisone	Aids in conversion of proteins to sugar, cortex of this gland produces the hormone.
6	Pancreas	Below the stomach, Heterocrine gland	Insulin	Regulates sugar metabolism. Too little insulin leads to high sugar level in blood and weakness (a condition called diabetes)
7	Ovary	Lie on the lateral walls of the pelvis	Estrogen	Development of secondary sexual characters e.g. development of breasts in female.
8	Testis	In the scrotum	Testosterone	Development of many masculine features such as growth of moustaches and beard

REPRODUCTION

Sexual Reproduction in Plants

The plants that sexually reproduce have the reproductive structures called the **flowers**. The flower is a condensed shoot with the nodes present very close to each other. The different parts of the flower are attached to the nodes. All the structures present at one node are collectively called the whorl. The first or the outermost two whorls are called the non-reproductive whorls. They are the calyx and corolla. The inner two whorls are androecium and gynoecium, the reproductive whorls.

Parts of a Flower

A typical flower consists of following parts –

(i) **Sepals :** It is the outer whorl of the flower. It is usually green in colour but in some flower it may be coloured to attract insects. It protects the inner whorls of the flower.

(ii) **Petals :** It is the second whorl of flower and consists of coloured petals. Being coloured in nature they attract various insects and animals for pollination.

(iii) **Stamen :** It is male reproductive part of a flower. Each stamen consists of a stalk called filament and a flattened top called the anther. The anthers produce pollens grains which produces male gametes.

(iv) **Carpel :** Carpels have a swollen ovary at the base, an alongated middle style and a terminal stigma. The ovary contains ovules. Each ovule possess an egg which is female gamete.

Structure of Anther

A typical anther is bilobed (dithecous); a longitudinal groove separates the thecae. In a cross-section, the anther is a tetragonal (four-sided) structure, consisting of four microsporangia, two in each of the lobes. Later the two microsporangia of each lobe become fused as a pollen sac, *i.e.*, a mature anther has two pollen sacs. A microsporangium is more often circular in outline and is surrounded by four wall layers :

(i) The outermost is the single layer of epidermis.

(ii) The second layer is endothecium, where cells develop thickenings.

(iii) Middle layers of 2-4 layers of cells and

(iv) Tapetum, the innermost layer of large diploid/polyploid and binucleate or multinucleate cells.

Tapetum nourishes the developing microspores or pollen grains; while the other three wall layers provide protection. When the another is young, the microsporangium contains compactly arranged homogenous cells forming the sporogenous tissue. At maturity, the two microsporangia of each lobe become fused as one pollen sac.

Female Reproductive Unit

The gynoecium/pistil represents the female reproductive unit of a flower. It may consists of one carpel (monocarpellary) or more than one carpel, [two carpels (bicarpellary), three carpels (tricarpellary) or many carpels (multicarpellary)]. When the number of carpels is more than one, the gynoecium may be syncarpous (all the carpels are fused together) or apocarpous (carpels remain free). Each pistil has three parts :

(i) **Ovary,** the basal swollen part where ovules are present.

(ii) **Style,** the elongated, filamentous part and

(iii) **Stigma,** the distal part, that acts as the platform for the landing of pollen grains.

The ovary encloses one or more cavities caled locule(s) inside. Placenta is the tissue seen in the locule(s), that bears the ovules (megasporangia). The number of ovules in an ovary may be one as in mango, rice, wheat or many as in orchilds, watermelon, papaya, etc.

Ovule

The ovule arises as a primordium on the placenta; it is attached to the placenta by a short stalk called funiculus or funicle. The junction between the funicle and the ovule is called hilum, which remains as a scar on the seed. The primordium grows into a mass of cells forming the nucellus, the body of the ovule. The nucellus becomes surrounded by two protective envelopes called integuments, except at the tip leaving a small opening called micropyle. The basal part of the ovule is called chalaza, that lies just opposite to the micropyle. Cells of the nucellus are rich in resere food materials. There is generally a single embryo sac or female gametophyte located in the nucellus; it has developed from a megaspore.

Pollination

The transfer of pollen grains from the opened anther of the stamen to the receptive stigma of the carpel is called **pollination**. Pollination is an important mechanism by which the pollen grains, produced inside the pollen sacs of anthers, are transported by various agencies to the stigma of female reproductive organ. It is an essential process that facilitates successful fertilisation in plants. The pollen grains protect male gametes from drying out.

Pollination is of two types :

1. Self Pollination 2. Cross Pollination

1. **Self Pollination.** Self pollination involves the transfer of pollen grains from the anther of a flowr to the stigma of the same flower or to the stigma of another flower borne on the same plant. In bisexual flowers, pollen grains are transfered from the anther to the stigma of the same flower. This is called **Autogamy.** It is generally not dependent on an external agency i.e. wind, water, insects, birds, etc for pollination, but may result in less vigorous offspring.

2. **Cross Pollination.** It is the transfer of the pollen grains from the anther of one flower to the stigma of another plant. It involves two separate plant and outside agencies like wind, water, air or insects.

   Plants use both abiotic (wind and water) as well as biotic (animals) agents to achieve pollination. Majority of plants use biotic agents for pollination and only a small portion of plants use abiotic agents. Pollen grains coming in contact with the stigma is a chance factor and to compensate for this, flowers produce large amount of pollen as compared to the number of ovules available for pollination.

Fertilisation

Fertilisation involves the fusion of a male gamete with female gamete. To bring about fertilisation, the pollen grains germinate on the stigma by putting out pollen tubes which grow through the style and find their way into the ovules, where they discharge

the male gametes in the vicinity of the female gamete, the egg. The male gamete fuses with the egg and form zygote.
Irrespective of the place of entry of pollen tube into the ovule it invariably enters the embryo sac from the micropylar end. Three modes of pollen tube entry into the embryo sac have been noted - (i) between the egg and one of the synergids, (ii) between the wall of the embryo sac and one of the synergids and (iii) directly into one of the synergids. It is believed that the pollen tube discharge its content in one of the synergids.
Inside the ovule, the pollen tube releases two male gametes into the embryo sac. The embryo sac of the ovule contains an egg with which one male gamete fuses. This fusion of male and female gamete is called syngamy and its produce zygote.

Post Fertilisation Events

This includes endosperm and embryo development, maturation of ovules into seeds and ovary into fruit.
Endosperm. The primary endosperm nucleus undergoes successive nuclear divisions to give rise to free nuclei. This stage of endosperm development is called free-nuclear endosperm. This is followed by cell wall formation and the endosperm becomes cellular. Endosperm is a triploid tissue where cells are filled with reserve food material which is used for the nutrition of the developing embryo. Hence, endosperm development precedes embryo development.
Embryo. The diploid zygote develops into embryo, at the micropylar end. This starts only after a certain amount of endosperm is formed. The zygote gives rise to a proembryo which develops into a gobular embryo and subsequently into a heart shaped and later mature embryo.

Fruit

Fruits develop from the ovary. The formation of seeds and fruits is simultaneous. Wall of the ovary develops into the wall of the fruit called **pericarp.** In fruits like guava, mango, etc. the fruits are fleshy while in fruits like mustard, groundnut, etc. they are dry. By the time the fruit develops the other floral parts degenerate and fall off. However, in some fruits such as apple, strawberry, etc. the thalamus contributes to fruit formation. Such fruits are called **false fruits.** Fruits that develop only from the ovary are called **true fruits.** Fruits are normally formed as a result of fertilisation but some fruits like banana develop without the act of fertilisation. Such fruits are called **parthenocarpic fruits.** These fruits are seedless. Such fruits can also be induced through application of hormones. They have great commercial value.

HUMAN REPRODUCTIVE SYSTEM

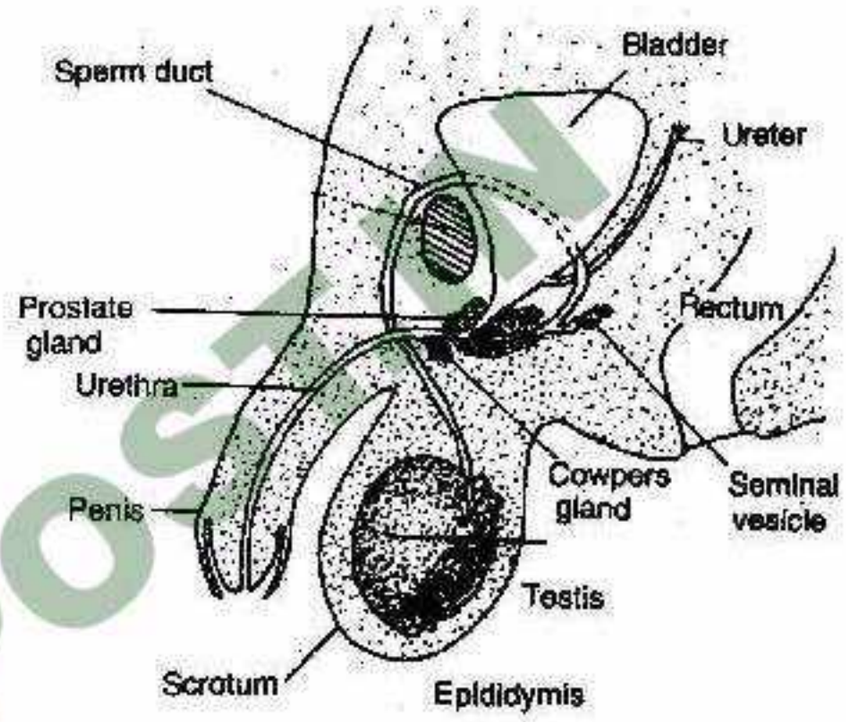
The human beings are **bisexual** with two separate sexes - male and female. The individuals of the two sexes show distinctive features called the **secondary sexual characteristics.** Some of the male secondary sexual characteristics are facial hair, cracking of voice, etc. female secondary sexual characteristics include development of breasts, broadening of hips, etc. Such distinguishing features are present in all the animals. These characteristics serve to identify and attract sex partners.

Male Reproductive System

The male reproductive system consists of –
(i) a pair of testes to produce sperms.
(ii) a pair of sperm ducts to carry the sperms.
(iii) accessory glands to contribute the seminal fluid.
(iv) a penis for transferring the sperms into the female.
The male reproductive system compromises of the following:

Testes

The male reproductive system comprises of a pair of **testes** that are present in a thin-walled sac called the **scrotum**. The scrotum is contained within the abdominal cavity in the embryonic stage. Shortly before birth, they come down and remain outside throughout life This is because the testes cannot produce sperms at the body temperature. A temperature 2-3 degrees lower is ideal for the production of sperms.



Human Male Reproductive system

Each testis is covered by a thick connective tissue layer. Internally, the testis is lobed. There are 15-20 lobes, each having a network of **seminiferous tubules** and the **interstitial cells** between the tubules. Longitudinal section showing lobules containing seminiferous tubules. The seminiferous tubules produce sperms that are passed along the tubules to the posterior region of the testis. The sperms are produced by a process called the spermatogenesis. The interstitial cells are also called the Leydig cells and they secrete the hormone **testosterone**. In addition, they also form a packing tissue between the seminiferous tubules.

Glands

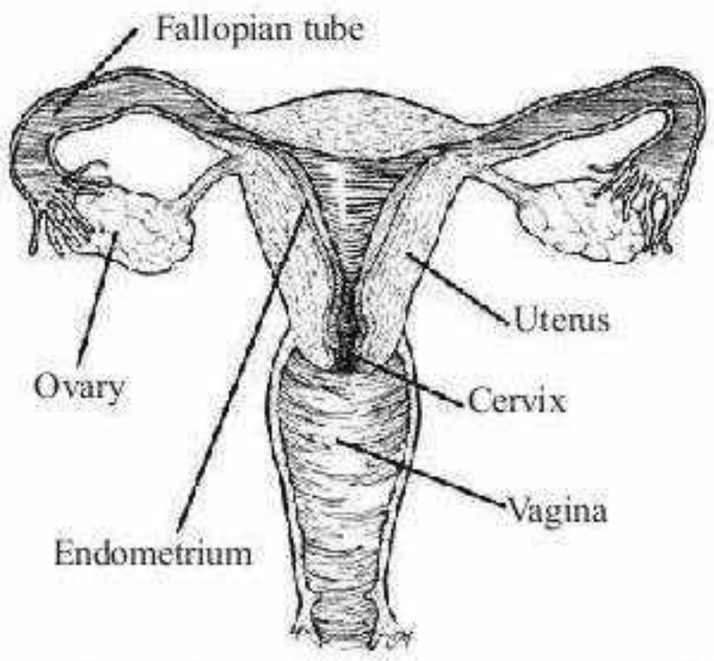
The various glands associated with the male reproductive system are as follows:
Seminal Vesicles : A pair of seminal vesicles are glands that are present behind the urinary bladder. Each sperm duct has the seminal vesicle of its side secreting a fluid into the common ejaculatory duct. This fluid along with the sperms is called the **semen**, a milky fluid.
Prostate Gland : It is a bi-lobed gland near the opening of the urethra. The prostate gland also pours its secretion into the urethra. It is alkaline and mixes with the semen.
Cowper's Glands : They are a pair of small ovoid glands that secrete lubricating fluid into the urethra just before it enters the penis. The secretions of these glands make the sluggish sperms more active and help in the passage of sperms through the duct system and then in the ejaculation

Penis

Penis is a muscular organ containing erectile tissue. The tissue is richly supplied with blood vessels. On sexual stimulation the penis is gorged (suppled) excess with blood cause it to become erect. During sexual intercourse, the penis is inserted into vagina of the female before ejaculation. Ejaculation is the release of sperms by the penis to the outside.

Female Reproductive System

The female reproductive system consists of a pair of ovaries, a pair of oviducts, uterus, vagina and vulva. The main functions of the female reproductive system are to produce eggs, receive the sperms, provide the site for fertilisation, implantation of the growing embryo and development of the foetus. It also produces hormones that control the various stages of ovulation and maintenance of pregnancy.



Female Reproductive System seen from the front

Ovaries

Ovaries are a pair of oval structures that are present one on either side. The ovaries produce eggs, one at a time, every alternate month. The eggs are produced by the germinal epithelial cells of the ovary.

Oviducts / Fallopian Tubes

Oviducts / Fallopian tubes are a pair of tubes of about 12cm in length. They run from the ovaries of each side to the uterus. At the ovarian end the tube is funnel-shaped with the end of the tube thrown into number of folds. These folds are ciliated which help to sweep the egg produced by the ovary into the fallopian tube. The fallopian tubes are the sites for fertilisation of the egg bv the sperms.

Uterus

Uterus is pear-shaped structure, broader on the upper end and narrower on the lower end. The upper end is called the body of the uterus and the lower end is called the cervix. At the upper end, it receives the oviducts of either side whereas the lower end the cervix opens into the vaginal canal that opens to the outside.

Vagina

Vagina is a 9cm long muscular tube that receives the penis during copulation. It is lined with epithelial cells. The secretions of the vaginal canal are acidic which is not conducive to the sperms as semen is alkaline. The vaginal opening in young females is partially covered with a thin mucous membrane called hymen. This is often broken early in females during play or strenuous work.

Vulva

Vulva is the external female genitalia. It comprises of the mons veneris, which is the raised pubis. The vaginal opening has two pair of folds on either side. The outer fold is thicker with hair, sweat glands and sebaceous glands and is called labia majora. The inner folds are thinner and devoid of hair. They are called labia minora. Covered by the upper part of the folds is the female equivalent of the penis called the clitoris. It is also an erectile and highly sensitive organ. In this region are two openings-the upper urethral meatus or opening and the lower vaginal orifice.

Pre-Fertilisation Events (Gametogenesis)

Sperms are produced in seminiferous tubules present in male reproductive organ–testis. This process is known as **sperm atogenesis**. The precursors of the sperm, the diploid spermatogonium divides mitotically to produce numerous diploid spermatocytes. Spermtocytes undergo meiotic cell division to produce, 4 haploid spermatids. Spermatids differentiate and develop into sperm. Sperm are single celled male gametes with a head, midpiece, and a tail.

Ovum (egg cell), the female gamete is produced in the ovaries of female reproductive system. This process is known **as oogenesis.** In contrast to males, in female the initial steps in egg production occur prior to their birth. Diploid oogona and primary oocytes are produced in foetus and by the time she is born, females have about 1-2 million oocytes. In oocytes, the first meiotic division is initiated and then stopped. The primary oocytes grows further and completes the meiosis I, forming a large secondary oocyte and a small polar body. Only after fertilization meiosis II will be completed. By completion of meiosis II secondary oocytes gets converted into a fertilized egg or zygote.

Menstruation

The reproductive cycle in the female human beings is called **menstrual cycle**. First menstruation begins at puberty and is called **Menarche.** Menstruation occurs at an average time period of about 28 to 29 days. This cycle of events starts from one menstruation till the next one and is called menstrual cycle.

One ovum is released during the middle of each menstrual cycle. Cycle starts with the menstrual phase when menstrual flow occurs and it lasts for 3-5 days. Menstrual occurs only if released ovum is not fertlised. Pregnancy can be indicated by lack of menstrual cycle. It may also be caused by stress, poor health etc.

Menstrual cycle ceases at about 50 years of age and this is turned as **menopause**. Cyclic menstruation is an indicator of normal reproductive phase and extends between menarche and menopause.

Fertilisation

Fertilisaiton can be defined as the fusion of the sperm with the egg nucleus to form a diploid cell known as **zygote**. The fertilisation is internal in the human reproductive sytem. It is achieved by the instertion of the male organ, penis into the vagina of the female. The sperms are deposited in the vagina of the females during a process called as copulation or sexual intercourse. The release of sperms is called ejaculation and at one ejaculation there may be upto 600 million sperms. Of these only a few thousand make the journey from the vaginal canal to

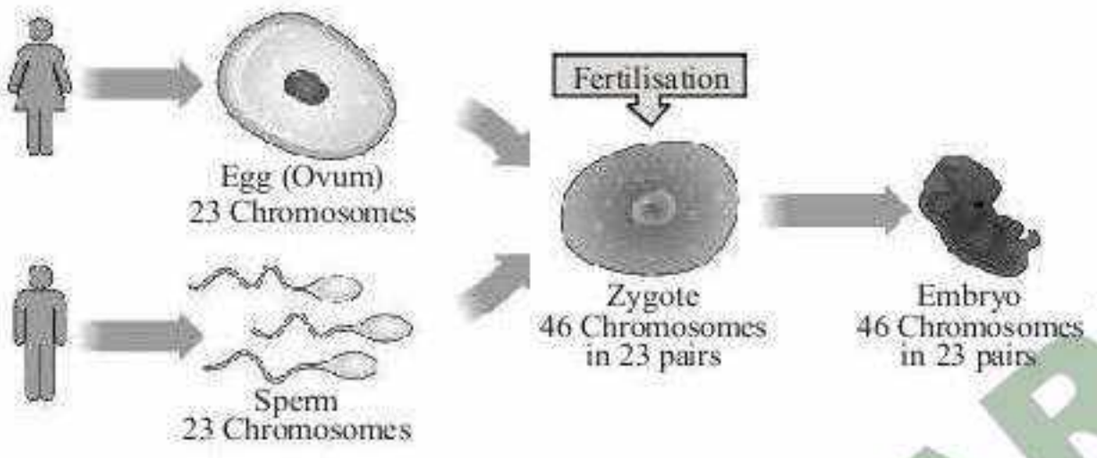
the oviducts. This may take 4-8 hours. The life of the sperm is 1–3 days after ejaculation.

In the fallopian tubes, many sperm surround an egg. However, only one enters the egg leaving behind the tail. The enzymes of the acrosome digest the several layers of tissue to reach egg cytoplasm. Once the sperm is inside, the male and female nuclei become lighter and are called pro-nuclei. The two pro-nuclei fuse forming a zygote. Once a sperms enters and egg, the thickening of the outer walls of the egg blocks the entry of other sperm.

Post-Fertilisation Events

Once the egg is fertilised, ovulation and menstruation do not take place. The fertilised structure, now called the zygote is diploid. It starts dividing and forms a blastocyst, the first stage of an embryo. The blastocyst gets implanted on the uterine walls. It then grows into a foetus.

The foetus remains attached to the mother through an umbilical cord which is embeded in a tissue called **placenta** at one end. The placenta in turn is embedded into the uterine wall and is richly suppled with vessels. The nutrients from the mother's blood pass into the umbilical cord and the waste from the foetus pass into the mother's blood through the placenta.



Reproduction in Human beings

Reproductive Health

The disease/ disorders affecting the reproductive system are of many types. Some are due to malfunctioning gonads, others are due to pathogens. Some of the disease disorders affecting the reproductive sytem are as follows:

(i) Infertility in Females (ii) Infertility in Males

Infertility

It is the inability to bring about fertilisation of sperm with eggs. The cause of infertility are varied and it affects both males and females.

Infertility in Females : The common causes of infertility among females is the inability to produce ova, mainly due to hormonal problems, blocked oviducts, damaged uterus and cervix, presence of anti-sperm antibodies in female reproductive system, etc.

Infertility in Males : This may be due to absence of sperm, low sperm count, abnormal sperms, autoimmunity (presence of antibodies in the male reproductive system itself), premature ejaculation and importance.

Infertility can be treated by either hormone treatment or modern methods of **invitrofertilisation** (IVF). IVF invovles the fertilisation of sperm and egg in a test tube. The zygote is then transferred to the uterus of the mother. Such babies are also called **test-tube babies**. Another method of treatment is GIFT - **gamete intra-fallopian transfer**. In this procedure, the gametes are transferred to the oviducts and the fertilisation takes place inside the body itself. However, it works only if the zygote is transferred to the oviduct and not to the uterus.

Menstrual Disorders

Hormonal imbalances in the body result in menstrual disorders such as painful, irregular or excessive menstruation.

HEREDITY AND EVOLUTION

Heredity

Transmission of characters (resemblances as well as variations) from parents to the offspring i.e. from one generation to the next is called heredity

The differences in the characters or traits shown by the individuals of a species, and also by the offsprings of the same parents are referred to as variations.

Accumulation of Variation during Reproduction

All around us we see different organisms. They all look different as species differ from each other. But when you look for differences among individuals of a species, no two individuals are identical to each other. We acquire a common body design along with subtle changes. Take an example of bacteria. Suppose a bacterium produces two bacteria by asexual reproduction. One of the offspring bacterium has a variation due to which it can tolerate a little more heat resistance will go on accumulating in the offsprings of successive generation of this bacterium, and this will ultimately give rise to a variant of bacteria which will be highly heat resistant and able to survive even at very high temperatures. The advantage of variation to a species is that increases the chance of its survival in a changing environment.

Variations arise either due to environmental influence or genetic factors (crossing over during meiosis, mutation, chance separation during gamete formation or chance coming together of chromosome during fertilisation). The environmental factors influence the phenotype of individuals and these are not heritable. Genetic changes affect the genes and are heritable and important from evolutionary point of view.

Rules for the Inheritance of Traits : Mendel's Contribution

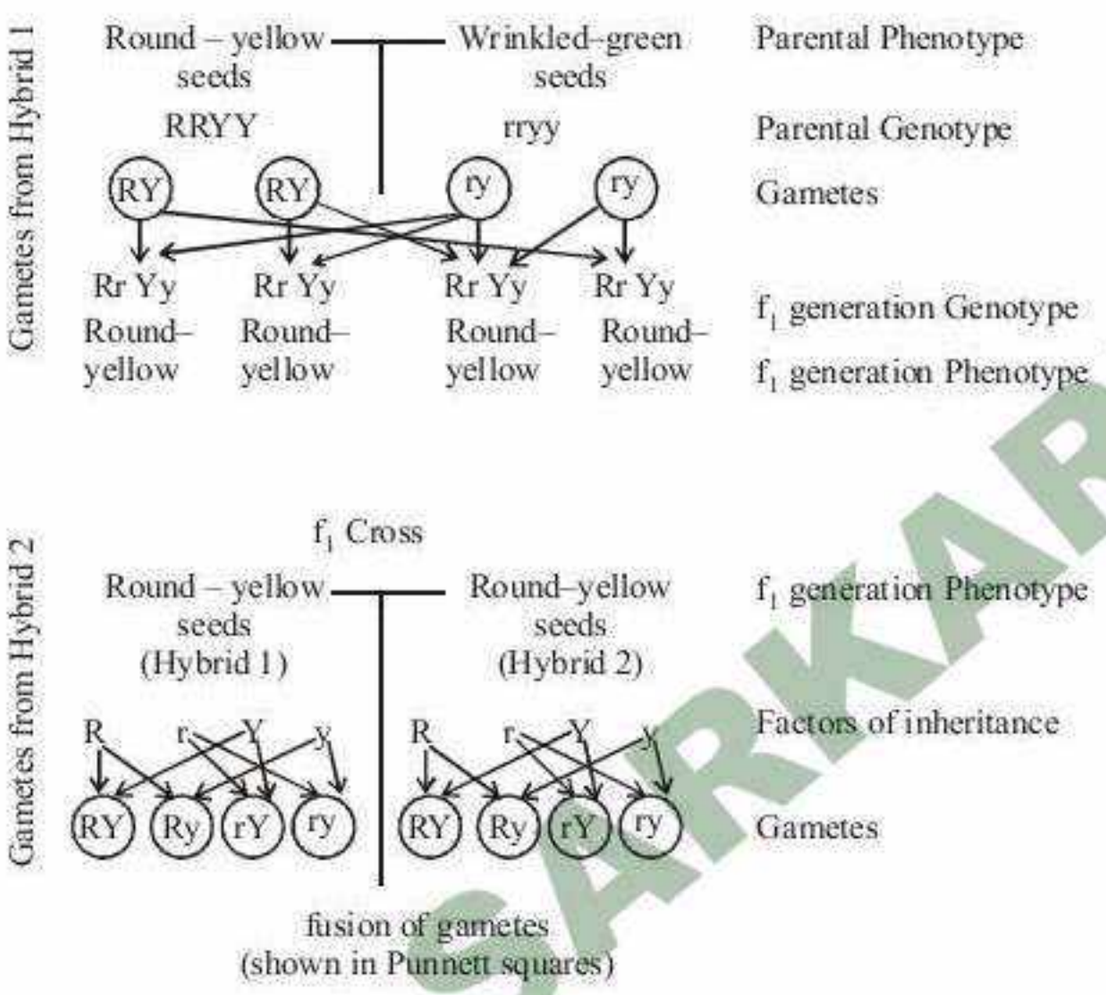
Heredity is the transmission of characteristics through generations. The characteristics include all physical, physiological and psychological aspects of an organism. All these characteristics are called **traits.** The study of genetics was started by Greger Johann Mendel, an Austrian Monk, in 1850s. However, his studies were not recognised by the world till after his death. Mendel is known as 'Father of Genetics'.

Mendel's Findings :

1. **Mendel's Law of Dominance and Recessive :** Each of the f_1 generation plant shows inheritance of Y allele from one parent and a G allele from the other. When the f_1 plants breed, each has equal chance of passing on either Y or G allele to each offspring.
   In all the seven traits that Mendel examined, one form appeared **dominant** over the other i.e., it marked the presence of the other allele, e.g. when genotype of pea colour is YG (heterozygous), the phenotype is yellow. However, the dominant yellow allele does not alter the **recessive** green in any way and both alleles can be passed on to the next generation unchanged.
2. **Law of Segregation:** According to this law, for any particular trait, the pair of alleles of each parent separate and only one allele passes from each parent to an offspring. Allele in a parent's pair of allele is inherited as a matter of chance (we now know segregation of alleles occurs during the process of meiosis)

3. **Law of Independent Assortment:** This is also known as 'Inheritance law'. According to this law, different pairs of alleles are passed to offspring independently of each other. The result is that new combination of genes present in neither parents is possible e.g. a pea plant's inheritance of the ability to produce purple flowers instead of white ones does not make it more likely that it will also inherit the ability to produce yellow pea seeds in contrast to green ones. Today, we know this is due to the fact that the genes for independently assorted traits are located an different chromosomes.

Mendel's experiment with crossing one trait (**monohybrid cross**) always resulted in a 3 : 1 ratio between dominant and recessive phenotype. His experiment with mixing two traits **(dihybrid cross)** showed 9 : 3 : 3 : 1 ratio. But the 9 : 3 : 3 : 1 table shows that each of the two genes are independently inherited with a 3 : 1 ratio i.e., different traits are inherited independently of each other.



	RY	Ry	rY	ry
RY	RRYY Round–yellow	RRYy Round–yellow	RrYY Round–yellow	RrYy Round–yellow
Ry	RRYy Round–yellow	Rryy Round–green	RrYy Round–yellow	Rryy Round–green
rY	RrYY Round–yellow	RrYy Round–yellow	rrYY wrinkled yellow	rrYy wrinkled yellow
ry	RrYy Round–yellow	Rryy Round–green	rrYy wrinkled yellow	rryy wrinkled green

Punnett Square

Sex Determination

Sex determination is a biological system that determines the development of sexual characters in an organism.

Most sexual organisms have two sexes: Males and females. Genetically, both the sexes have different alleles or even different genes that specify their sexual morphology. In a human, the sexual chromosomes complement is 46, 44 of which are autosomes while 2 distinct chromosomes are the **sex chromosomes**, which determine the sex of an organism and various **sex-linked characteristics.** In most animals, those that have **XX** chromosomes are females while males have an **X** and **Y** chromosomes.

In humans, sex is predetermined in the sperm gamete. The egg gamete mother cell is said to be **homogametic** because all its cells possess the XX sex chromosomes, sperm gametes are said to be **heterogametic** because around half of them contain the X-chromosome and others possess the Y-chromosome to compliment the first X-chromosome.

Hence, there are two possibilities that can occur during fertilisation between male and female gametes, XX and XY. Since, sperm are the variable factor i.e., which sperm will fertilise the egg, the one carrying X-chromosome or the one carrying the Y-chromosome.

Evolution

Evolution is the product of two opposing forces : processes that constantly introduce variation in traits, and processes that make particular variants become more common or rare. The main cause for variation is **mutation**, gene flow, reshuffling of genes in sexual reproduction, which changes the sequence of a gene. Two main processes which cause variants to become more common or rare in a population are natural selection, which causes taits that help survival and reproduction to become more common, and traits that hinder survival and reproduction to become more rare. Natural selection occurs because only a few individuals in each generation will survive, since resources are limited and organisms produce many more offspring than their environment can support. Over many generations, mutations produce small random changes in traits which are filtered by Natural Selection and the beneficial changes are retained. This causes adjustment of trait so that they become suited to an organism's environment. These adjustments are called **adaptations**.

Organic Evolution

The word evolution has been derived from the Latin word *evoluere* which means to unroll. It can be defined as the gradual unfolding of organisms from pre existing organism through change since the beginning of life. The origin of life is inseparably associated with evolution. In the following section, you will study about evolution of the living organisms called organic evolution.

Darwin's Theory of Evolution

Charles Darwin (1809 – 1882) gave this theory in his book entitled. **'The origin of Species'.** According to this theory, all life is related and has descended from a common ancestor: birds, bananas, fishes, flowers, man–all are related. Darwin's theory presumes "descent with modification" i.e., complex creatures evolve from more simplistic ancestors over time or genetic mutations occur within an organisms genetic code, the beneficial mutations are preserved because they help in survival a process known as "Natural Selection". These beneficial mutations are passed on to the next generation. Overtime, beneficial mutations accumulate and the result is an entirely different organism.

Speciation

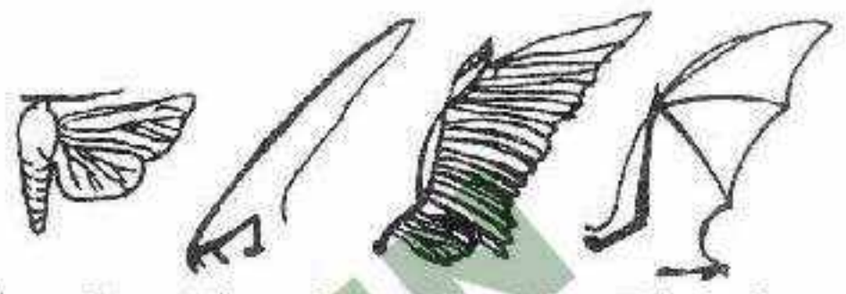
The origin of new species from the existing one due to reproductive isolation of a part of its population is called Speciation.
After a few generations, genetic drift will accumulate more variations in each of the two geographically isolated sub-populations. Natural selection will also play its role. In this way, the geographically isolated sub-populations become more and more different from each other. Ultimately, reproductive isolation occurs between individuals of these two groups i.e., they will no longer be able to exchange genetic material between them. At this point natural selection will work on the genetic variation within that population until it has become a new species.

Evidences for Evolution

Different organisms show common features which provides evidence in favour of evolution i.e., they can be considered to have been evolved from common ancestor. The more the number of features the organisms/species have in common, the more closely they are related. The more closely they are related, the more recently they would have had a common ancestor. The following sources provide evidence for evolution :

(i) Homologous organs : These are organs having same structure, but may be similar or different in functions. Example, forelimbs of man (arm or hand), whale (flipper or paddle), bat (wings), bird (wings), lizard and frog. All have the same selection but modified for various functions. This indicates that they all have inherited a common plan from a common ancestor.

(ii) Analogous organs : These are organs of different origin and basic plan, but similar in functions. Example, wings of insects and bird, or bat. This indicates their origin from different groups.



Analogous Organs

What is the difference between homologous and analogous organs?		
1	Homologous organs are those that have same internal bone structures, but their function differs.	Analogous structures are ones that basically have the same function but not the same underlying structure
2	Examples: Wing of a bat, lateral fin of a whale, and the human arm–they all have similar bone structure, but they carry out different functions.	Examples: Bat's wing and fly's wing–they both are used to help the creature fly, but they have different patterns in bone structure.
3	Homologous structures mean they had come from a common ancestor-support divergent evolution.	The similarity of the function also reflects that they are adapted to a similar environment–support convergent evolution.

(iii) Vestigial Organs
These are organs occurring as reduced and functionless structures in body. It is considered that vestigeal organs were functional in remote ancestors, but became vestigial and functionless due to disuse in course of evolution.

(iv) Connecting Links : These are animals possessing characters of two different groups. *Echidna* and *Platypus* are connecting links between reptiles and mammals. They indicate that mammals have evolved from reptiles. *Archeopteryx* the connecting link between reptile and birds.

(v) Embryology : The embryology of different vertebrates provides very strong evidences favouring organic evolution. The early embryos of different vertebrates show striking similarities. The indicates common origin and ancestory of the different vertebrates. On this basis Ernest Haeckel propose the law named "Biogenetic Law". According to this law the embryonic development of any organism repeated complete evolutionary history.

Fossils

Fossils are organic remains of plants and animals that existed long ago. An entire organism or a part of its body may have become buried in the sediments of earth resulting in the formation of fossils. The study of fossils indicates the structural features of organisms that existed then. A comparison of this with the existing forms gives an indication as to how evolution has taken place. Fossils are found deeply embedded in solid rocks. They are available only in sedimenntary rocks. Most recent rock layers are on top, the oldest fossils are found in the deepest rocks. In many places, old rocks have become exposed due to erosion and weathering.
Sedimentary rocks are not the only source for fossils. They have been found in the tarpits, in amber, and in ice. Insects have been found in amber, while the entire woolly mammoths have been preserved in ice.

Human Evolution

The evolutionary sequence from earliest known human ancestors is not a straight line but is a 'tree' with many dead ends. As the fossil evidences are limited, the scientists are unable to tell as to how so many human species have existed and which was ancestor of the others. The 'tree' of human evolution provides a simple guide to relationship but does not clearly indicate ancestry.
Paranthropus was strongly built "man-apes" that lived in southern and eastern Africa between three and one million years ago.
Australopithecus are thought to be the earliest hominids i.e.,

human-like people. They had a small brain and projecting jaw. They stood upright and walked on two feet. This is known from its leg bones and backbone and also from the 3.7 million year old footprints found in Tanzania.

Homo habilus or the "handyman" is the earliest known species of *Homo* (genes to which the modern day human belongs). It lived in the woodlands and Savannahs of Africa. It had a brain size of 650–800 ml. It made and used simple stone tools, and was a successful forager and scavenger.

Homo erectus was the first human to leave Africa and move to Europe and Asia. It had a sloping forehead, flattish face and brain size between 850-1100 ml. These humans exploited more habitats than their ancestors. They were first to use fire.

Homo nenderthals were the first humans to have adopted to life in cold climates of Europe and Asia. They had strong physique and large brain. They more clothes, made a range of tools and used fire to keep warm. They were the first humans to burry their dead.

Homo sapiens or the "modern human" first evolved in Africa. They had a large brain, were considerably intelligent and had developed the ability to use language. Modern man took control of their surroundings as they developed agriculture, societies and technology.

OUR ENVIRONMENT

Ecosystem

The term **Ecosystem** was coined by Sir Arthur Tansley in 1935. Ecosystem is essentially a technical term for nature. **Ecosystem can be defined as a self-sustaining structural and functional unit of the biosphere.** This system depends upon the sun for its energy.

COMPONENTS OF ECOSYSTEM

An ecosystem has two basic components :-

(i) **Abiotic components** which includes the non-living components that affects the distribution, number, metabolism and behaviour of organisms in an ecosystem. These include
   (a) **Inorganic substances** like carbon, nitrogen, oxygen, water, etc. These occur either in the form of compounds dissolved in water in the soil or in free state in the air.
   (b) **Organic compounds** like carbohydrates, proteins, lipids, nucleic acid, etc. These are present in living organism and dead organic matter. Dead organic matter is broken down by the action of decomposers into inorganic substance for their recycling.
   (c) **Climatic factors** which include light, temperature, humidity, wind, rainfall, water, sunlight, edaplic factors such as soil texture and topography.

(ii) **Biotic components** include the living components of the ecosystem.

The biotic components usually have
   (a) **Producers** which convert light energy into chemical energy and then into food, e.g., plants.
   (b) **Consumers** depend upon producers for food e.g., animals and few plants.
   (c) **Decomposers** take the chemicals from producers and consumers and break them into simple form so they can be reused. e.g., fungi, bacteria, etc.

Types of Ecosystem

Depending on the nature, duration and size, ecosystem can be classified as follows :

I. On basis of nature ecosystem can be-
   (1) **Natural Ecosystem**
   (2) **Artificial Ecosystem**

1. Natural Ecosystem

They are ecosystem which develop in natue without human support.

Natural ecosystem are of two types terrestial and aquatic.

- **Aquatic Ecosystem** are found in water bodies which may be fresh water or sea water. e.g., ponds, lakes, rivers (fresh water), estuarine, marine (salt water)
- **Terrestrial ecosystems -** This ecosystem occurs over land. They are of three types desert, grass land and forest.

2. Artifical Ecosystem

They are ecosystems which have been created and are maintained by human beings. Artificial ecosystems are also called man made. Agroecosystem is the largest man-made ecosystem and garden is a common artificial ecosystem maintained by man. Aquarium is another artificial ecosystem.

Food Chain

Anything we eat to survive is called food. Food can be transferred from one organism to the other through food chain. The sequence of living organism is an ecosystem in which one organism consumes another organism to transfer food energy is called **food chain**.

Food chains are attempts to demonstrate the fate of individual organisms in an ecosystem. Let us have a look at the ecosystem operating in a grassland. In a grassland, there is a lot of grass (which is producer). It is eaten by small insects (consumer), and the insects are killed and eaten by a toad, which in turn is caught by a snake. The snake is eaten by hawk. Like any other chain it has a beginning and end. The beginning is always with producers. The end is generally the organism that is not preyed on by any larger form. Traditionally, food chains are drawn with the producer at the bottom. Successive trophic levels are connected by arrows which lead from the organism being eaten to the organisms eating it. Although decomposers play an important role in an ecosystem, they are usually not included. It is rare for a food chain to have more than five levels. Herbivores are called primary consumers; first-level carnivores called secondary consumers; second-level carnivores as tertiary consumers; third-level carnivores as quaternary consumers; and so on.

Following are some more examples of food chain.

(i) grains → sparrows → cats
(ii) Algae, moss and food crumbs in the drains → cockroach → lizard → birds
(iii) grass → rabbit → hawks (garden and parks)
(iv) bark of a tree → wood house → spider → shrew → fox (woodland)
(v) cacti → ants/locusts → spiders → lizards → snakes (desert)
(vi) throny → bushes → camel (desert)

Food Web

Food web is a network of food chains operating in an ecosystem which get connected at various trophic levels so as to form a number of feeding connections amongst different organisms of the biotic community. Here each organism is eaten by two to many other kinds of organisms which in turn are eaten by several other organisms. For example, deer is prey of jackal, wolf and tiger. Rabbit is prey for fox, jackal, hawk and a number of carnivores. Mouse is food for hawk, snake, fox and wild cat. Because of it, an animal comes to have several choices. Wolf can feed on fox, jackal, wild car, deer, goat, sheep, etc. A rabbit can feed on a avariety of plants though its choicest food is only one or two. A herbivore like rabbit does not get starved if its favourite food becomes scarce. It begins to feed on alternate plants. Similarly, if population of rabbit decreases, its predators begin to eat mice, shrews and squirrels. Meanwhile rabbits increase in number and the balance of nature is restored.

There are many food chains in a food web. Food web is divided into two broad categories :

(i) **Grazing web :** Here the energy and nutrients move from plants to herbivores consuming them to the carnivores or omnivores preying upon the herbivores.

(ii) **Detrital web :** Here the plant and animal matter is broken down by decomposers e.g., bacteria and fungi, and moves to deritivores and then carnivores.

There is often a relationship between the grazing and detrital web. Mushrooms produced by decomposers in the detrital web become a food source for deer, squirrels, and mice in the grazing web.

Energy Transfer in An Ecosystem

Linderman (1942) put forth the 'Ten percent Law' for the transfer of energy from one trophic level to the next. According to this law, during the transfer of organic food from one trophic level to the next, only about ten percent of the organic matter is stored as flesh the remaining is lost during transfer or broken down in respiration.

Plants utilise sun energy for primary production and can store only 10% of the utilised energy as net production available for the herbivores. When the plants are consumed by animal, about 10% of the energy in the food is fixed into animal flesh which is available for next trophic level i.e. the carnivores. When a carnivore consumes that animal, only about 10% of energy is fixed in its flesh for the higher level. So, at each transfer 80-90% of potential energy is dissipated as heat (according to 2nd law of thermodynamics) where only 10-20% of energy is available to the next trophic level.

Global Warming

Scientist have determined that a number of human activities are contributing to global warming by adding excessive amounts of greenhouse gases to the atmosphere. Greenhouse gases such as carbon dioxide accumulate in the atmosphere and trap heat that normally would exit into outer space.

While many greenhouse gases occur naturally and are needed to create the greenhouse effect that keeps the earth warm enough to support life, human use of fossil fuels is the main source of excess greenhouse gases. By driving cars, using electricity from coal-fired power plants, or heating our homes with oil or natural gas, we release carbon dioxide and other heat trapping gases into the atmosphere. Deforestation is another significant source of greenhouse gases, because fewer trees means less carbon dioxide conversion to oxygen.

Ozone Depletion

About 90% of earth's ozone is concentrated in the stratosphere. Stratospheric ozone projects the earth from potentially damaging doses of ultraviolet radiations. Its concentration is maximum at 23-25 km above equator and 11-18 km above poles. This rich zone of ozone in the stratosphere is called **ozone layer** or **ozonosphere**. It is also called **ozone shield** because this region intercepts the ultraviolet radiations.

Ozone layer

In the stratosphere, ozone is being photodissociated and generated simultaneously by the absorption of harmful ultraviolet radiations coming from the sun.

Thinking of ozone layer is called **ozone depletion.** With the technological advancement in the past century various man made substances have caused deletion of ozone from the stratosphere thinking of ozone was noticed in 1985 above the Antartica, by Farman and coworkers. The wedely known substances which cause ozone depletion are :

- Refrigerants (CFCs-chloroflurocarbons)
- Insulating foams
- Solvents
- Aerosols

IMPROVEMENT IN FOOED RESOURCES

Agriculture

The term "agriculture" is derived from two Latin words: *Ager-field and cultra-cultivation*. Thus, agriculture is the branch of science that deals with the mass production of plants and animals useful to human beings. It involves study of:

Improved agricultural practices has increased the production of about 400 million tones of plant food products and about 90 million tones of animal food products. Also, it has resulted in a variety of "revolutions" which made India self-reliant. These revolutions include:

Agriculture revolution	Production
Green revolution	Cereals
White revolution	Milk
Blue revolution	Fish
Grey revolution	Fertilizers
Red revolution	Meat/Tomatoes
Golden revolution	Horticulture
Pink revolution	Prawn
Silver revolution	Eggs and Chicken
Round revolution	Potato
Yellow revolution	Oil seeds

Crop

Crop is a plant grown in the fields on a large scale to obtain food. For example, if all the plants of rice are grown in the field, then it is called a rice crop. Similarly, if all the plants of wheat are grown, then it is called a wheat crop. Crops are cultivated by humans for food, fodder and other materials.

Types of Crops

Different crops are grown in different seasons. Have you ever thought why? This is because each crop requires a different climatic condition, temperature range, and photoperiod for its growth and to carry out its life cycle. Therefore, some crops are grown in the rainy season while others are grown during winters.

Based on the seasons of cultivation, crops are classified in two categories:

- **Kharif crops**: The crops which are grown in the rainy season (or kharif season) are known as Kharif crops. These crops are cultivated between the months of June and October. Examples of kharif crops include paddy, maize, cotton, green gram, Soya bean, pigeon pea, and black gram.
- **Rabi crops**: The crops which are grown in the winter season (or Rabi season) are known as Rabi crops. These crops are cultivated between the months of November and April.

  Examples of Rabi crops include wheat, barley, gram, peas, mustard, and linseed.

Such seasonal cultivation of crops assures a maximum productivity of crop.

Methods of Crop Variety Improvement

1. **Hybridization** is the method by which two characteristics present in different organisms can be brought together into one organism. Therefore, a hybrid plant produced from two varieties will have characteristics from both the parent plants. Therefore, the farmer will be able to produce nutritionally-rich grains, which can be then cultivated throughout the year. Steps to be followed to obtain an improved variety of crop are:
   (i) **Choice of parental plants:** Selecting two existing varieties of plants having different desirable characteristics; say for example, one having higher yield and other having more resistance to diseases.
   (ii) **Cross breeding of selected parental plants:** This produces a new variety, which has characteristics of both the parents. The process of crossing plants of two varieties having different traits to produce a hybrid having good traits of both is called *hybridization*.
2. **Introduction :** It is the oldest method of crop improvement. It involves taking a new variety of a plant from an area where it grows naturally to a region where it does not occur before. The initial introduction of new varieties is carried out in those areas which have similar climatic and soil conditions. Slowly, the area is allowed to spread as the variety gets acclimatized to other conditions.
3. **Artificial Selection :** It involves picking up of plants with better traits for further multiplication. The selection operating for long time spans can give rise to varieties different from starting generation. For example, cabbage, cauliflower and broccoli have been obtained through artificial selection from wild cabbage.
4. **DNA recombination technology :** Genes are responsible for the features present in an organism. Therefore, another method to grow plants with the desired characteristics is to incorporate genes responsible for that character into plants. This method will result in the production of genetically modified plants. Thus, DNA recombination technology transfers genes from one organism to another so as to modify the latter. For example : Bt cotton. Bt cotton is a genetically modified crop, which carries bacterial genes that protect the crop from insects. By now, about 200 genetically modified crops varieties have been produced.

Food items	Crop	Varieties
Cereals	Rice	Kasturi, Jaya, Padma, IR-8
	Wheat	Sharbati Sonora, Sonalika, Kalyan Sona, Hira Moti, Pusa Lerma
	Maize	Vikram, Navjot, Shakti, Ganga 101, Deccan hybrid
Pulses	Pigeon pea	Pusa 84, Manak
	Chick pea	Pusa 240, Pant 114
Oil seeds	Sunflower	Arun, Pusa
	Mustard	Kranti, Pusa Bold
Vegetables	Lady Finger	Pusa Savani
	Brinjal	Pusa Purple, Pusa Kranti

Cropping patterns

Cropping patterns are models of raising crops which help in obtaining maximum benefit from a single piece of land. These patterns reduce the risk of crop failure, disease and infestation.

The common types of cropping patterns are:

1. **Crop rotation :** Have you ever been to a village? Farmers plant wheat crop during the month of November and harvest them in March and April. Similarly, rice crop is planted in June-July and harvested in October and November. The land that lies fallow in between these two cereal crops is used by the farmers for sowing a leguminous crop at this time. A leguminous crop does not take as long as wheat or rice to grow. So, by the time the farmer has to plant the cereal crops (rice, wheat etc.) the pulse is ready to be harvested. Have you ever thought why it is done so? What this type of method is known as?

   The practice of growing two or more varieties of crops on the same field in a sequential season is known as crop rotation. Generally a leguminous crop like pulses, beans and peas, is rotated with non-leguminous crop such as wheat, maize *etc.*

   Leguminous crops harbour nitrogen fixing bacteria in nodules of their roots. These bacteria convert free nitrogen from atmosphere into usable form. Thus, after the leguminous crop is harvested, the soil is left fertile for other crops. In this way, rotating different crops (leguminous and non-leguminous crops) in the same field replenishes the soil with nitrogen naturally and thereby increases the crop production.

   Advantages of crop rotation:

   (i) It improves the fertility of soil and hence brings about an increase in food production.
   (ii) It helps in weed control.
   (iii) It protects crop from diseases.
   (iv) It reduces the dependence on fertilizers.
   (v) It results in optimum utilization of nutrients as different crops obtain nutrients from different layers of soil.

2. **Multiple cropping:** Multiple cropping is the growing of two or more crops one after another in the same field. It is of two types:

(I) Mixed cropping : It is the technique of growing two or more different crops simultaneously on the same field. The farmers mix the seeds of two crops and sow in the field. It is like an insurance against crop failure due to abnormal weather conditions and attack of pests and pathogens.

For example :

- Maize + Urad bean
- Soyabean + Pigeon pea
- Wheat + Chick pea
- Wheat + Mustard
- Barley + Gram

There are certain criteria that farmers follow while selecting different crops for mixed cropping. Some of these are discussed below:

(a) The crops should not have same root pattern. If one crop is deep rooted, the other should have shallow roots.

(b) Both the crops should have different water and nutrient requirements. If one crop plant requires higher amount of water and nutrients, the other should require lesser amount.

(c) Both the crops should have different maturity time. If one is long duration crop, the other should be of short duration or early maturity.

(d) The crops should have different growth habit. They should have different structure of leaves, stems, branching pattern of stem and flowers. If one plant is tall, the other should be dwarf.

(e) Always select the crops such that the products and waste materials of one crop stimulates the growth of the other crop. *For example*, if a wheat crop is grown along with a leguminous crop, then the usage of nitrogen from the soil by wheat plant is compensated by the addition of nitrogen in the soil by nitrogen fixing legume. This in turn increases the soil fertility and ultimately the yield of crop.

Need of following above criteria:

(i) All these criteria ensure that the component crops do not compete with each other for any of their requirement.

(ii) It ensures that in case one crop fails, the other crop continues to flourish and cover the risk of complete failure of one crop.

Advantages of mixed cropping:

(i) It reduces the risk of total crop failure.

(ii) It increases the yield of crops due to the complementary effect of component crop. If a wheat (non-leguminous) crop is grown along with a leguminous crop, then the usage of nitrogen from the soil by wheat plant is compensated by the addition of nitrogen in the soil by nitrogen fixing legume. This increases the soil fertility and ultimately the yield of crop.

(iii) It tends to harvest variety of produce such as pulses, cereals, vegetables *etc*.

(iv) It improves the fertility of soil and reduces the requirement of fertilizers.

(v) It helps in optimum utilization of the soil.

(vi) It reduces the chances of pest infestation.

(vii) It enhances the optimum utilization of nutrients as they are absorbed from different layers of the soil.

(II) Inter cropping: It the practice of growing two or more crops simultaneously in a same field in a definite row patterns. This technique enhances the productivity per unit area. The crops selected have different nutrient requirements, different sowing and harvesting dates.

For example :

i. Soyabean + Maize

ii. Bajra + Lobia

Advantages of intercropping:

(i) It increases the productivity per unit area.

(ii) It saves time and labour of the farmer.

(iii) It makes better use of natural resources of sunlight, land and water.

(iv) Since the seeds of different crops can be sown separately, so specific fertilizers required for each crop can be added.

(v) The produce of each crop can be harvested, threshed and marketed separately.

(vi) This method keeps a check on soil erosion.

Animal Husbandry

Ever since the beginning of civilisation, humans have been trying to make use animals around him for many requirements, such as for food (milk, meat and egg), clothing (wool), labour (carrying load) and security *etc*. The development of desirable qualities in all such animal species, through creating better breeds, has been an important human achievement. For this, humans have consistently tried to improve the breeds of domesticated animals to make them more useful for them.

The branch of science, which deals with the study of various breeds of domesticated animals and their management for obtaining better products and services, is known as *animal husbandry*. The term husbandry is derived from the word "husband", which means "one who takes care".

Animal husbandry is the science of managing animal livestock. It involves feeding, breeding, and controlling diseases in farm animals. It involves the rearing of animals like cattle, poultry, and fish to obtain desired products from them.

- **Milk giving (milch) animals:** Cows, buffaloes and goats who give us milk.
- **Meat and egg giving animals:** Pigs, cattle, goat, sheep, fowls and ducks which are the main source of meat. From hens and ducks we get eggs.
- **Working (draught) animals:** Bullocks, buffaloes, camels and horses are draught animals used for doing work in the field and for transportation of goods and human beings. Mules are also used especially by the army to take things from one place to another in the hilly areas.

Animal Breeding

Animal breeding is the method of mating closely related individuals. In this process, two individuals of desirable characters are selected as parents. These are then crossed to obtain new breeds of animal. The new breed so obtained possesses the characteristics of both. For example, exotic or foreign breeds like Jersey, Brown Swiss *etc.* are selected for increased milk production while local breeds like Red Sindhi, Sahiwal *etc.* are selected for highly resistant to diseases.

These two breeds are crossed to produce a hybrid breed, in which both the characteristics are available. Therefore, the offspring not only produces more milk, but is also more resistant to diseases.

Breed

A breed is a special variety of animals within a species. It is similar in most characters such as general appearance, size, configuration, and features with other members of the same species. Jersey and Brown Swiss are examples of foreign breeds of cattle. These two varieties of cattle have the ability to produce abundant quantities of milk. This milk is very nutritious with high protein content.

It is of three types:

(i) **Local or Desi or Indigenous breed-** They are high yielding varieties of indigenous (Indian) breed *e.g.* Gir, Sahiwal, Thararkar, Kankrej *etc.*

(ii) Foreign or exotic breed- They are high yielding varieties that have been imported from foreign and reared widely in India *e.g.* Hilstein, Friesian, Jersey, Swiss etc

(iii) Improved breeds-They are hybrid that possesses characteristics of both indigenous and exotic. *e.g.* Friewal, Karan Swiss.

There are several methods employed in animal breeding, which can be classified into the following categories:

(A) **Natural methods** of breeding include inbreeding and out-breeding. Breeding between animals of the same breed is known as inbreeding, while breeding between animals of different breeds is known as out-breeding. Out-breeding of animals is of three types:

(a) **Out-crossing:** In this type of out-breeding, the mating of animals occurs within the same breed. Thus, they have no common ancestors up to the last 4-5 generations.

(b) **Cross-breeding:** In this type of out-breeding, the mating occurs between different breeds of the same species, thereby producing a hybrid.

(c) **Interspecific hybridization:** In this type of out-breeding, the mating occurs between different species.

(B) **Artificial methods of breeding** include modern techniques of breeding. It involves controlled breeding experiments, which are of two types:-

(a) **Artificial insemination:** It is a process of introducing the semen (collected from the male) into the oviduct or the uterus of the female body by the breeder. This method of breeding helps the breeder overcome certain problems faced in abnormal mating.

(b) **Multiple ovulation embryo technology (MOET):** It is a technique for cattle improvement in which super-ovulation is induced by a hormone injection. Then, fertilization is achieved by artificial insemination and early embryos are collected. Each of these embryos is then transplanted into the surrogate mother for further development of the embryo.

Fish Production

Fish is an aquatic food which is rich source of proteins. It is highly nutritious and easily digestible. A large section of Indian population especially one living in coastal area uses fish as food.

Fisheries : It is the occupation of catching fishes, prawns, lobsters, oysters *etc.* On the basis of mode of obtaining fish, fisheries are of two types:

(i) **Capture fishing :** It is the process of obtaining fish from natural resources, both marine and inland.

(ii) **Culture fishery :** It is the practice of farming fish. It is also known as fish farming or pisciculture.

Aquaculture : The growing of various types of aquatic animals that are of high economic value such as prawns, lobsters, fishes, crabs *etc* is called aquaculture.

Marine Fisheries : They are fish catching areas found in sea. It is of three types: coastal, offshore and deep sea. The edible marine capture fishes are tuna, sardines, Bombay duck, pomphrets *etc.*

Mariculture : The culture of marine fishes for commercial use is called Mariculture. *For example*s, Mullets, Bhetki, Pearl spots, Eel, and Milk fish. Mariculture is growing rapidly as the demand for the fish is decreasing while the stock is declining due to excessive exploitation from sea.

Inland fisheries : The fisheries that deal with fresh and brackish water are known as inland fisheries. Fresh water occurs in rivers, reservoirs, lakes and ponds while brackish water is found in estuaries and lagoons. Inland fisheries account about 50% of total fish production in the country.

Inland fisheries are of two types: Culture fishery and Capture fishery.

Culture fishery is a type of fishery practiced in small water bodies where fish is first reared and then harvested.

The fish culture is of different types:

(a) Monoculture, where single species of fish is grown.

(b) Monosex culture, where fish of only one sex is grown.

(c) Poly-culture, where combination of five to six species is grown.

Composite Fish Culture

Due to over-exploitation and pollution, the availability of fish in natural water has declined considerably, which in turn has forced scientists to adopt various methods to increase its production.

Farming of fish under artificial condition is the easiest way of increasing fish production and its availability for consumption. Farmers can take up fish culture in village ponds; tanks *etc.* and can improve their financial position, The technology developed for fish culture in which more than one type of fishes is cultured simultaneously is known as composite fish culture. The technology enables to get maximum fish production from a pond or tank.

Fishes with different food habitats are chosen so that they do not compete for food among themselves. *For example*, in an experiment, a combination of five to six species was used. Out of six species, three are of Indian origin (Catla, Rohu and Mrigal) and three are exotic (Silver carp, Grass carp and Common carp) from China.

These six species have complementary feeding habits and do not harm each other. Basically it constituted a good example of polyculture.

The food habits of six species are :

(i) Catla is surface feeder that feeds on small animals.
(ii) Silver carp is also surface feeder but feeds on phytoplankton.
(iii) Rohu feeds in middle zone of pond
(iv) Grass carp feeds on water weeds.
(v) Mrigal carp is a bottom feeder, which feeds on decaying plants and detritus.
(vi) Common carp is an omnivorous bottom feeder. It feeds on all types of living organisms.

Advantages of Composite Fish Culture:

(i) Fishes do not compete among themselves for food as they all have different types of food habits.
(ii) It ensures a complete utilization of food resources in the pond.
(iii) It increases the yield of fish.

Bee Keeping

The practice of bee keeping is called apiculture (Latin.apis-bee, culturare-cultivate). Apiculture is rearing, care and management of honey bees for obtaining products like honey, propolis, bee vemon etc. It also provides honey, a valuable nutritional food. It provides bees wax. Beeswax is secreted by the wax glands located on the underside of the last four abdominal segments (4th to 7th) of the worker bee. This wax is used in constructing bee combs in which the colony of the bees develop. Bee wax has many uses in industry. It is used in cosmetics, creams and ointments. It provides Propolis, which is antiseptic and antibiotic. Bee venom is used in treatment of rheumatoid arthritis. Honey bees are excellent pollinating agents. Thus, it helps in increasing agricultural yield.

Honey

Honey is viscous sweet syrup, which is formed from the nectar of flowers. Worker bees collect nectar from flowers, modify and concentrate them to form honey. Honey contains 20-40% water, 60-80% sugar, 0.2-0.5% vitamins, propolis, enzymes and pollen grains.

Importance of Honey

(a) It is useful in the treatment of disorders of humans related to digestion, vomiting and stomach, liver ailments.
(b) It acts as blood purifier, a cure against cough and cold, sore throat, ulcer of stomach and intestine.
(c) It helps in growth of human body as it is a source of iron and calcium.
(d) It acts as a source of sugar in confectionary items.
(e) It helps in building up haemoglobin.
(f) It acts as an immediate source of energy.

Common Species of Honey bee

There are two varieties of honey bees that are used for commercial production of honey in India.

(i) **Indigenous varieties**, which includes:
  (a) *Apis cerana indica* (Indian bee)
  (b) *Apis dorsate* (Rock bee)
  (c) *Apis florae* (Little bee)
(ii) **Exotic varieties**, which includes:
  (a) *Apis mellifera* (Italian or European bee)
  (b) *Apis adamsoni* (South African bee)

The Honey Bee Colony

Honey bees are social insects that live in colonies in nests or hives. There are different groups of bees in the same colony that performs different tasks. A honey bee colony has three castes:

(i) **Queen:** Honey bee Queen is the supreme bee in a colony. All the activities in the hive revolve around her. Basically, she is the mother of the colony. She is responsible for laying eggs, and lays about 2000 eggs in a day. She lays two types of eggs:
  (a) *Fertilized eggs* that produce either sterile workers or fertile females, *i.e.* new queen.
  (b) *Unfertilized eggs* that produce drones.

  Queen lives for about 3 to 4 years.
(ii) **Workers:** They the most active members of the colony. They are actually imperfectly developed females, which cannot reproduce. Workers live for 3 to 12 months. The function of workers changes with age.
  (a) During 1st half of their life cycle, they do indoor duties. Each worker bee acts as a scavenger, cleaning the hive, like walls and floor of empty cells of the colony for reuse. They also start feeding the entire brood, with a mixture of honey and pollen. By 7th day, it starts producing royal jelly. Royal jelly is fed to queen and future queen bees. They also defend the colony from intruders by stinging.
  (b) During second half, they become field workers and perform duties outside the colony. They explore new sources of nectar. They collect nectar, pollen and propolis. The nectar collected changes into honey in their crops.
(iii) **Drones:** Drones are male bee produced by unfertilized eggs. They are males of the colony and depend for food on worker bees. Drones are stingless and their main role is to mate with queen.

DIVERSITY IN LIVING ORGANISM

There are enormous varieties of living organisms on earth. **Classification** is the arrangement of organisms into groups and subgroups on the basis of their similarities and dissimilarities. Biologists have devised techniques for identification, naming and grouping of various organisms. There is a need to standardize the naming of living organisms such that a particular organism is known by the same name all over the world. This process is called **nomenclature**.

The word **systematics** is derived from the Latin word 'systema' which means systematic arrangement of organisms. Linnaeus used

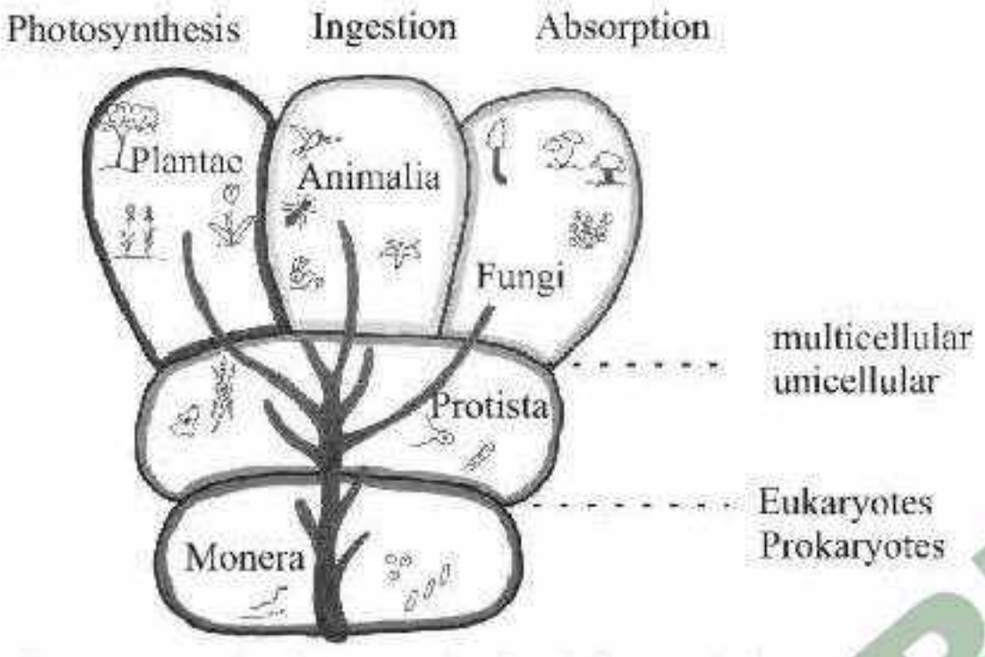
Systema Naturae as the title of his publication. Systematics takes into account evolutionary relationships between organisms.

Classification is not a single step process but involves hierarchy of steps. Each step in hierarchy represents a **rank** or **category.** Since the category is a part of overall taxonomic arrangement, it is called the *taxonomic category*. All categories together constitute the **taxonomic hierarchy**.

Kingdom → Phylum (for animals)/**Division** (for plants) → **Class → Order → Family → Genus → Species**

Linnaeus classified the living world into two kingdoms- Plantae and Animalia in 1758.

R.H. Whittaker proposed a five kingdom classification of living organisms on the basis of Linnaeus two kingdoms classification. The five kingdoms proposed by Whittaker are **Monera, Protista, Fungi, Plantae, Animalia**.



Five kingdom system showing complexity during evolution

Kingdom Monera

Monera includes unicellular (single celled) organisms. They are prokaryotes. It means, their genetic material is not organized into a nucleus. It lies directly inside the cytoplasm and is called nucleoid. Membrane bound cell organelles like mitochondria; Golgi apparatus, lysosomes, etc are absent. Cell wall may or may not be present. The mode of nutrition may be autotrophic or heterotrophic.

Examples: Bacteria (*Vibrio cholerae*, *Salmonella typhi*) and blue green algae (e.g. *Anabaena*, *Nostoc*)

Kingdom Protista

Protista includes unicellular (single-celled) organisms. They are eukaryotes. Membrane bound organelles like nucleus, mitochondria, endoplasmic reticulum, golgi bodies are present.

Chrysophytes : This group includes diatoms and golden algae (desmids). They are found in fresh water as well as in marine environments. Diatoms are the chief 'producers' in the oceans.

Dinoflagellates : These organisms are mostly marine. They appear yellow, green, brown, blue or red depending on the main pigments present in their cells.

Euglenoids : Majority of them are fresh water organisms found in stagnant water. Though they are photosynthetic in the presence of sunlight, when deprived of sunlight they behave like heterotrophs by predating on other smaller organisms. Interestingly, the pigments of euglenoids are identical to those present in higher plants. Example : *Euglena*.

Slime Moulds : Slime moulds are saprophytic protists. Under suitable conditions, they form an aggregation called plasmodium which may grow and spread over several feet.

Protozoans : All protozoans are heterotrophs and live as predators or parasites. They are believed to be primitive relatives of animals. There are four major groups of protozoans. *Amoeboid protozoans* : These organisms live in fresh water, sea water or moist soil.

Kingdom Fungi

Fungi are basically multi-cellular. Yeast is an exception in being unicellular. The body of fungi is made of thread-like structures called hyphae. The hyphae grow in the form of a mat like structure called mycelium. The cell wall is generally composed of chitin (a nitrogen containing carbohydrate). They do not contain chlorophyll and hence are heterotrophic. Most of them are decomposers, hence fungi are also known as kingdom of multi-cellular decomposers. They may be saprophytic (depend on dead or decaying organic matter for their food) or may be parasitic (depend on living organisms for their food).

They can also live as **symbionts**–in association with algae as **lichens** and with roots of higher plants as **mycorrhiza**.

Lichens : Lichens are dual organisms that are formed by permanent symbiotic association between an algae and a fungus. They co-exist for mutual benefit. This type of relationship is known as symbiosis. The alga manufactures food for itself and for the fungus. Fungus provides protection to alga and helps in fixation and absorption of water and minerals.

Mycorrhizo : It is a symbiollic association between fungi and roots of vascular plants. Its shows mutalistic type of relationship in which fungi obtain sugar component while they benefit plant by providing efficient uptake of mineral neutrient.

Viruses : The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell. Once they infect a cell they take over the machinery of the host cell to replicate themselves, killing the host. D.J. Ivanowsky (1892)

Kingdom Plantae

Kingdom plantae shows a lot of diversity, because of which, it has been divided into four divisions: **Algae**, **Bryophyta**, **Pteridophyta**, and **Spermatophyta** (Gymnosperms and Angiosperms).

Division Thallophta

(Greek: Thallos-Undifferentiated, Phyton-Plant)

Algae:

Algae are thallophytes which are capable of manufacturing their own food through photosynthesis. The body of algae is simple with little differentiation of body design. The size ranges from unicellular microscopic forms like *Chlamydomonas* to colonial forms like *Volvox* and to the filamentous forms like *Ulothrix* and *Spirogyra*. Examples : *Spirogyra, Laminaria, Sargassum* and *Gracilaria.*

Division Bryophyta

It is a division of non-vascular plants having an embryo stage in their developmental process. They are the simplest land plants and are known as amphibians of plant kingdom as they live in soil but are dependent on water for sexual reproduction. The plant body is commonly differentiated to form stem and leaf-like structure. They have no specialized tissue for the conduction of

water and other substances from one part of the body to another. Plant body of bryophytes is gametophyte. Sporophyte lives as a parasite over it. The sex organs are multicellular, male sex organ is called **antheridium** and produces antherozoids whereas female sex organ is **archegonium** and produces a single egg. Examples: It includes various mosses and liverworts.

Division Pteridophyta

It is a division of seedless vascular plants. Unlike bryophytes, the main dominant plant body is sporophyte which is differentiated into true root, stem and leaves. They have well developed vascular system (xylem and phloem). Sporophytes bear sporangia which produces spore, on germination these spores give rise to gametophyte called prothallus. **Prothallus** bears the male and female sex organs **antheridia** and **archegonia** respectively. Seeds are absent. They produce naked embryos called spores.

Examples: *Selaginella, Equisetum, Marsilea, etc.*

Spermatophyta

It is a division of seed-producing plants. A seed has an embryo that contains reserve food for its future growth. The main plant body is sporophyte which is differentiated into stem, leaves and roots. They have well-developed vascular tissues throughout the plant body. The reproductive process produces seeds which on germination forms a new plant. Spermatophyta has two sub-divisions- Gymnospermae and Angiospermae.

Sub-division Gymnospermae

Gymnosperms include plants that bear naked seeds. Sporangia are formed over modified leaf like structure called sporophylls. Sporophylls are of two types: **megasporophyll** bears megasporangium (ovule) whereas **microsporophyll** bears microsporangium (pollen sac). The microsporophyll and megasporophyll form the male and female cones which produced male and female gametes respectively. Examples: *Cycas*, *Pinus* (Pine), *Cedrus* (Deodar) etc.

Sub-division Angiospermae

These are flowering plants, in which seeds are enclosed by a protective structure called fruits. The reproductive organs are aggregated into flowers. The male sex organs are called **stamen** and female sex organs are called **pistil**. The seed contains an embryo together with the nourishment-containing cotyledons (one in some and two in others). On the basis of number of cotyledons (fleshy embryonic leaves), the angiosperms are divided into two groups:

Dicotyledonae (Dicots)

The angiosperms with two cotyledons are called dicots. Their leaves have reticualte venation with a network of veins. The root system has prominent tap root. The flowers have five or multiple of five petals. Examples : Pea, potato, rose, banyan, apple, etc.

Monocotyledonae (Moncots)

The angiosperms with only one cotyledon are called monocots. Their leaves have parallel venation. The root system consists of fibrous roots. The flowers have three or multiple of three petals. Examples : Maize, wheat, rice, sugarcane, coconut etc.

Kingdom Animalia : All animals are multicellular, eukaryotic heterotrophs and made up of multiple cells with mitochondria and they rely on other organisms for their nourishment. They move about in search of food or for other need. The kingdom Animalia is very vast and highly varied and sub-divided into eleven phyla.

Phylum Porifera (Animals bearing pores)

These are the simplest multicellular, diploblastic, acoelomate animals. Body consists of a hollow tube, and found attached to the rocks. They have porous body with numerous pores for entry of water carrying food and oxygen and a single opening for the exit of water. Examples : *Spongilla, Sycon, Euplectella.*

Phylum Colenterata (Cnidaria)

They are exclusively marine animals except for few like ***Hydra*** that are found in fresh water. They are multicellular, diploblastic animals with tissue grade of organization. Tentacles that surround the mouth capture the prey, paralyzed by their stinging cells and push it into the mouth. The same mouth throws the undigested left out food out of the body again. Examples : *Hydra*, *Aurelia* (jelly fish), *Physalia* (Portugese- man-of war).

Phylum–Ctenophora

Ctenophores, commonly known as **sea walnuts** or **comb jellies** are exclusively marine, radially symmetrical, diploblastic organisms with tissue level of organisation. **Bioluminescence** (the property of a living organism to emit light) is well-marked in ctenophores. Sexes are not separate. Reproduction takes place only by sexual means. Examples : *Pleurobrachia* and *Ctenoplana*.

Phylum Platyhelminthes (Flat worms)

Body is soft, elongated, dorso-ventrally flattened and leaf like with bilaterally symmetrical. The animals are triploblastic, acoelomate with tissue grade of organization. Specialised cell called flame cells helps in osmoregulation and excretion. Examples: *Planaria*, *Taenia* (tape worm), *Fasciola* (liver fluke).

Phylum Aschelminthes (Roundworms)

The body of organisms is cylindrical and elongated. They are bilaterally symmetrical, triploblastic and pseudocoelomate animals with organ level of organization. Alimentary canal is complete with well developed muscular pharynx and anus. Sexes are separate (dioecious), *i.e.*, male and females are distinct. Examples : *Ascaris* (round worm), *Wuchereria* (filaria worm), etc.

Phylum Annelida (The segmented animals)

Annelids are bilaterally symmetrical, triploblastic and coelomate animals. They are soft, elongated, vermiform, cylindrical or dorsoventrally flattened. Body is metamerically segmented externally by transverse grooves and internally by septa. Digestive system is well developed. Alimentary canal is tube like and extends straight from mouth to anus. Examples: *Nereis*, *Pheretima* (Earthworm), Leech, etc.

Phylum Arthropoda (arthro-jointed, poda-legs): Animals with jointed legs

This is the largest phylum of Animalia which includes insects. The body is triploblastic, bilaterally symmetrical and metamerically segmented with organ level of organization. Body is also covered by a hard chitinous exoskeleton. The body consists of head, thorax and abdomen with jointed legs. Alimentary canal is complete. Mouth and anus lie at the opposite ends of the body. Excretion takes place by malpighian tubules (insects) and green glands (crab and prawn). Examples : Economically important insects–*Apis* (Honey bee), *Bombyx* (Silkworm), *Laccifer* (Lac insect).

Vectors–*Anopheles*, *Culex* and *Aedes* (Mosquitoes)

Gregarious pest–*Locusta* (Locust)

Living fossil–*Limulus* (King crab).

Phylum Mollusca (Soft bodied animals)

It is the second largest phylum of the animal kingdom and an ancient group that lived on this planet from over 500 million years. They are triploblastic, coelomates and usually with bilateral symmetry. The body is soft and divided into three regions- head, dorsal visceral mass and ventral foot. Foot is meant for creeping and for other kinds of locomotion. The body is protected by a hard calcareous shell. Examples : Snails, slugs, *Octopus*, cuttlefish, etc.

Phylum Echinodermata (The spiny skinned animals)

All are marine, triploblastic and coelomate. Adults are radially symmetrical and larvae are bilaterally symmetrical. The most distinctive feature is the presence of water vascular system with an array of radiating canals and tube like appendages called tube feet. Tube feet are used for locomotion, capturing of food and respiration. Head is absent and five radially arranged arms are present. Examples : Starfish, Sea urchin, Sea cucumber etc.

Phylum–Hemichordata

This phylum consists of a small group of **worm-like** marine animals with organ-system level of organisation. They are bilaterally symmetrical, triploblastic and coelomate animals. The body is cylindrical and is composed of an anterior **proboscis**, a **collar** and a long **trunk**. Excretory organ is proboscis gland. Sexes are separate. Examples : *Balanoglossus* and *Saccoglossus*.

Phylum Chordata

It is a phylum of triploblastic bilaterally symmetrical animals. All members of this phylum possess: Flexible rod like notochord along the mid-dorsal axis of the body. The notochord is later replaced by a backbone (vertebral column), A hollow dorsal nerve cord, Paired gill slits, A tail extending behind the anal opening.

Phylum Chordata is divided into three sub-phyla:

(i) **Subphylum Urochordata (uro:tail):** In urochordata, the notochord is present in the tail of the larva and disappears in the adult. Example: *Herdmania*.

(ii) **Subphylum Cephalochordata (cephalo: head):** In cephalochordate, notochord extends upto the anterior end of the body and persists throughout the life. Example: *Branchiostoma* (*Amphioxus).*

(iii) **Subphylum Vertebrata:** In organisms belonging to sub phylum vertebrata, notochord is replaced by vertebral column in adults. It is the largest group in Chordata.

SUPERCLASS: PISCES

They are exclusively aquatic animals with streamlined body covered with scales. Pisces are cold-blooded animals. Notochord is persistent. Heart is two chambered and respiration occurs by gills. Gills are able to withdraw oxygen dissolved in water. They have fins for locomotion and balancing.

Pisces is divided into two classes:

Class : Chondrichthyes (cartilaginous fishes) :

Cartilaginous fishes have skeleton made of cartilage. Gills are exposed (not covered by any gill-cover). Operculum is absent. Example: Shark

Class : Osteichthyes (Bony fishes):

Bony fishes have skeleton made of bones. Gills are covered by an operculum. Example : Rohu, Catla etc.

CLASS : AMPHIBIA

The animlas are amphibious in nature that means they can live on land as well as in water. Body temperature changes with that of external environment. Skin is smooth and without scales. It has large number of mucus glands that keeps the skin moist. Respiration is by gills, lungs and through skin. The heart is three chambered (two auricles and one ventricle). They lay eggs in water. Examples: Toad, frog, salamanders, newt, etc.

CLASS REPTILIA : CREEPING VERTEBRATES

They are mostly terrestrial animals and their body is covered by dry and cornified skin, epidermal scales. Body varies in form and is usually divided into head, neck, trunk and tail. Respiration takes place through lungs. Heart is three chambered except for crocodiles which have four chambered heart. They lay eggs on land. They are oviparous. Examples: Lizards, snakes, turtles etc.

CLASS AVES (LATIN. AVIS: BIRD)

The body is streamlined to reduce air resistance during flight. They are warm-blooded, tetrapodous vertebrates. Forelimbs are modified into wings while hind limbs have four clawed digits meant for walking, running or perching. Jaws are prolonged to form horny beak. Teeth are absent. Bones are very light because of air spaces. This helps the bird to lighten the body weight for flight. They lay eggs with calcareous shell. They are oviparous. Heart is four chambered. Respiratory system possesses well developed lungs with air sacs attached to them. Examples : Ostrich, crow, parrot, eagle, pigeon etc.

CLASS MAMMALIA

They are the most evolved animals of animal kingdom. They have well developed brain. They are endothermous (warm-blooded) animals. They maintain a fixed body temperature. The females have milk producing glands called mammary glands. They are the only animals which nourish their young ones with milk. Two pairs of pentadactayl limbs are present. Digits in the fore limb and hind limbs are generally five and ending as claws, nail and hoof. Respiration occurs by lungs, heart is four chambered. They generally gave birth to young ones except **Platypus** and **Echidna** that lays eggs. Examples: Kangaroo, dog, man, chimpanzee, elephant, etc.

WHY DO WE FALL ILL

Diseases and its Causes

Disease means uncomfortable. Disruption in the functioning of any tissue, organ or organ system will cause discomfort or disease. The diseases are diagnosed with the help of symptoms or signs.

Symptoms : Symptoms are evidences of the presence of diseases. The malfunctioning of organs produces external symptoms of diseases. It indicates that there is something wrong with the body.

It can be in the form of structural and functional changes in the body or body part. *For example*, cold, cough, loose motions, pain in abdomen, headache, fever etc are symptoms of certain disease.

However, symptoms do not give any exact cause of the disease. For example, headache can be due to number of diseases, like typhoid, jaundice or malaria. Sometimes, it is simply due to day's heavy work or exam stress.

Types of Diseases

Diseases are broadly classified into two categories:

(i) **Congenital Diseases:** These are diseases which are present since birth. For instance, hole in the heart of an infant. They are caused by some genetic abnormalities or metabolic disorder or malfunctioning of an organ.

(ii) **Acquired Diseases:** These are diseases which may occur after birth during one's lifetime.

Based on their ability or inability to spread from one individual to another, acquired diseases are of two types:

(a) **Infectious or Communicable diseases:** The diseases which can be transmitted from diseased person to healthy person by means of infectious agents are known as infectious or communicable diseases. *For example*, tuberculosis, measles, malaria etc.

(b) **Non infectious or Non-communicable diseases:** The diseases which cannot be transmitted from an affected individual to a healthy person are known as non-infectious or non-communicable diseases. *For example*, high blood pressure, Cancer, Allergy, Obesity etc.

Non-infectious diseases are not caused by any pathogen or living organism. They are mostly due to internal or intrinsic non-infectious causes. *For example*, High blood pressure is caused due to lack of exercise or excessive weight.

Similarly, Cancer is caused due to genetic abnormalities.

Difference table between Infectious (Communicable) and Non-infectious (Non-communicable) diseases

Infectious (Communicable) Diseases	Non-infectious (Non-communicable) diseases
It can be transmitted from diseased person to healthy person.	It cannot be transmitted from one person to another.
They are caused by attack of pathogens i.e. external agents or factors.	They are caused by factors other than living pathogens i.e. caused by internal factors, such as deficiency of nutrients, genetic abnormalities etc.
Transmission of disease occurs through direct contact or some medium (water, food, air etc).	Transmission of disease by contact is absent.
Examples: Malaria, Cholera, Tuberculosis	*Examples:* Diabetes, Cancer, Obesity etc.

MODES OF TRANSMISSION OF DISEASES

Diseases can spread through the following means:

(i) **By air:** *Y*ou must have observed that when you sit near a person infected with cold, you catch it too? Can you explain why? It happens because the virus that causes cold can reach your body through air. Hence, common cold is an air borne disease.

A number of disease causing microbes spread through air. The pathogens may reach the body through little droplets through out when an infected person sneezes or coughs. A healthy individual standing nearby can inhale these droplets, causing infection in that person. Diseases spreading through air are : Common cold, Pneumonia, Tuberculosis, Diphtheria etc. Air borne diseases are more common in crowed areas as well as in poorly ventilated rooms.

(ii) **By water and food:** Some diseases are transmitted when excretions from an infected person containing causal microorganisms get mixed with drinking water. Consumption of this contaminated water leads to the spread of diseases.

In addition, when food is prepared using this contaminated water, it can lead to food borne diseases. Some water and food borne diseases are cholera, typhoid, hepatitis A, Jaundice, Diarrhea etc.

(iii) **Direct physical contact:** Sexual act involves close contact between two people, which leads to the transfer of diseases such as syphilis, gonorrhoea, AIDS, etc. These diseases are known as *sexually transmitted diseases*. However, casual physical contact such as handshake, hugging, and kissing does not lead to the transfer of these diseases.

Diseases that spread through sexual contacts are: AIDS, Syphilis, gonorrhea.

(iii) **Blood to blood contact:** This type of contact is established through blood transfusion or during pregnancy (between mother and baby) and through breast-feeding. Disease that spread through blood is AIDS.

Viral Disease

1. **Bird Flu :** Bird flu, or avian influenza, is a viral infection spread from bird to bird. Nowadays a particular deadly strain of bird flu H5N1 continues to spread among poultry in Egypt and in certain parts of Asia. Human get infected with this disease by close contact with bird and bird droppings. Symptoms of Bird flu are muscle ache, cough and sore throat, infection in eye and fever. Treatment bird flu with antiviral medication required oseltamivir, peramivir, or zanamivir.

2. **Severe Acute Respiratory Syndrome (SARS) :** Severe Acute Respiratory Syndrome (SARS) is one of the severe and readily transmissible new disease emerged in the 21St Century. SARS is caused by coronavirus called, SARS-associated coronavirus (SARS-CoV). First time this disease was reported in November 2002 in Guangdong province, China. In general SARS begins with high fever headache an overall feeling of discomfort, and body aches. Some people also have mild respiratory symptoms at the outset. Infection with SARAS Virus causes acute respiratory distress and may lead to death even. Ribavirin, a nucleoside analog, was widely chosen as an empirical therapy for SARS because of its broad-spectrum antiviral activity against many DNA and RNA viruses.

3. **Hepatitis :** Hepatitis is refers to the inflammatory condition to liver. It's commonly caused by a viral infection, but there are other possible causes of hepatitis. These include autoimmune hepatitis and hepatitis that occurs as a secondary result of medications, drugs, toxins, and alcohol. There are five main types of hepatitis.

(i) **Hepatitis A :** This type of Hepatitis is caused by infected food and water. Everyone who develops

Hepatitis A makes a full recovery - it does not lead to chronic disease. Inflammation and swelling of liver is the main symptom in this type of hepatitis.

(ii) **Hepatitis B :** This type of hepatitis is caused by Hepatitis B Virus. This type of hepatitis is spread with infectious body fluid such as blood saliva or semen.

(iii) **Hepatitis C :** This type comes from the hepatitis C virus (HCV). Hepatitis C is transmitted through direct contact with infected body fluids, typically through injection drug use and sexual contact.

(iv) **Hepatitis D :** This is also called delta hepatitis. Hepatitis D is a serious liver disease caused by the hepatitis D virus (HDV). HDV is contracted through puncture wounds or contact with infected blood. Hepatitis D is a rare form of hepatitis that occurs in conjunction with hepatitis B infection.

(v) **Hepatitis E :** Hepatitis E is a waterborne disease caused by the hepatitis E virus (HEV). Hepatitis E is mainly found in areas with poor sanitation and is typically caused by ingesting fecal matter.

4. **AIDS :** Acquired Immune Deficiency Syndrome (AIDS) is caused by Human Deficiency Virus (HIV) which destroys the CD4 Cells that are essential for the body immune symptoms. HIV is transmitted (spread) through the blood, semen, genital fluids, or breast milk of a person infected with HIV. Unprotected sex and sharing of drug injection equipment with the person infected with HIV are the most common ways of HIV transmission. It takes many years to develop the HIV symptoms but the HIV infected person can spread the virus at any stage of HIV infection. 1st December is also remembered as World AIDS day globally people unite together to fight against HIV showing support to the people infected with HIV.

Many people with HIV have no symptoms for several years. Others may develop symptoms similar to flu, usually two to six weeks after catching the virus. The symptoms can last up to four weeks. But in severe cases the immune system of the body gets destroyed gradually.

Some of the test which required for the test of AIDS are Enzyme linked Immunosorbant Assay (ELIZA), Radio Immuno Presipitation Assay (RIP) and Polymerase Chain Reaction (PCR).

Bacterial Disease

1. **Tuberculosis :** In the 18th and 19th centuries, a tuberculosis epidemic flourished throughout Europe and North America, before the German microbiologist Robert Koch discovered the microbial causes of tuberculosis in 1882. The symptoms of TB are chronic cough with blood-containing sputum, fever, night sweats and weight loss. Causal organism of Tb *Mycobacterium tuberculosis*, a small, aerobic, nonmotile bacillus. People with active pulmonary TB cough, sneeze, speak, sing, or spit, they expel infectious aerosol droplets 0.5 to 5.0 μm in diameter. People with prolonged, frequent, or close contact with people with TB are at particularly high risk of becoming infected with *Mycobacterium*. Blood tests may be used to confirm or rule out latent or active tuberculosis. Sputum test and X-Ray of chest also shows the sign of Tuberculosis. Bacillus Calmette Guerin is the only vaccine used for this disease.

2. **Diptheria :** Diphtheria is an infectious disease caused by bacteria that usually produce exotoxins that damage human tissue. This disease is caused by Irregular rod shaped bacteria called *Corynebacterium diptheriae*. The symptoms of diphtheria include swallowing problem, fever, enlarged lymph nodes and producing skin ulcers. Disease spread through respiratory infection by direct contact, droplet and food. Diphtheria antitoxin is given as a shot into a muscle or through an IV (intravenous line). The infection is then treated with antibiotics, such as penicillin and erythromycin.

3. **Typhoid or Enteric fever :** Typhoid is an infection caused by the bacteria *Salmonella typhimurium*. This bacterium resides within the intestine and bloodstream of humans. It is spread between individuals by direct contact with the feces of an infected person. *S. typhi* enters through the mouth and spends 1-3 weeks in the intestine. After this time, it makes its way through the intestinal wall and into the bloodstream. Bacteria from the soil may also get entered in the body through wound. Widal test is used for the treatment of this disease in which antibodies against a particular strain of salmonella is demonstrated and can be used for further treatment.

4. **Botulism/ Food poisoning :** Food borne botulism typically begins a rare disease occur through bacterium *Clostridium botulinum*. Botulinum bacteria grows on food and produces toxins that, when ingested, cause paralysis. Botulism neurotoxins prevent neurotransmitters from functioning properly. This means that they inhibit motor control. As botulism progresses, the patient experiences paralysis from top to bottom. Blood stool test and gastric secretion sample is used for the botulism sample test. Botulism can be treated with an antitoxin that blocks circulation of the toxin in the bloodstream.

5. **Cholera:** Cholera is a disease caused by bacteria, *Vibrio cholera* that produces a watery diarrhea that can rapidly lead to dehydration. Cholera symptoms include vomiting, wrinkled skin, low blood pressure, dry mouth, rapid heart rate. Cholera is most frequently transmitted by water sources contaminated with the causative bacterium *Vibrio cholerae*, although contaminated foods, especially raw shellfish, may also transmit the cholera-causing bacteria.

Fungal Disease

1. **Athlete's foot :** It is a fungal disease which affects the skin of feet. It is caused by *Trichophyton*. It is a contagious disease and can spread to toenails and hands. This disease is very common in athlete's therefore it is called as athlete's foot. Anyone who visit public places barefoot especially locker rooms, showers and swimming pools. Symptoms are itching, stinging and burning between the toes. A skin lesion potassium hydroxide (KOH) exam is the most common test for athlete's foot. A doctor scrapes off a small area of infected skin and places it in potassium hydroxide (KOH). The KOH destroys normal cells and leaves the fungal cells untouched so they are easy to see under a microscope. Athlete's foot can often be treated with over-the-counter (OTC) topical antifungal medications. OTC topical antifungal medications, includes miconazole, terbinafine, clotrimazole etc.

2. **Ringworm :** Dermatophysis is more commonly known as ringworm is a fungal disease of skin. It is caused by fungus *Microsporum and Trichophyton*. Ringworm infection can affect both humans and animals. The infection initially presents itself with red patches on affected areas of the skin and later spreads to other parts of the body. Ringworm is very common in children and people who own pet cats. Ketoconazole is often used to treat fungal disease.

Disease caused by Protozoans

1. **Malaria :** Malaria is a life-threatening disease that's typically transmitted through the bite of an infected Anopheles mosquito. Infected mosquito carries *Plasmodium*, a protozoan and when it bites the protozoan is transferred to the blood stream. Once the parasite gets entered in the human body it reaches to liver, where it gets matures and multiplies by infecting red blood cells resulting in symptoms that occur in cycles that last two to three days at a time. Symptoms of malaria develop in 10 days to four week. Some of the common symptoms are shaking chills that can range from moderate to severe, high fever, sweating, headache, vomiting and diarrhea.
2. **Amoebic dysentery or Amoebiasis :** Amoebic Dysentery is an infection of the intestines causing diarrhoea that contains blood or mucus. This is caused by *Entamoeba histolytica*, a type of amoeba, and is more common in the tropics. The amoeba group together and form a cyst, the cysts come out of the body in human feces. In areas of poor sanitation, these cysts (which can survive for a long time), can contaminate food and water, and infect other humans. The cysts can also linger in infected people's hands after going to the toilet. Symptoms of Amoebic dysentery include abdominal pain, fever, and watery diarrhea. Antirheumatic drug Ridaura (auranofin) may offer a cheap, low-dose treatment for the amoebic infections.

Viral Disease

Disease	Causal Organism	Mode of transmission
Small pox	Variola Virus	Most transmission of smallpox occur through infectious droplets of saliva are expelled during coughing or sneezing from infected person.
Chikengunia	Arbo virus	Most common symptom is fever and joint pain. Other symptoms may include headache, muscle pain, joint swelling, or rash
Measles	Rubella Virus	Measles is transmitted primarily from person to person by large respiratory droplets but can also spread by the airborne route
Influenza	Flu Virus	Flu viruses spread mainly through tiny droplets made when people with flu cough, sneeze, or talk
Rabies	Rhabdovirus	By animal or insect bites or stings.
Mumps	Paramyxo Virus	Person to person through respiratory droplets.
Dengue	Flaviribo Virus	Dengue is spread through bite of female mosquito (*Aedes aegypti*)

Bacterial Disease

Diseases	Causal Organism	Mode of transmission
Pneumonia	*Diplococcus pneumoniae*	They spread through air borne droplet from cough and sneeze.
Plague	*Yersinia pestis*	Rat flea spread this disease from rodents to man.
Whooping cough	*Haemophilus pertussis*	They spread through air borne droplet from cough and sneeze.
Tetanus	*Clostridium tetani*	Wound or breaks in the skin that are more likely to get infected with tetanus bacteria.
Leprosy	*Mycobacterium leprae*	Long and close contact with the infected person

Protozoan Disease

Diseases	Causal Organism	Mode of transmission
Kala-azar	*Leishmania donovani*	This disease is transmitted to humans by the bite of infected female *Phlebotomine* sandflies.
Giardiasis	*Giardia intestinalis*	Transmitted through contaminated food.
Trypano-somiasis	*Trypanosoma brucie*	It is transmitted by tse-tse fly (*Glossina palpalis*)

Sexually Transmissible Disease

Syphilis : Syphilis is a contagious disease spread through sexual activity. This disease is caused by spirochete bacterium, *Treponema pallidum*. An infected pregnant mother can give the infection to unborn baby resulting in congenital syphilis. Syphilis can be diagnosed through blood test only.

Gonorrhoea : Gonorrhoea is a bacterial sexually transmitted infection (STI). It can be painful and can cause serious health problems such as infertility in both men and women. It is caused by bacteria *Neisseria gonorrhaeae*.

Genital herpes : Genital herpes virus is passed from one person to another through sexual contact. This disease is caused by Herpes Simplex Virus (HSV).

Cancer

Cancer is a complex genetical disease which occurs due to the environmental factors. Cancer causing agent (carcinogen) may be present in food and water, in air in sunlight and in chemicals. Since epithelial cells cover our body surface and internal organs also like respiratory organ and alimentary tract which are more exposed to the carcinogens and more than 90% of cancer occur in epithelia. Tumors are of two main types 'benign' and 'malignant'. Benign tumors are slow growing and are located at a place and

compress the surrounding tissue by their expensive mass of cells. Whereas malignant tumors are rapidly growing, invading surrounding tissue and most significantly colonizing the distant organ. Five common types of cancer in India are breast cancer, stomach cancer, oral cancer and cervical cancer. Breast cancer is the most common malignancy type diagnosed in women in developed countries and the second most common type diagnosed in developing countries. In 2003, Indian Council of Medical Research (ICMR) reported that oral cancer is very common in India. There has been great increase in oral sub-mucous fibrosis especially in youngsters.

Immunity

Immunity is defined as the body's ability to destroy pathogens or other foreign materials and to prevent further cases of certain infectious diseases. This ability of vital importance because the body is exposed to pathogen from the moment of birth. The study of body's defense mechanisms against pathogen is called Immunity. Edward Jenner (1749-1823) is known as Father of Immunology.

Antigen : It is a toxin or other foreign substance which induces an immune response in the body, especially the production of antibodies. Most antigen are proteins but some are carbohydrates, lipids and nucleic acids.

Antibodies : Antibodies are immunoglobulin's (Igs) which are produced in response to antigenic stimulations. Thus all antibodies are immunoglobulin by all immunoglobulin is not antibodies. Antibodies may be bound to cell membrane or they may remain free.

Types of Antibodies

Class	Description
IgG	IgG is the main type of antibody found in blood and extracellular fluid allowing it to control infection of body tissues.
IgA	This antibody is mainly present in secretion of the body such as tears and saliva.
IgE	IgE antibodies are found in the lungs, skin, and mucous membranes. They are associated mainly with allergic reactions.
IgM	It is the most efficient complement fixing immunoglobulin and comprises approximately 10% of normal human serum Ig content. This is the largest antibody with 5 subunit.
IgD	Immunoglobulin D (IgD) is a monomeric antibody that is expressed in the plasma membranes of immature B-lymphocytes.

Types of Immunity: they are of two kinds :

(i) Innate/Inborn/Non-specific defense mechanism

(ii) Acquired/Adaptive/Specific defense mechanism

	Innate Immunity	Acquired Immunity
1.	It is present from birth	It develop during the life time
2.	The immunity remain throughout the life	This immunity can be short live or lifelong.
3.	Contact with pathogen or its antigen is not essential	Contact with pathogen or its antigen is essential
4.	This type of immunity is inheritable	This type of immunity can be passed from one generation to the next.

Monoclonal Antibodies

Now antibodies can be designed so that they can specifically target a certain antigen, such as one found on cancer cells. They can then make many copies of that antibody in the lab. These are known as monoclonal antibodies. Monoclonal antibodies mimic the antibodies of our body naturally produces as part of our immune system's response to germs, vaccines and other invaders.

Some application of monoclonal antibodies :

- Grouping blood types and identifying viruses
- Labeling in tests for pregnancy, cancers, blood clots, and heart disease.
- Purification of proteins and drugs
- Counteract transplant rejection

Vaccination

The principle of immunization or vaccination is based on the property of 'memory' of immune system. In vaccination, preparations of antigenic proteins of pathogen or inactivated weakened pathogen (vaccine) are introduced in the body. The antibody produced in the body against these antigens would neutralize the pathogenic agent during real infection. The vaccine also generates memory-B and T-cells that recognize the pathogen quickly on subsequent exposure and overwhelm the invaders with massive production of antibodies.

A **vaccine** typically contains an agent that resembles a disease-causing micro-organism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins. Vaccine stimulates the antibody production and formation of memory cells without causing disease. Now vaccine is available for diphtheria, cholera, typhoid whooping cough, tetanus, tuberculosis, plague, measles, mumps and polio.

Classification of vaccination :

(i) **First Generation Vaccines :** These vaccines are produced by conventional technique using whole microorganisms. These are never of uniform quality and produced side effects.

(ii) **Second Generation Vaccines :** These vaccines are prepared with the help of recombinant DNA technology. Some examples are Hepatitis B virus vaccine, herpes virus vaccine, pneumonia vaccine.

(iii) **Third generation vaccine (synthetic vaccines) :** These are chemically synthesized multivalent vaccines. These vaccines have high purity. Some examples are vaccine against diphtheria and leukemia virus vaccine.

Drug and Alcohol Abuse

Drug addiction or drug abuse is taking drug for purpose other than clinical use, in amount, concentration or frequency that impair physical, physiological and psychological functions of the body.

Types of drugs :

Types of Drugs	Examples	Effects
Tranquillizers	Phenothiazenes, benzodiazepines	Lessen tension and anxiety without sedation and inducing sleep.
Sedatives and hypnotics	Barbiturates, benzodiazepines	Depress CNS activity; give feeling of calmness relaxation, drowsiness. High dose induces deep sleep.
Opiate narcotics	Opium, morphine, codeine, heroine, smack, pethidine, methadone	Suppress brain activity relive pain, stimulate nervous system.
Stimulants	Caffeine, cocaine, betel, nut, amphetamines	Make a person more wakeful, alert and active, cause excitement.
Hallucinogens	LSD, mescaline, psilocybin, psilocin bhang(hashish), ganja, charas, marijuna	Alter thoughts, feeling and preceptions. Cause illusions.

Drug Addiction : Drug addiction is a chronic, often relapsing brain disease that causes compulsive drug seeking and use, despite harmful consequences to the drug addict and those around them. Drug addiction is a brain disease because the abuse of drugs leads to changes in the structure and function of the brain.

Some common addictive drugs are opioids, hallucinogens, depressant and stimulants.

(i) **Opioids :** Opiates are alkaloid compounds found naturally in the opium poppy plant *Papaver somniferum*.

(ii) **Hallucinogens :** Hallucinogens are a class of drugs that cause hallucinations-profound distortions in a person's perceptions of reality. Hallucinogens can be found in some plants and mushrooms (or their extracts) or can be man-made, and they are commonly divided into two broad categories:

- Classical hallucinogens (such as LSD) it is obtained from ergot, a fungus *Claviceps purpurea*.
- Dissociative drug (PCP) also known as angel dust.

Plant that provide drug :

Plant Name	Family	Part of the plant	Name of the drug and its type
White or Opium poppy plant, *Papaver somniferum*	Papaveraceae	Latex of unripe capsule	Opium and its derivatives: Morphine, codeine, heroin (Narcotic and Analgesic)
Hemp plant, Canabis indica Canabis sativa	Moraaceae	Leaves and flowering shoots of the plant	Bhang (Hallucinogen) Ganja (Hallucinogen) Charas (Hallucinogen) Marijuana (Hallucinogen)
Tea Plant, Thea sinensis	Theaceae	Dried leaves	Caffeine (Stimulant)
Coffee plant, Coffea arabica	Rubiaceae	Dried seeds	Caffeine (Stimulant)
Cocoa plant, Theobroma cacao	Sterculiaceae	Dried seeds	Caffeine (Stimulant)
Coca plant Erythro-xylum	Erythro -zylaceae coca	Dried leaves and young twigs	Cocaine (Stimulant)
Ergot fungus, Claviceps purpurea	Ascomycetes	Fruiting bodies	Lysergic acid diethylamide (LSD) (hallucinogen)

Regular consumption of alcohol either in low concentration (beer, wine etc.) or in high concentration (brandy, whiskey, rum, gin, vodka etc.) causes dependency on alcohol which is called alcoholism. Alcoholism is addiction or dependence on alcoholic drinks which is often associated with definite behavior.

EXERCISE

Level- 1

1. The density of water varies with temperature which helps the aquatic animals to live in cold water. At what temperature is the density of water maximum?
   (a) 1°C (b) 2°C
   (c) 3°C (d) 4°C
2. If a small raindrop falls through air
   (a) its velocity goes on increasing
   (b) its velocity goes on decreasing
   (c) its velocity goes on increasing for sometime and then becomes constant
   (d) it falls with constant speed for sometime and then its velocity increases
3. Which one of the following common devices works on the basis of the principle of mutual induction?
   (a) Tubelight (b) Transformer
   (c) Photodiode (d) LED
4. Which one of the following is the permissible level of noise in a silent zone at day time?
   (a) 50 dB (b) 60 dB
   (c) 65 dB (d) 75 dB
5. Earthquake (shock) waves are
   (a) infrasonic waves (b) ultrasonic waves
   (c) seismic (d) infrared waves
6. A perfect black body has the unique characteristic feature as
   (a) a good absorber only
   (b) a good radiator only
   (c) a good absorber and a good radiator
   (d) neither a radiator nor an absorber
7. Which one of the following statement is true?
   (a) Temperatures differing 25° on the fahrenheit (F) scale must differ by 45° on the celsius (C) scale
   (b) 0°F corresponds to – 32°C
   (c) Temperatures which differ by 10° on the celsius scale must differ by 18° on the Fahrenheit scale
   (d) Water at 90°C is warmer than water at 202°F
8. An oil tanker is partially filled with oil and moves forward on a level road with uniform acceleration. The free surface of oil then
   (a) remains horizontal.
   (b) is inclined to the horizontal with smaller depth at the rear end.
   (c) is inclined to the horizontal with larger depth at the rear end.
   (d) assumes parabolic curves.
9. Tungsten is used for the construction of filament in electric bulb because of its
   (a) high specific resistance
   (b) low specific resistance
   (c) high light emitting power
   (d) high melting point
10. Before X-ray examination (coloured X-ray) of the stomach, patients are given suitable salt of barium because
   (a) barium salts are white in colour and this helps stomach to appear clearly
   (b) barium is a good absorber of X-rays and helps stomach to appear clearly
   (c) barium salts are easily available
   (d) barium allows X-rays to pass through the stomach
11. Dual Energy X-ray Absorptiometry (DEXA) is used to measure
   (a) spread of solid tumour
   (b) bone density
   (c) ulcerous growth in stomach
   (d) extent of brain haemorrhage
12. The best colours for a sun umbrella will be
   (a) black on top and red on inside
   (b) black on top and white on inside
   (c) red on top and black on inside
   (d) white on top and black on inside
13. Fat can be separated from milk in a cream separation because of
   (a) cohesive force (b) gravitational force
   (c) centrifugal force (d) centripetal force
14. A diffraction pattern is obtained using a beam of red light. Which one among the following will be the outcome, if the red light is replaced by blue light?
   (a) Bands disappear
   (b) Diffraction pattern becomes broader and further apart
   (c) Diffraction pattern becomes narrower and crowded together
   (d) No change
15. Half portion of a rectangular piece of ice is wrapped with a white piece of cloth while the other half with a black one. In this context, which one among the following statements is correct?
   (a) Ice melts more easily under black wrap
   (b) Ice melts more easily under white wrap
   (c) No ice melts at all under the black wrap
   (d) No ice melts at all under the white wrap
16. If the door of a running refrigerator in a closed room is kept open, what will be the net effect on the room?
   (a) It will cool the room
   (b) It will heat the room
   (c) It will make no difference on the average
   (d) It will make the temperature go up and down
17. Viewfinders, used in automobiles to locate the position of the vehicles behind, are made of
   (a) plane mirror (b) concave mirror
   (c) convex mirror (d) parabolic mirror

18. If a ship moves from freshwater into seawater, it will
(a) sink completely
(b) sink a little bit
(c) rise a little higher
(d) remain unaffected

19. Two identical piano wires have same fundamental frequency when kept under the same tension.
What will happen if tension of one of the wire is slightly increased and both the wires are made to vibrate simultaneously?
(a) Noise (b) Beats
(c) Resonance (d) Non-linear effects

20. A passenger in a moving train tosses a five rupee coin. If the coin falls behind him, then the train must be moving with a uniform
(a) acceleration (b) deceleration
(c) speed (d) velocity

21. A mobile phone charger is
(a) an inverter
(b) a UPS
(c) a step-down transformer
(d) a step-up transformer

22. Inactive Nitrogen and Argon gases are usually used in electric bulbs in order to
(a) increase the intensity of light emitted
(b) increase the life of the filament
(c) make the emitted light coloured
(d) make the production of bulb economical

23. Dirty cloths containing grease and oil stains are cleaned by adding detergents to water. Stains are removed because detergent
(a) reduces drastically the surface tension between water and oil
(b) increases the surface tension between water and oil
(c) increases the viscosity of water and oil
(d) decreases the viscosity in detergent mixed water

24. An electron and a proton are circulating with same speed in circular paths of equal radius. Which one among the following will happen, if the mass of a proton is about 2,000 times that of an electron ?
(a) The centripetal force required by the electron is about 2,000 times more than that required by the proton
(b) The centripetal force required by the proton is about 2,000 times more than that required by the electron
(c) No centripetal force is required for any charged particle
(d) Equal centripetal force acts on both the particles as they rotate in the same circular path

25. In an observation, α-particles, β-particles and γ-rays have same energies. Their penetrating power in a given medium in increasing order will be
(a) α, β, γ (b) β, γ, α
(c) α, γ, β (d) β, α, γ

26. An object is raised to a height of 3 m from the ground. It is then allowed to fall on to a table 1 m high from ground level. In this context, which one among the following statements is correct ?
(a) Its potential energy decreases by two-thirds its original value of total energy.
(b) Its potential energy decreases by one-third its original value of total energy.
(c) Its kinetic energy increases by two-thirds, while potential energy increases by one-third.
(d) Its kinetic energy increases by one-third, while potential energy decreases by one-third.

27. Creation of something from nothing is against the law of
(a) constant proportions
(b) conservation of mass-energy
(c) multiple proportions
(d) conservation of momentum

28. In cricket match, while catching a fast moving ball, a fielder in the ground gradually pulls his hands backwards with the moving ball to reduce the velocity to zero. The act represents
(a) Newton's first law of motion
(b) Newton's second law of motion
(c) Newton's third law of motion
(d) Law of conservation of energy

29. The upper and lower portions in common type of bi-focal lenses are respectively
(a) concave and convex
(b) convex and concave
(c) both concave of different focal lengths
(d) both convex of different focal lengths

30. You are asked to jog in a circular track of radius 35 m. Right one complete round on the circular track, your displacement and distance covered by you respectively
(a) zero and 220 m
(b) 220 m and zero
(c) zero and 110 m
(d) 110 m and 220 m

31. A liquid is kept in a regular cylindrical vessel upto a certain height. If this vessel is replaced by another cylindrical vessel having half the area of cross-section of the bottom, the pressure on the bottom will
(a) remain unaffected
(b) be reduced to half the earlier pressure
(c) be increased to twice the earlier pressure
(d) be reduced to one-fourth the earlier pressure

32. After rising a short distance the smooth column of smoke from a cigarette breaks up into an irregular and random pattern. In a similar fashion, a stream of fluid flowing past an obstacle breaks up into eddies and vortices which give the flow irregular velocity components transverse to the flow direction. Other examples include the wakes left in water by moving ships the sound produced by whistling and by wind instruments. These examples are the results of
(a) laminar flow of air
(b) streamline flow of air
(c) turbulent flow of air
(d) viscous flow at low speed

33. Two pieces of conductor of same material and of equal length are connected in series with a cell. One of the two pieces has cross-sectional area double that of the other. Which one of the following statements is correct in this regard ?

(a) The thicker one will allow stronger current to pass through it.
(b) The thinner one would allow stronger current to pass through it.
(c) Same amount of electric current would pass through both the pieces producing more heat in the thicker one.
(d) Same amount of electric current would pass through both the pieces producing more heat in the thinner one.

34. A boy throws four stones of same shape, size and weight with equal speed at different initial angles with the horizontal line. If the angles are 15°, 30°, 45° and 60°, at which angle the stone will cover the maximum horizontally?
(a) 15° (b) 30°
(c) 45° (d) 60°

35. Raw mangoes shrivel when pickled in brine. The phenomenon is associated with
(a) osmosis
(b) reverse osmosis
(c) increase of surface tension of fluid
(d) decrease of surface tension of fluid

36. When we put some crystals of potassium permanganate in a beaker containing water, we observe that after sometime whole water has turned pink. This is due to
(a) boiling
(b) melting of potassium permanganate crystals
(c) sublimation of crystals
(d) diffusion

37. In which phase of matter would you expect alcohol exists at room temperature?
(a) Solid (b) Liquid
(c) Gas (d) Plasma

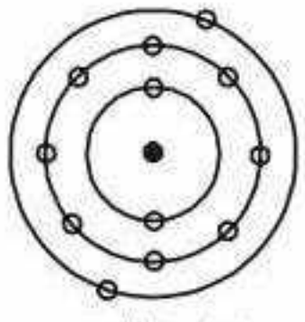
38. Which one of the following will result in the formation of a mixture?
(a) Crushing of a marble tile into small particles
(b) Breaking of ice cubes into small pieces
(c) Adding sodium metal to water
(d) Adding milk in water

39. Mixture of sand and sulphur may best be separated by
(a) fractional crystallisation from aqueous solution
(b) magnetic method
(c) fractional distillation
(d) dissolving in CS_2 and filtering

40. The law of definite proportions was given by –
(a) John Dalton (b) Humphry Davy
(c) Proust (d) Michael Faraday

41. When an atom loses electrons, it is called a (an) _____ and has a _____ charge.
(a) anion, positive (b) cation, positive
(c) anion, negative (d) cation, positive

42. The diagram given below represent an atom of



(a) Chlorine (b) Magnesium
(c) Calcium (d) Helium

43. Which of the following isotopes is used as the standard for atomic mass ?
(a) ^{12}C (b) ^{16}O
(c) ^{13}C (d) ^{1}H

44. Which of the following compounds has electrovalent linkage?
(a) CH_3Cl (b) NaCl
(c) CH_4 (d) Cl_2

45. The bond between two identical non-metal atoms has a pair of electrons
(a) unequally shared between the two
(b) transferred fully from one atom to another
(c) with identical spins
(d) equally shared between them

46. When hydrogen sulphide gas is passed through a blue solution of copper sulphate, a black precipitate of copper sulphide is obtained and the sulphuric acid so formed remains in the solution. The reaction is an example of –
(a) a combination reaction
(b) a displacement reaction
(c) a decomposition reaction
(d) a double decomposition reaction

47. A student added dilute HCl to a test tube containing zinc granules and made following observations :
(a) the zinc surface became dull and black.
(b) a gas evolved which burnt with a pop sound.
(c) the solution remained colourless.
(d) the solution becomes green in colour.

48. When we increase the temperature, the rate of reaction increases because of
(a) more number of collisions
(b) decrease in mean free path
(c) more number of energetic electrons
(d) less number of energetic electrons

49. A positive catalyst increases rate of reaction by
(a) decreasing enthalpy
(b) decreasing internal energy
(c) decreasing activation energy
(d) increasing activation energy

50. In the melting of ice, which one of the conditions will be more favourable ?
(a) high temperature and high pressure
(b) low temperature and low pressure
(c) low temperature and high pressure
(d) high temperature and Low pressure

51. When $NaNO_3$ is heated in a closed vessel, oxygen is liberated and $NaNO_2$ is left behind. At equilibrium:
(a) addition of $NaNO_2$ favours reverse reaction
(b) addition of $NaNO_2$ favours forward reaction
(c) increasing temperature favours forward reaction
(d) decreasing pressure favours reverse reaction

52. Bleaching powder is soluble in cold water giving a milky solution due to –
(a) available chlorine
(b) lime present in it
(c) calcium carbonate formation
(d) the absorption of carbon dioxide from atmosphere

53. A blue litmus paper was first dipped in dil. HCl and then in dil. NaOH solution. It was observed that the colour of the litmus paper –
(a) changed to red
(b) changed first to red and then to blue
(c) changed blue to colourless
(d) remains blue in both the solutions.

54. Neutralization of an acid with a base, invariably results in the production of
(a) H_3O^+ (b) H_2O
(c) H^+ and OH^- (d) OH^-

55. A salt 'X' is dissolved in water of pH = 7. The salt is made resulting solution becomes alkaline in nature. The salt is made
(a) a strong acid and strong base
(b) a strong acid and weak base
(c) a weak acid and weak base
(d) a weak acid and strong base

56. Standard hydrogen electrode consists of which metal electrode
(a) Tungsten (b) Palladium
(c) Silver (d) Platinum

57. On the basis of electrochemical series which of the following is the strongest oxidising agent.
(a) Cl_2 (b) Br_2
(c) F_2 (d) I_2

58. The white phosphorus is stored –
(a) in air (b) under water
(c) under kerosene (d) under CS_2

59. The slag obtained during the extraction of copper from copper pyrities is composed mainly of –
(a) $CaSiO_3$ (b) $FeSiO_3$
(c) $CuSiO_3$ (d) SiO_2

60. Which of the following is the purest form of carbon –
(a) charcoal (b) coal
(c) diamond (d) graphite

61. Methane, ethane and propane are said to form a homologous series because all are –
(a) hydrocarbons
(b) saturated compounds
(c) aliphatic compounds
(d) differ from each other by a CH_2 group

62. How many different isomers are possible for a hydrocarbon with the molecular formula C_4H_{10} –
(a) 1 (b) 2
(c) 3 (d) 5

63. Which of these contains the carbonyl group?
(a) ketones (b) aldehydes
(c) esters (d) all of these

64. Cyclohexane, a hydrocarbon floats on water because –
(a) it is immiscible with water
(b) its density is low as compared to water
(c) it is non-polar substance
(d) it is immiscible and lighter than water

65. Which one gives only one monosubstitution product on chlorination –
(a) n-pentane (b) Neopentane
(c) Isopentane (d) n-butane

66. In the modern periodic table one of the following does not have appropriate position –
(a) transition elements
(b) inert gases
(c) inner transition elements
(d) galogens

67. The element with smallest size in the 4th period is –
(a) chlorine (b) iodine
(c) fluorine (d) bromine

68. Which of the following are formed by hydrogen ?
1. Covalent hydrides
2. Ionic hydrides
3. Metallic hydrides
Select the correct answer using the code given below :
(a) 1 and 2 (b) 1 and 3
(c) 1, 2 and 3 (d) 2 and 3

69. Consider the following:
Crude oil is a direct source of
1. Asphalt 2. Paraffin wax
3. Fatty acids 4. Gas oil
Which of the above are correct?
(a) 1 and 2 (b) 2 and 3
(c) 1 and 4 (d) 1, 2 and 4

70. Fats and oils are :
(a) Polyhydric alcohols
(b) Solid and liquid hydrocarbon
(c) Lipids
(d) Weak carboxylic acids

71. Which of the following expression at constant pressure represents Charle's law?
(a) $V \propto \frac{1}{T}$ (b) $V \propto \frac{1}{T^2}$
(c) $V \propto T$ (d) $V \propto d$

72. When hard water is evaporated completely, the white solid remains in the container. It may be due to the presence of **(CDS)**
1. Carbonates of Ca and Mg
2. Sulphates of Ca and Mg
3. Chlorides of Ca and Mg
Select the correct answer using the code given below :
(a) 1 and 2 only (b) 1, 2 and 3
(c) 3 only (d) 1 and 3 only

73. Which one among the following compounds has same equivalent weight and molecular weight ? **(CDS)**
(a) H_2SO_4 (b) $CaCl_2$
(c) Na_2SO_4 (d) NaCl

74. A metallic plate sticks firmly on the mouth of a water vessel made from another metal. By way of heating, one can detach the plate from the vessel. This is because heat expands **(CDS)**
(a) the vessel only
(b) both the vessel and the plate equally
(c) the vessel more than the plate
(d) the vessel and contracts the plate

75. Electricity is produced through dry cell from **(CDS)**
(a) chemical energy (b) thermal energy
(c) mechanical energy (d) nuclear energy

76. Which one among the following fuels is used in gas welding? **(CDS)**
(a) LPG (b) Ethylene
(c) Methane (d) Acetylene

77. Which one among the following is a micronutrient present in soil for various crops ? **(CDS)**
(a) Calcium (b) Manganese
(c) Magnesium (d) Potassium

78. Which one among the following metals is prominently used in mobile phone batteries ? **(CDS)**
(a) Copper (b) Zinc
(c) Nickel (d) Lithium

79. Which one among the following processes is **not** part of a chemical weathering ? **(CDS)**
(a) Hydration (b) Exfoliation
(c) Oxidation (d) Solution

80. Which of the following statements with regard to Portland Cement are Correct? **(CDS)**
1. Silica imparts strength to cement.
2. Alumina makes the cement quick setting
3. Excess of lime increases the strength of cement.
4. Calcium sulphate decreases the initial setting time of cement

Select the correct answer using the code
(a) 2 and 4 only (b) 1 and 3
(c) 1, 2 and 4 (d) 1 and 2 only

81. Red phosphorus is used in the manufacture of safety matches. This is due to the fact that **(CDS)**
(a) it shows phosphorescence
(b) at ordinary temperature, it is less reactive than other varieties of phosphorus
(c) it cannot be converted to white phosphorus on heating
(d) it does not react with halogen on heating

82. Which of the following is not gaseous air pollutant? **(CDS)**
(a) Oxides of Sulphur (b) Oxides of nitrogen
(c) Hydrocarbon (d) Smoke

83. Which one of the following is not true for diamond? **(CDS)**
(a) Each carbon atom is linked to four other carbon atoms
(b) Three-dimensional network structure of carbon atoms is formed
(c) It is used as an abrasive for sharpening hard tools
(d) It can be used as a lubricant.

84. The atomic theory of matter was first proposed by **(CDS)**
(a) John Dalton (b) Rutherford
(c) J. J. Thomson (d) Niels Bohr

85. Which one of the following minerals contains mostly silica? **(CDS)**
(a) Mica (b) Quartz
(c) Olivine (d) Pyroxene

86. A piece of ice, 100 g in mass is kept at 0°C. The amount of heat is requires to melt at 0°C is (take latent heat of melting of ice to be 333.6 j / g) : **(CDS)**
(a) 750.6 J (b) 83.4 J
(c) 33360 J (d) 3.336 J

87. Which one of the following is an example of chemical change? **(CDS)**
(a) Burning of paper
(b) Magnetization of soft iron
(c) Dissolution of cane sugar in water
(d) Preparation of ice cubes from water

88. The synthetic rubber has replaced natural rubber for domestic and industrial purposes. Which one of the following is the main reason behind that? **(CDS)**
(a) Natural rubber is unable to meet the growing demand of different industries
(b) Natural rubber is grown in tropical countries only
(c) Raw material for synthetic rubber is easily available
(d) Nutural rubber is not durable

89. The handle of pressure cookers is made of plastic because it should be made non-conductor of heat. The plastic used there is the first man-made plastic, which is : **(CDS)**
(a) Polythene (b) Terylene
(c) Nylon (d) Bakelite

90. Methyl lsocyanate gas, which was involved in the disaster in Bhopal in December 1984, was used in the Union Carbide factory for production of : **(CDS)**
(a) Dyes (b) Detergents
(c) Explosives (d) Pesticides

91. Two systems are said to be in thermal equilibrium if and only if : **(CDS)**
(a) there can be a heat flow between them even if they are at different temperatures
(b) there cannot be a heat flow between them even if they are at different temperatures
(c) there is no heat flow between them
(d) their temperatures are slightly different

92. German silver is used to make decorative articles, coinage metal, ornaments, The name is given because : **(CDS)**
(a) it is an alloy of copper and contains silver as one of its components
(b) Germans were the first to use silver
(c) Its appearance is like silver
(d) It is an alloy of silver

93. In human digestive system, the process of digestion starts in **(CDS)**
(a) Oesophagus (b) Buccal cavity
(c) Duodenum (d) Stomach

94. Which one of the following diseases in humans can spread through air ? **(CDS)**
(a) Dengue (b) Tuberculosis
(c) HIV-AIDS (d) Goitre

95. Which one among the following structures or cells is ***not*** present in connective tissues ? **(CDS)**
(a) Chondrocytes (b) Axon
(c) Collagen fibre (d) Lymphocytes

96. Genetic screening is
(a) analysis of DNA to check the presence of a particular gene in a person
(b) analysis of gene in a population
(c) pedigree analysis
(d) screening of infertility in parents

97. Who among the following is considered as the father of genetic engineering?
(a) Philip Drinker (b) Paul Berg
(c) Thomas Addison (d) Alpheuss Packard Jr.

98. Which of the following cause(s) variation in the genetic material of progeny?
1. Sexual reproduction 2. Asexual reproduction
3. Mutations 4. Epigenetic changes

Select the correct answer using the code given below.
(a) 2 only (b) 1, 2 and 3
(c) 1, 3 and 4 (d) 1 and 3 only

99. Cobalt is associated with
(a) growth hormone (b) vitamin B_{12}
(c) hemoglobin (d) intestinal enzymes

100. Absorption of water in the human body can be found in
1. renal tubule in kidney 2. hepatic cells in liver
3. large intestine 4. pancreatic duct

Select the correct answer using the code given below.
(a) 1, 2 and 3 (b) 1 and 3 only
(c) 2 and 4 (d) 3 only

101. Measles is a disease caused by
(a) bacteria (b) virus
(c) protozoa (d) worm

102. Neutrophils and lymphocytes originate from
(a) kidney tubule (b) spleen
(c) bone marrow (d) lymph node

103. The mandate of the scheme entitled 'Directly Observed Treatment, Short-Course (DOTS)' launched by WHO is to ensure that
(a) doctors treat patients with medicine for a short duration
(b) doctors do not start treatment without a trial
(c) patients complete their course of drug
(d) patients voluntarily take vaccines

104. Penicillin inhibits synthesis of bacterial
(a) cell wan (b) protein
(c) RNA (d) DNA

105. Most antibiotics target bacterial parasites interfering with various factors of growth of metabolism such as
1. synthesis of cell wall
2. bacterial protein Synthesis
3. synthesis of nuclear membrane
4. mitochondrial function
Select the correct answer using the code given below
(a) 1, 2 and 3 (b) 1 and 4
(c) 2 and 3 only (d) 1 and 2 only

106. May 31 is celebrated as 'World No Tobacco Day' by the World Health Organization. Which one of the following was the theme of the 'World No Tobacco Day, 2015'?
(a) Raise taxes on tobacco
(b) Stop illicit trade of tobacco products
(c) Ban tobacco advertising, promotion and sponsorship
(d) Tobacco-free youth

107. Plants contain a variety sterols like stigmasterol, ergosterol, sitosterol etc. which very closely resemble eholesteral. These plant sterols are referred as :
(a) Phylosterols (b) Caleiferols
(c) Ergocaleiferols (d) Lumisterols

108. In artificial insemination (AI) process. Which of the following is/are introduced into the uterus of the female ?
(a) Egg only (b) Fertilized egg
(c) Sperm only (d) Egg and sperm

109. Genetically modified (GM) crops contain modified genetic material due to :
1. introduction of new DNA
2. removal of existing DNA
3. introduction of RNA
4. introduction of new traits
Select the correct answer using the code given below :
(a) 1 and 2 only (b) 1, 2 and 3
(c) 3 and 4 (d) 1,2 and 4

110. Which one of the following vitamins has a role in blood clotting ?
(a) Vitamin A (b) Vitamin B
(c) Vitamin D (d) Vitamin K

111. Vitamin B_{12} deficiency causes pernicious anemia, Animals cannot synthsize vitamin B_{12}. Humans must obtain all their vitamin B_{12} from their diet. The complexing metal ion in vitamin B_{12} is :
(a) Mg^2 (Magnesium ion) (b) Fe^2 (Iron ion)
(c) Co^2(Cobalt ion) (d) Zn^2(Zine ion)

112. Glcouse is a scourse of energy. Which one of the following types of moleeule in gluose ?
(a) Carbohydrate (b) Protein
(c) Fat (d) Nue;eic acid

113. Norman Borlaug won Nobel pence Prize on his contributions in
1. development of high yielding crop
2. modernization of irrigation infrastructure
3. introduction of symhelic fertilizers and pesticides
Select the correct answer using the code given below :
(a) 1 only (b) 2 only
(c) 2 and 3 only (d) 1,2 and 3

114. Which one of the following hormones contains pepude chain ?
(a) Oxytocin (b) Cortielropin
(c) Insulin (d) Cortisone

115. Which one of the following is considered as 'good cholesterol' with reference to individuals facing the risk of cardio-vascular diseases and hypertension?
(a) High Density Lipoprotein (HDL)
(b) Low Density Lipoprotein(LDL)
(c) Triglyceride
(d) Fatty acids

116. The rate of change of momentum of a body equal of the resultant :
(a) energy (b) power
(c) force (d) impulse

117. The Germplasm is required for the propagation of plants and animals, Germplasm is the :
1. genetic resources
2. seeds or tissues for breeding
3. egg and sperm repository
4. a germ cell's determining zone
Select the correct answer using the code given below
(a) 1 only (b) 1, 2 and 3
(c) 2 and 3 only (d) 2 and 4

118. Dengue virus is known to cause low platelet count in blood of patient by :
1. interfering in the process of platelet production in bone marrow
2. infecting endothelial cells
3. binding with plateiets
4. accumulating platelets in intestine
Select the correct answer using the code given below:
(a) 1 and 2 only (b) 1 and 3 only
(c) 3 and 4 (d) 1, 2 and 3

119. Angiosperms have
(a) tracheids and vessels
(b) tracheids only
(c) vessels only
(d) tracheids and albuminous cells

120. Which of the following groups of plants produce seeds but lacks fruits?
(a) Fungi (b) Bryophytes
(c) Pteridophytes (d) Gymnosperms

121. Corals are
(a) Poriferans attached to some solid support
(b) Cnidarians that are solitary living
(c) Poriferans present at the sea bed
(d) Cnidarians that live in colonies

122. Mouth parts of Cockroach are of type
(a) biting and chewing (b) piercing and sucking
(c) siphoning (d) sponging

123. Synapse in the junction of
(a) dendrites (b) simply nerves
(c) nucleus (d) axon

124. A nail is inserted in the trunk of a tree at a height of 1 metre from the ground level. After 3 years the nail will
(a) move downwards
(b) move upwards
(c) remain at the same position
(d) move sideways

125. The connective tissue that connects muscle to bone is called
(a) ligament (b) tendon
(c) cartilage (d) areolar

Level- 2

1. **Assertion (A):** In a pressure cooker food is cooked above boiling point.
Reason (R): Boiling point of water increases as the pressure increases.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

2. **Assertion (A)**: Steam is more harmful for human body than the boiling water in case of burn.
Reason (R) : Boiling water contains more heat than steam.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

3. Consider the following statements
1. Clear sky appears blue due to poor scattering of blue wavelength of visible light.
2. Red part of light shows more scattering than blue light in the atmosphere.
3. In the absence of atmosphere, there would be no scattering of light and sky will look black.
Which of the statements given above is/are correct?
(a) Only 1 (b) 1 and 2
(c) Only 3 (d) All of these

4. Consider the following satements
X-rays
1. can pass through aluminum.
2. can be deflected by magnetic field.
3. move with a velocity less than the velocity of ultraviolet ray in vacuum.
Which of the statements given above is/are correct?
(a) 1,2 and 3 (b) Only 1
(c) 2 and 3 (d) 1 and 2

DIRECTIONS (Qs. 5): *The following question consist of two statements, Statement I and Statement II. You are to examine these two statements carefully and select the answers to these items using the code given below :*
Code :
(a) Both the statements are individually true and Statement II is the correct explanation of Statement I.
(b) Both the statements are individually true, but Statement II is not the correct explanation of Statement I.
(c) Statement I is true, but Statement II is false.
(d) Statement I is false, but statement II is true.

5. **Statement I :** When a gun is fired it recoils, i.e., it pushes back, with much less velocity than the velocity of the bullet.
Statement II : Velocity of the recoiling gun is less because the gun is much heavier than the bullet.

6. Graphene is frequently in news recently. What is its importance?
1. It is a two-dimensional material and has good electrical conductivity.
2. It is one of the thinnest but strongest materials tested so far.
3. It is entirely made of silicon and has high optical transparency.
4. It can be used as 'conducting electrodes' required for touch screens, LCDs and organic LEDs.
Which of the statements given above are correct?
(a) 1 and 2 only (b) 3 and 4 only
(c) 1, 2 and 4 only (d) 1, 2, 3 and 4

7.

List I	List II
(A) Resistance of resistance box	(1) Tungsten
(B) Fuse wire	(2) Maganin
(C) Bulb	(3) Tin-lead alloy
(D) Insulator	(4) glass

(a) A – 3 ; B – 1 ; C – 2 ; D – 4
(b) A – 4 ; B – 2 ; C – 3 ; D – 1
(c) A – 4 ; B – 3 ; C – 2 ; D – 1
(d) A – 2 ; B – 3 ; C – 1 ; D – 4

8. From the following statements, concerning ideal gas at any given temperature T, select the correct ones
1. The coefficient of volume expansion at constant pressure is same for all ideal gases
2. The average translational kinetic energy per molecule of oxygen gas is 3KT (K being Boltzmann constant)
3. In a gaseous mixture, the average translational kinetic energy of the molecules of each component is same
4. The mean free path of molecules increases with the decrease in pressure
(a) 1 and 2 (b) 3 and 4
(c) 1, 3 and 4 (d) 1, 2 and 3

9. Which of the following statements is/ are true?
1. Absolute zero temperature is zero energy temperature.
2. Two different gases at the same temperature pressure have equal root mean square velocities.
3. The root mean square speed of the molecules of different ideal gases, maintained at the same temperature are the same.
4. Given sample of 1cc of hydrogen and 1 cc of oxygen both at NTP; oxygen sample has a large number of molecules.
(a) 1 only (b) 2 and 3
(c) 1, 3 and 4 (d) 2, 3 and 4

10. If a body is projected with speed less than escape velocity the body
1. can reach a certain height and may fall down following a straight line path.
2. can reach a certain height and may fall down following a parabolic path
3. may orbit the earth in a circular orbit
4. may orbit the earth in an elliptical orbit
Which of the statements given above are correct?
(a) 1 and 2 (b) 2, 3 and 4
(c) 1, 2 and 3 (d) All are correct

DIRECTIONS : (Qs. 11-25) *Each of these questions contains an Assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.*

(a) If both **Assertion** and **Reason** are **correct** and Reason is the **correct explanation** of Assertion.
(b) If both **Assertion** and **Reason** are correct, but Reason is **not the correct explanation** of Assertion.
(c) If **Assertion** is **correct** but **Reason** is **incorrect**.
(d) If **Assertion** is **incorrect** but **Reason** is **correct**.

11. **Assertion :** Basic difference between an electric line and magnetic line of force is that former is discontinuous and the later is continuous or endless.
Reason : No electric lines of force exist inside a charged body but magnetic lines do exist inside a magnet.

12. **Assertion :** A small coil carrying current, in equilibrium, is perpendicular to the direction of the uniform magnetic field.
Reason : Torque is maximum when plane of coil and direction of the magnetic field are parallel to each other.

13. **Assertion :** A proton moves horizontally towards a vertical long conductor having an upward electric current. It will deflect vertically downward.
Reason : Seeing the proton and the conductor from the side of the proton, the magnetic field at the site of the proton will be towards right. Hence the force $\vec{F} = q\vec{v} \times \vec{B}$ will deflect the proton vertically downward.

14. **Assertion :** An induced e.m.f. appears in any coil in which the current is changing.
Reason : Self induction phenomenon obeys Faraday's law of induction.

15. **Assertion :** U^{235} nucleus, by absorbing a slow neutron undergoes nuclear fission with the evolution of a significant quantity of heat
Reason : During nuclear fission a part of the original mass of U^{235} is lost and gets converted into heat.

16. **Assertion :** In street light circuits, photo-cells are used to switch on and off the lights automatically at dusk and dawn.
Reason : A photocell can convert a change in intensity of illumination into a change in photocurrent that can be used to control lighting system.

17. **Assertion :** The positive charge particle is placed in front of a spherical uncharged conductor. The number of lines of forces terminating on the sphere will be more than those emerging from it.
Reason : The surface charge density at a point on the sphere nearest to the point charge will be negative and maximum in magnitude compared to other points on the sphere.

18. **Assertion :** A deuteron and an α-particle are placed in an electric field. If F_1 and F_2 be the forces acting on them and a_1 and a_2 be their accelerations respectively then, $a_1 = a_2$.
Reason : Forces will be same in electric field.

19. **Assertion :** The strength of photoelectric current depends upon the intensity of incident radiation.
Reason : A photon of energy E (= hν) possesses a mass equal to E/c^2 and momentum equal to E/c.

20. **Assertion :** In a decay process of a nucleus, the mass of products is less than that of the parent.
Reason : The rest mass energy of the products must be less than that of the parent.

21. **Assertion :** When a concave mirror is held under water, its focal length will increase.
Reason : The focal length of a concave mirror is independent of the medium in which it is placed.

22. **Assertion :** Resistivity of material may change with temperature.
Reason : Resistivity is a material property & independent on temperature.

23. **Assertion :** A tube light emits white light.
Reason : Emission of light in a tube takes place at a very high temperature

24. **Assertion :** There exists two angles of incidence for the same magnitude of deviation (except minimum deviation) by a prism kept in air.
Reason : In a prism kept in air, a ray is incident on first surface and emerges out of second surface. Now if another ray is incident on second surface (of prism) along the previous emergent ray, then this ray emerges out of first surface along the previous incident ray. This particle is called principle of reversibility of light.

25. **Assertion:** The optical instruments are used to increase the size of the image of the object.
Reason: The optical instruments are used increase the visual angle.

DIRECTIONS (Qs. 26-30) : *Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s) in column II.*

26. Match the following :

Column-I	**Column-II**
(A) Inverted crown-flint glass prism	(p) Deviation $\propto \frac{1}{\text{dispersive power}}$
(B) Achromatism	(q) Deviation without dispersion
(C) Hollow prism	(r) Absence of chromatic aberration
(D) Glass slab	(s) Dispersion without deviation

27. Column II gives lens that can be use to correct the defect of vision given in column I, match them correctly.

Column-I	**Column-II**
(A) Myopia	(p) Convex lens
(B) Hypermetropia	(q) Concave lens
(C) Astigmatism	(r) Cylindrical lens
(D) Presbyopia	(s) Bi-focal lens

28. Match the following :

Column-I	**Column-II**
(A) Power of convex mirror	(p) Positive power
(B) Power of concave mirror	(q) Negative power
(C) Power of plane mirror	(r) Zero power
(D) Power of convex lens	(s) Infinite power

29.

Column-I	**Column-II**
(A) Ohm	(p) $\frac{\rho L}{A}$
(B) Resistance	(q) $\frac{1 \text{ volt}}{1 \text{ ampere}}$
(C) Resistivity	(r) zero resistance
(D) Super conductor	(s) ohm-meter

30. Column II gives name of material use for device given in column I

Column-I	Column-II
(A) Resistance of resistance box	(p) tungsten
(B) Fuse wire	(q) maganin
(C) Bulb	(r) tin-lead alloy
(D) Insulator	(s) glass

31. Consider the following statements:
1. Velocity of particles, while crossing mean position in case of stationary waves varies from maximum at anti-nodes to zero at nodes.
2. Amplitude of vibration at antinodes is maximum and at nodes, the amplitude is zero, and all particles between two successive nodes cross the mean position together.
3. Like sound, light can not propagate in vacuum.
4. Light waves are transverse in nature.

Which of the statements given above are correct?
(a) 2 and 3 (b) 3 and 4
(c) 1, 2 and 4 (d) 2, 3 and 4

DIRECTIONS : *Question contains statements give in two columons which have to be matched statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s) in column II.*

32. Column I shows some devices and column II shows transformation of energy for which they are used. Then match the following.

Column-I	Column-II
(A) Electric motor	(p) Electrical energy to heat energy
(B) Engine on an automobile	(q) Electrical energy to mechanical energy.
(C) Electric heater	(r) Light energy to electrical energy
(D) Photocell	(s) Heat energy to mechanical energy.

33. Consider the following statements:
1. The values of u and f for a concave lens are always negative by convention.
2. The power of a convex lens is negative and that of a concave lens is positive.
3. A concave lens always forms a virtual, erect and smaller image.

Which of these statements are correct?
(a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

DIRECTIONS: (Qs. 34-36): *Match List-I with List- II and select the correct answer using the codes given below the lists.*

34.

List-I	List-II
(A) Orsted's experiment	(1) Magnetic meridian
(B) Steel	(2) Permanent magnet
(C) Sure test of magnet	(3) Magnetic effects of current
(D) Vertical plane passing through magnetic axis	(4) Repulsion

(a) A – 3 ; B – 1 ; C – 2 ; D – 4
(b) A – 3 ; B – 2 ; C – 4 ; D – 1
(c) A – 4 ; B – 3 ; C – 2 ; D – 1
(d) A – 2 ; B – 4 ; C – 1 ; D – 3

35.

List-I	List-II
(A) Magnet with single pole	(1) Resultant field is zero
(B) Null points	(2) Earth's magnetic fields
(C) Terrestrial magnetism	(3) Does not exist
(D) Artificial magnet	(4) Horse shoe magnet

(a) A – 3 ; B – 1 ; C – 2 ; D – 4
(b) A – 4 ; B – 2 ; C – 3 ; D – 1
(c) A – 3 ; B – 1 ; C – 2 ; D – 4
(d) A – 2 ; B – 4 ; C – 1 ; D – 3

36.

List-I	List-II
(A) high pitch	(1) Faint sound
(B) low pitch	(2) Loud sound
(C) small amplitude	(3) High frequency
(D) large amplitude	(4) Low frequency

(a) A – 2, B – 1, C – 4, D – 3
(b) A – 2, B – 3, C – 4, D – 1
(c) A – 4, B – 1, C – 2, D – 3
(d) A – 3, B – 4, C – 1, D – 2

37.

List-I	List-II
(A) Direct conversion of vapours into solid	(1) Sublimation
(B) Direct conversion of a solid into vapours	(2) Hoar frost
(C) The phase change from liquid to vapour	(3) Condensation
(D) The phase change from vapour to liquid	(4) Vaporisation

Choose the correct option from the codes given below :
(a) A – 2, B – 1, C – 4, D – 3
(b) A – 2, B – 3, C – 4, D – 1
(c) A – 3, B – 1, C – 2, D – 4
(d) A – 3, B – 4, C – 1, D – 2

38.

List-I	List-II
(A) Isothermal process	(1) Volume of the system remains constant
(B) Adiabatic process	(2) Pressure of the system remains constant
(C) Isobaric process	(3) Temperature of the system remains constant
(D) Isochoric process	(4) No heat transfer takes place between the system and the surrounding

(a) A – 2, B – 1, C – 4, D – 3
(b) A – 2, B – 3, C – 4, D – 1
(c) A – 3, B – 4, C – 2, D – 1
(d) A – 4, B – 3, C – 1, D – 2

39.

List-I	List-II
(A) G	(1) Law of periods
(B) gh	(2) 24 Hrs
(C) $T^2 \propto R^3$	(3) $6.67\times10^{-11}\ Nm^2kg^{-2}$
(D) Time period of a geostationary satellite	(4) $g_0\left(1-\frac{2h}{R}\right)$

(a) A – 2, B – 1, C – 4, D – 3
(b) A – 2, B – 3, C – 4, D – 1
(c) A – 3, B – 4, C – 1, D – 2
(d) A – 4, B – 3, C – 2, D – 1

40.

List-I		List-II
(A)	Resistance of resistance box	(1) Tungsten
(B)	Fuse wire	(2) Maganin
(C)	Bulb	(3) Tin-lead alloy
(D)	Insulator	(4) glass

(a) A – 3 ; B – 1 ; C – 2 ; D – 4
(b) A – 4 ; B – 2 ; C – 3 ; D – 1
(c) A – 4 ; B – 3 ; C – 2 ; D – 1
(d) A – 2 ; B – 3 ; C – 1 ; D – 4

41.

List-I (Position of the object)		List-II (Magnification)
A.	An object is placed at focus before a convex mirror	(1) Magnification is $-\infty$
B.	An object is placed at centre of curvature before a concave mirror	(2) Magnification is 0.5
C.	An object is placed at focus before a concave mirror	(3) Magnification is –1

42.

List-I		List-II
(A)	Rectifier	(1) Convert information into electrical signal
(B)	Inverter	(2) Convert AC into DC
(C)	Zener diode	(3) Convert DC into AC
(D)	Transducer	(4) Voltage stabilization

(a) A – 3 ; B – 4 ; C – 1 ; D – 2
(b) A – 4 ; B – 2 ; C – 3 ; D – 1
(c) A – 2 ; B – 3 ; C – 4 ; D – 1
(d) A – 2 ; B – 4 ; C – 1 ; D – 3

43.

List-I		List-II
(A)	Faster transmission of sound	(1) > 20 kHz
(B)	Slower transmission of sound	(2) 20 Hz – 20 kHz
(C)	Ultrasonic range	(3) Rarer medium
(D)	Audible range	(4) Denser medium

(a) A – 2, B – 1, C – 4, D – 3
(b) A – 2, B – 3, C – 4, D – 1
(c) A – 4, B – 1, C – 2, D – 3
(d) A – 4, B – 3, C – 1, D – 2

44. Consider the following statements :
1. A dam for storing water is made thinner at the bottom then at the top.
2. The ratio of buoyant forces experienced by a solid body when immersed in two liquids whose relative densities are 1 and 0.5 respectively is 2 : 1.
3. The buoyancy of an object depends both on the material and shape of the object.

Which of these statements is/are correct ?
(a) 1 and 2 (b) 1 and 3
(c) 2 only (d) 3 only

45. Consider the following statements :
If there were no phenomenon of capillarity
1. it would be difficult to use a kerosene lamp
2. one would not be able to use a straw to consume a soft drink
3. the blotting paper would fail to function
4. the big trees that we see around would not have grown on the Earth

Which of the statements given above are correct?
(a) 1, 2 and 3 only (b) 1, 3 and 4 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

46. When two waves of same frequency, same wavelength, same velocity moves in the same direction, their superimposition results in the interference.
1. In interference energy is neither created nor destroyed but is redistributed.
2. For observable interference, the sources must be coherent.
3. Due to interference the resultant intensity of sound at a point is different from the sum of intensities due to each wave separately.

Which of the statements given above is/ are correct?
(a) 1 only (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3.

47. Consider the following statements:
1. When a beetle moves along the sand within a few tens of centimeters of a sand the scorpion immediately turn towards the beetle and dashes to it.
2. When a beetle disturbs the sand, it sends pulses along the sands surface one set of pulses is longitudinal while other set is transverse.
3. The reverberation time dependent on the shape of enclosure, position of source and observer.
4. The unit of absorption coefficient in mks system is metric sabine.

Which of the statements given above are correct?
(a) 2 and 4 (b) 1, 2 and 4
(c) 2, 3 and 4 (d) 1, 2, 3 and 4

DIRECTIONS (Qs. 48 and 49) : *Match List-I with List-II and select the correct answer using the codes given below the lists.*

48.

List-I		List-II
(A)	Insecticides	(1) Na_3AsO_3
(B)	Herbicides	(2) $CuSO_4$
(C)	Fungicides	(3) Zn_3P_2
(D)	Rodenticides	(4) BHC

(a) A – 1, B – 4, C – 2, D – 3
(b) A – 4, B – 2, C – 1, D – 3
(c) A – 4, B – 1, C – 2, D – 3
(d) A – 4, B – 1, C – 3, D – 2

49.

List-I		List-II
A.	Morphine	1. Antiseptic
B.	Sodium	2. Alloy
C.	Boric acid	3. Analgesic
D.	German silver	4. Kerosene oil

Codes:

	A	B	C	D
(a)	4	3	1	2
(b)	2	4	3	1
(c)	3	1	4	2
(d)	3	4	1	2

50. Which of the following statements are correct?
1. For treatment of thyroid cancer we use I-131.
2. For treatment of cancer Co-59 is used.
3. For treatment of leukema P-33 is commonly used
4. The excessive use of radio therapy may be harmful and may cause cancer

(a) 1 and 4 (b) 1, 2 and 4
(c) 2 and 3 (d) 1, 3 and 4

51. Consider the following statements :
1. Among the nitrogenous fertilizers used, urea contains maximum percentage of N.
2. The mixture of calcium sulphate and calcium dihydrogen phosphate is known as superphosphate of lime.
3. Potassium magnesium sulphate is called the muriate of potash.
Which of the statements given above are correct?
(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

52. Which of the following statements are true for pure substances?
1. Pure substances contain only one kind of particles
2. Pure substances may be compounds or mixtures
3. Pure substances have the same composition throughout
4. Pure substances can be exemplified by all elements other than nickel
(a) 1 and 2 (b) 1 and 3
(c) 3 and 4 (d) 2 and 3

53. Which of the following statements are true about the quantum numbers n, l, m and s?
1. l gives an idea of the shape of the orbital
2. m gives the information of the energy of electron in a given orbital
3. n gives the idea of the size of the orbital
4. s gives the direction of spin of electron in an orbital
(a) 1, 3 and 4 (b) 2, 3 and 4
(c) 1, 2 and 3 (d) 1, 2 and 4

54. Which of the following statement(s) is/are correct ?
1. The electronic configuration of Cr is $[Ar]\ 3d^5 4s^1$ (Atomic no. of Cr = 24)
2. The magnetic quantum number may have a negative value
3. Weight of electrons contribute to weight of atom.
(a) Only 2 (b) 2 and 3
(c) Only 3 (d) 1 and 2

DIRECTIONS (Qs. 55) : *Match List - I with List - II and select the correct answer using the codes given below the lists.*

55.

	List-I	List-II
(A)	9.033×10^{24} atoms	(1) 46 g of He
(B)	2 moles of Na	(2) 15 moles
(C)	11.2 L of O_2 at STP	(3) 3.011×10^{23} molecules
(D)	22 g of CO_2	(4) 16 g

(a) A – 2; B – 1; C – 4; D – 3
(b) A – 1; B – 2; C – 4; D – 3
(c) A – 1; B – 3; C – 4; D – 2
(d) A – 2; B – 1; C – 3; D – 4

56. Which of the following statements are correct ?
1. Radioactive isotope C-14 is formed by the bombardment of N-14 in the upper atmosphere by cosmic ray neutrons.
2. C–14 decays into N-14 through alpha decay)
3. All living things contain constant proportion of C-14 and hence constant activity per g of carbon
4. After the death of animal or plant, incorporation of C-14 stops and activity decreases due to continuous decay of C-14 which permits the age determination of organic matter.
(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 2, 3 and 4 (d) 1, 2 and 4

57. A radioactive element X has an atomic number of 100. It decays directly into an element Y which decays directly into an element Z. In both processes a charged particle is emitted. Point out the correct statement(s) of the following
1. Y has an atomic number of 102
2. Y has an atomic number of 101
3. Z has an atomic number of 100
4. Z has an atomic number of 99
(a) Only 3 (b) 2 and 4
(c) 2, 3 and 4 (d) 1 and 3

58. Considering Thomson's model of atom, which of the following statements are correct ?
1. The mass of the atom is assumed to be uniformly distributed over the atom
2. The positive charge is assumed to be uniformly distributed over the atom
3. The electrons are uniformly distributed in the positively charged sphere
4. The electrons attract each other to stabilise the atom
(a) 1, 2 and 3 (b) 1 and 3
(c) 1 and 4 (d) 1, 3 and 4

DIRECTIONS (Qs. 59-61) : *Match List - I with List - II and select the correct answer using the codes given below the lists.*

59.

	List-I (Elements)	List-II Molecules (Possible formulae)
(A)	Sulphur	(1) S_2, S_4, S_8, S
(B)	Phosphorus	(2) P_4, P, P_2, P_6
(C)	Ozone	(3) O_2, O_3, O, O_4
(D)	Helium	(4) He, He_2

(a) Sulphur–S_2, Phosphorus P, Ozone O, Helium He_2
(b) Sulphur–S_8, Phosphorus P_4, Ozone O_3, Helium He
(c) Sulphur–S, Phosphorus P_2, Ozone O_4, Helium He_2
(d) Sulphur–S_4, Phosphorus P_6, Ozone O_2, Helium He

60.

	List-I	List-II
A.	Zero mass	1. Positron
B.	Fractional charge	2. Neutrino
C.	Fractional spin	3. Quark
D.	Integral spin	4. Photon

Codes:

	A	B	C	D
(a)	4	3	1	2
(b)	3	2	4	1
(c)	2	3	4	1
(d)	3	2	1	4

61.

	List-I	List-II
A.	Moderator	1. Uranium
B.	Control rod	2. Graphite
C.	Fuel rods	3. Boron
D.	Coolant	4. Lead
		5. Sodium

Codes:

	A	B	C	D
(a)	2	1	3	5
(b)	2	3	1	5
(c)	3	2	1	5
(d)	3	4	1	2

62. Which of the following statements about pH and H^+ ion concentration are incorrect?
1. Addition of one drop of concentrated HCl in NH_4OH solution decreases pH of the solution.
2. A solution of the mixture of one equivalent of each of CH_3COOH and NaOH has a pH of 7
3. pH of pure neutral water is not zero
4. A cold and concentrated H_2SO_4 has lower H^+ ion concentration than a dilute solution of H_2SO_4

(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 1, 2 and 4 (d) 2, 3 and 4

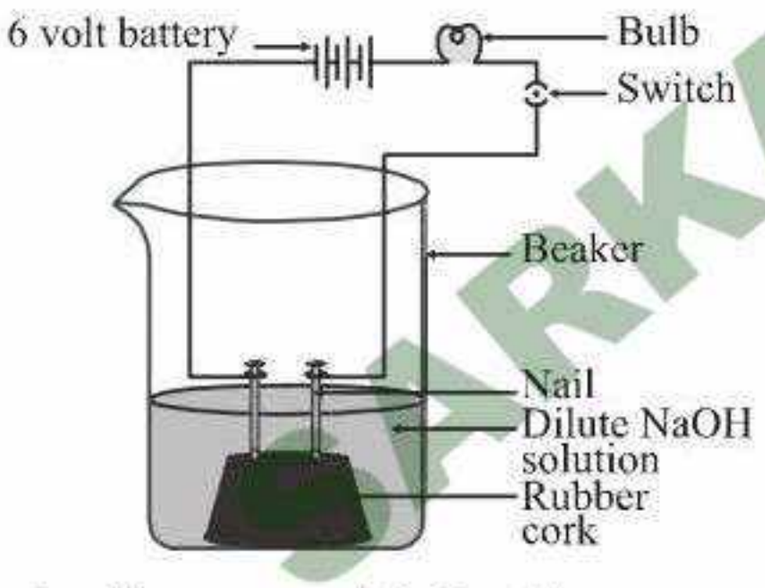
63. Which of the following statements about the given reaction are correct ?

$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

1. Iron metal is getting oxidised
2. Water is getting reduced
3. Water is acting as reducing agent
4. Water is acting as oxidising agent

(a) 1, 2 and 3 (b) 3 and 4
(c) 1, 2 and 4 (d) 2 and 4

64. In an attempt to demonstrate electrical conductivity through an electrolyte, the following apparatus (Fig.) was set up. Which among the following statement(s) is (are) correct?
1. Bulb will not glow because electrolyte is not acidic
2. Bulb will glow because NaOH is a strong base and furnishes ions for conduction.
3. Bulb will not glow because circuit is incomplete
4. Bulb will not glow because it depends upon the type of electrolytic solution



(a) 1 and 3 (b) 2 and 4
(c) 2 only (d) 4 only

65. Consider the following statements :
1. The hydronium ion (H_3O^+) is the strongest acid that can exist in aqueous solution.
2. Mixing concentrated acid or bases with water is a highly endothermic reaction.

Which of these statement(s) is/are correct ?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

66.

	List-I	List-II
(A)	Caustic soda	(1) Manufacture of antacid
(B)	Sulphuric acid	(2) Preservation of food
(C)	Calcium hydroxide	(3) Manufacturing of soap
(D)	Acetic acid	(4) Automobile batteries

(a) A – (3); B – (4); C – (1); D – (2)
(b) A – (2); B – (4); C – (1); D – (3)
(c) A – (3); B – (1); C – (4); D – (2)
(d) A – (4); B – (3); C – (1); D – (2)

67.

	List-I	List-II
A.	Sour milk	1. Malic acid
B.	Vinegar and pickle	2. Carbonic acid
C.	Soda water	3. Acetic acid
D.	Apple	4. Lactic acid

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	4	3	1	2
(c)	4	3	2	1
(d)	3	4	2	1

68. Consider the following statements:
1. Atomic radii decreases across a row of the periodic table when we move from left to right.
2. Atomic radii increases down the column as we move from top to bottom.
3. Although the order of elements is based on atomic numbers, vertical families share similar chemical properties.

Which of the statements given above are correct?
(a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

69. Mark the correct statements out of the following
1. The bond order in the species O_2, O^+_2 and O^-_2 decreases

$$\text{Bond order} = \frac{1}{2}\left[\begin{array}{cc} \text{Number of electrons} & \text{Number of electrons} \\ \text{in bonding M.O.} & - \text{in antibonding M.O.} \\ \text{i.e.} N_b & \text{i.e.} N_a \end{array}\right]$$

2. The bond energy in a diatomic molecule always increases when an electron is lost
3. Electrons in antibonding M.O. contribute to repulsion between two atoms.
4. With increase in bond order, bond length decreases and bond strength increases.

(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 2, 3 and 4 (d) 1, 2 and 4

DIRECTIONS (Qs. 70 and 71) : *Match List-I with List-II and select the correct answer using the codes given below the lists.*

70.

	List-I	List-II
(A)	Element with largest size in second period	(1) boron
(B)	Element with smallest size in group 13	(2) fluorine
(C)	Element with maximum non-metallic character	(3) bromine
(D)	Element with smallest size in fourth period	(4) lithium
(E)	Element with most metallic character in group 14	(5) lead

(a) A – (4); B – (1); C – (2); D – (5); E – (3)
(b) A – (1); B – (4); C – (2); D – (3); E – (5)
(c) A – (4); B – (2); C – (1); D – (3); E – (5)
(d) A – (4); B – (1); C – (2); D – (3); E – (5)

71.

List-I	List-II
(A) Electronegativity	(1) Isotopes
(B) Lanthanides	(2) increases along a period
(C) Transition elements	(3) *f*-group of elements
(D) Ionisation energy	(4) *d*-group of elements
(E) Elements of same atomic number but different mass number	(5) decreases along a group

(a) A – (2); B – (3); C – (4); D – (1); E – (5)
(b) A – (3); B – (2); C – (4); D – (5); E – (1)
(c) A – (2); B – (3); C – (4); D – (5); E – (1)
(d) A – (2); B – (4); C – (3); D – (5); E – (2)

72. Select the correct statements :
1. Water available under earth's surface is called underground water
2. The characteristic shape and colour of crystals are due to water of crystallisation
3. The chemical formula of washing soda is $Na_2CO_3.5H_2O$

(a) 1 and 3 (b) 2 and 3
(c) 1 and 2 (d) 1, 2 and 3

73. Amongst the following statements, which are correct?
1. The ceaseless zig-zag motion of sol particles is due to the unbalanced bombardment of particles by the molecules of dispersion medium
2. The intensity of zig-zag motion increases with the increase in the size of the particles
3. The zig-zag motion of particles becomes intense at high temperature
4. This motion has a stirring effect which does not permit the particles to settle

(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 1, 2 and 4 (d) 2, 3 and 4

74. Which of the following statements are true about the aqueous solution of soaps and detergents?
1. Their molecules or ions have colloidal dimensions
2. Their molecules or ions aggregate spontaneously in solution to form particles of colloidal dimensions
3. In these aggregates of ions, the polar ends are directed towards water and hydrocarbon ends towards the centre
4. The detergent action is due to the absorption of grease/oil stain into the interior of these aggregates.

(a) 1 and 3 (b) 1, 2 and 3
(c) 3 and 4 (d) 1, 2, 3 and 4

75. Which of the following statements are true regarding oxygen?
1. It reacts with non-metals to form oxides which are basic in nature.
2. Ozone is an isotope of oxygen.
3. It is soluble in alkaline pyrogallol.
4. It is slightly heavier than air.

Select the correct answer using the codes given below:
(a) 1 and 3 (b) 2 and 4
(c) 3 and 4 (d) 1 and 3

76. Consider the following statements:
Hydrogen peroxide (H_2O_2) can act as:
1. oxidising agent
2. reducing agent
3. bleaching agent

Which of the statements given above are correct ?
(a) 1, 2 and 3 (b) 1 and 2
(c) 2 and 3 (d) 1 and 3

77. Solubility of gases in water
1. decrease with rise in temperature
2. increase with rise in temperature
3. increase with increase in pressure
4. decrease with increase in pressure

(a) 1 and 3 (b) 1, 2 and 4
(c) 2 and 3 (d) 1, 2 and 3

78. Which of the following will produce carbon dioxide gas on heating?
1. $CaCO_3$ 2. $ZnCO_3$
3. Na_2CO_3 4. K_2CO_3

(a) 2 and 3 (b) 1 and 4
(c) 1 and 2 (d) 3 and 4

DIRECTIONS (Qs. 79) : *Match List-I with List-II and select the correct answer using the codes given below the lists.*

79.

List-I	List-II
(A) Allotrope of carbon	(1) Hydrocarbons
(B) Good lubricant	(2) Unsaturated hydrocarbons
(C) Compounds of carbon and hydrogen	(3) Fullerene
(D) n – butane and iso – butane	(4) Graphite
(E) Alkynes	(5) Isomers

(a) A – (3); B – (4); C – (1); D – (5); E – (2)
(b) A – (4); B – (5); C – (2); D – (1); E – (3)
(c) A – (3); B – (4); C – (2); D – (1); E – (5)
(d) A – (5); B – (4); C – (2); D – (1); E – (3)

80. Consider the following statements :
1. Metals can form positive ions by losing electrons to non-metals.
2. Different metals have same reactivities with water and dilute acids.
3. A more reactive metal displaces a less reactive metal from its salt solution.

Which of these statements are correct?
(a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

81. Which of the statements about "Denaturation" given below are correct ?
1. Denaturation of proteins causes loss of secondary and tertiary structures of the protein.
2. Denaturation leads to the conversion of double strand of DNA into single strand
3. Denaturation affects primary structure which gets distorted

(a) 2 and 3 (b) 1 and 3
(c) 1 and 2 (d) 1, 2 and 3

DIRECTIONS (Qs. 82) : *Match List-I with List-II and select the correct answer using the codes given below the lists.*

82.

List-I	List-II
(A) Brass	(1) Homogeneous mixture of copper and zinc
(B) Bronze	(2) Homogeneous mixture of iron and carbon
(C) Steel	(3) Homogeneous mixture of copper and tin
(D) Solder	(4) Homogeneous mixture of tin and lead

(a) A – (1), B – (3), C – (2), D – (4)
(b) A – (3), B – (1), C – (2), D – (4)
(c) A – (1), B – (2), C – (3), D – (4)
(d) A – (1), B – (3), C – (4), D – (2)

83. Identify the incorrect statements regarding entropy.
1. At absolute zero temperature, entropy of a perfectly crystalline substance is taken to be zero
2. At absolute zero temperature, the entropy of a perfectly crystalline substance is positive
3. Absolute entropy of a substance cannot be determined
4. At 0°C, the entropy of a perfectly crystalline substance is taken to be zero
(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 1, 2 and 4 (d) 1, 3 and 4

84. According to Faraday's first law the amount of substance deposited at electrode when an electric current is passed through electrolyte depends upon
1. amount of current passed
2. dissociation of electrolyte
3. time till which current is passed
4. nature of electrode material
(a) 1, 2 and 3 (b) 1 and 3
(c) 2, 3 and 4 (d) 2 and 4

85. A binary liquid solution is prepared by mixing n-heptane and ethanol. Which of the following statements is incorrect regarding the behaviour of the solution?
1. The solution is non-ideal, showing -ve deviation from Raoult's Law.
2. The solution is non-ideal, showing +ve deviation from Raoult's Law.
3. n-heptane shows +ve deviation while ethanol shows -ve deviation from Raoult's Law.
4. The solution formed is an ideal solution.
(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 1, 2 and 4 (d) 2, 3 and 4

DIRECTIONS (Qs. 86) : *Match List-I with List-II and select the correct answer using the codes given below the lists.*

86.

	List – I	List – II
(A)	Boyle's law	(1) Temperature
(B)	Charle's law	(2) Pressure
(C)	Gay-Lussac law	(3) Volume
(D)	Ideal gas equation	(4) Number of moles of a gas

(a) A – (2, 3), B – (1,3), C – (1, 2), D – (1, 2, 3, 4)
(b) A – (1, 3), B – (2, 3), C – (1, 2), D – (1, 2, 3, 4)
(c) A – (2, 3), B – (1, 2), C – (1, 3), D – (1, 2, 3, 4)
(d) A – (2, 3), B – (1, 3), C – (1, 2, 3, 4), D – (1, 2)

87. Which one among the following statements is correct ? **(CDS)**
(a) Prokaryotic cells possess nucleus.
(b) Cell membrane is present both in plant and animal cells.
(c) Mitochondria and chloroplasts are not found in eukaryotic cells.
(d) Ribosomes are present in eukaryotic cells only.

88. Which one among the following statements is ***not*** true for Mammals ? **(CDS)**
(a) They possess hair on the body.
(b) Some of them lay eggs.
(c) Their heart is three chambered
(d) Some are aquatic.

89. Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I (Plant)	List-II (Natural vegetation type)
A. Ebony	1. Moist deciduous
B. Shisham	2 Himalayan moist
C. Walnut	3. Alpine
D. Birch	4. Tropical evergreen

Code:

	A	B	C	D
(a)	4	1	2	3
(b)	4	2	1	3
(c)	3	2	1	4
(d)	3	1	2	4

90. Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I (Geological time scale)	List-II (Life-form)
A. Pleistocene	1. Mammals
B. Paleocene	2. Human genus
C. Permian	3. Invertebrates
D. Cambrian	4. Frogs

Code:

	A	B	C	D
(a)	2	1	4	3
(b)	2	4	1	3
(c)	3	4	1	2
(d)	3	1	4	2

DIRECTIONS (Qs. 91 to 100) : *Match List-I with List-II and select the correct answer using the codes given below the lists.*

91.

List-I	List-II
(A) Endoplasmic reticulum	(1) Sorting, packaging, labelling of cell products
(B) Chloroplast	(2) Production and segregation of proteins to be secreted
(C) Golgi body	(3) Digestion of nutrients and wornout cell parts
(D) Lysosomes	(4) Organelle of photosynthesis

(a) A – 4 ; B – 2 ; C – 1 ; D – 3
(b) A – 4 ; B – 2 ; C – 3 ; D – 1
(c) A – 4 ; B – 3 ; C – 2 ; D – 1
(d) A – 2 ; B – 4 ; C – 1 ; D – 3

92.

List-I (Physiological processes)	List-II (Cell organelles)
A. Photosynthesis	1. Plasma membrane
B. Mineral uptake	2. Chloroplast
C. Respiration	3. Mitochondria
D. Protein synthesis	4. Ribosomes

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	1	2	4	3
(c)	2	1	3	4
(d)	2	1	4	3

93.

List-I	List-II
A. Ribosome	1. Suicidal bag of cells
B. Lysosome	2. Protein factory of cells
C. Mitochondria	3. Controller of cell
D. Nucleus	4. Power house of cell

Codes:

	A	B	C	D
(a)	2	1	4	3
(b)	4	3	2	1
(c)	1	4	3	2
(d)	3	2	1	4

94. Which of the followings organelles having single membrane bound structures ?
1. Endoplasmic reticulum
2. Golgi bodies
3. Mitochondria
4. Plastids

(a) 1 and 2 (b) 2 and 4
(c) 3 and 4 (d) All of these

95. Nuclear material without cover is found in
1. mycoplasma and green algae
2. bacteria and fungi only
3. bacteria and blue green algae
4. virus

(a) 1 and 2 (b) 2 and 4
(c) 3 and 4 (d) 1 and 3

96. Which of the following statements are wrong?
1. Leucocytes disintegrate in the spleen and liver.
2. RBC, WBC and blood platelets are produced by bone marrow.
3. Neutrophils bring about destruction and detoxification of toxins of protein origin.
4. The important function of lymphocytes is to produce antibodies.

(a) 1 and 2 (b) 1 and 4
(c) 1 and 3 (d) 2 and 3

97.

	List – I	List– II
(A)	Pore bearing animals	(1) Arthropoda
(B)	Diploblastic	(2) Coelenterata
(C)	Metameric segmentation	(3) Porifera
(D)	Jointed legs	(4) Echinodermata
(E)	Soft bodied animals	(5) Mollusca
(G)	Spiny skinned animals	(6) Annelida

(a) A – 2, B – 3, C – 1, D – 6, E – 5, F – 4
(b) A – 2, B – 3, C – 6, D – 1, E – 5, F – 4
(c) A – 3, B – 2, C – 6, D – 1, E – 5, F – 4
(d) A – 3, B – 6, C – 2, D – 1, E – 5, F – 4

98.

	List-I (Animals)	List-II (Class/Phylum)
A.	Octopus	1. Pisces
B.	Jellyfish	2. Arthropoda
C.	Silver fish	3. Mollusca
D.	Bombay duck	4. Coelenterata

Codes:

	A	B	C	D
(a)	3	4	2	1
(b)	3	2	4	1
(c)	2	3	1	4
(d)	2	1	3	4

99.

	List-I (Organisms)	List-II (Scientific name)
A.	Man	1. *Homo sapiens*
B.	Cat	2. *Felis domestica*
C.	Cow	3. *Bos indicus*
D.	Dog	4. *Canis familiaris*

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	1	3	2	4
(c)	4	3	2	1
(d)	3	4	1	2

100. Which of the following statements is/are correct?
1. Viruses lack enzymes necessary for the generation of energy.
2. Viruses can be cultured in any synthetic medium.
3. Viruses are transmitted from one organism to another by biological vectors only.

Select the correct answer using the codes given below.
(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

101. Consider the following statements:
1. Carolus Linnaeus is the father of binomial nomenclature of organisms.
2. The word taxonomy was coined by Augustin de Candolle.

Which of the above statements is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

102. Consider the following statements:
1. The virus was discovered by Ivanovski.
2. The bacteria were discovered by Anton Van Leeuwenhoek.
3. The cell theory was proposed by Schleiden and Schwann.

Which of the statements given above is/are correct?
(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

103.

	List-I	List-II
(A)	Autotrophic nutrition	(1) Leech
(B)	Heterotrophic nutrition	(2) *Paramecium*
(C)	Parasitic nutrition	(3) Deer
(D)	Digestion in food vaculoes	(4) Green plants

(a) A – 3, B – 4, C – 1, D – 2
(b) A – 4, B – 3, C – 1, D – 2
(c) A – 4, B – 3, C – 2, D – 1
(d) A – 4, B – 1, C – 3, D – 1

104.

	List-I	List-II
(A)	Hypothalamus	(1) Estrogen
(B)	Anterior pituitary	(2) FSH and LH
(C)	Testis	(3) Testosterone
(D)	Ovary	(4) Gonadotropin releasing hormone

(a) A – 4, B – 2, C – 1, D – 3
(b) A – 2, B – 4, C – 3, D – 1
(c) A – 4, B – 2, C – 3, D – 1
(d) A – 4, B – 3, C – 2, D – 1

105.

	Column I	Column II
A.	Ligament	1. Stores fat
B.	Tendon	2. Connects bone to bone
C.	Areolar tissue	3. Connects muscle to bone
D.	Adipose tissue	4. Forms blood cells
		5. Filling tissue

Codes:

	A	B	C	D
(a)	2	3	5	4
(b)	2	3	5	1
(c)	2	3	1	4
(d)	2	4	5	1

106. Which of the following statements about transmission of nerve impulse are correct?
1. Nerve impulse travels from dendritic end towards axonal end.
2. At the dendritic end electrical impulses bring about the release of some chemicals which generate an electrical impulse at the axonal end of another neuron.
3. The chemicals released from the axonal end of one neuron cross the synapse and generate a similar electrical impulse in a dendrite of another neuron.
4. A neuron transmits electrical impulses not only to another neuron but also to muscle and gland cells.

(a) 1 and 2 (b) 3 and 4
(c) 1, 3 and 4 (d) All of these

107. Which of the following statements are true about respiration?
1. During inhalation, ribs move inward and diaphragm is raised.
2. In the alveoli, exchange of gases takes place i.e., oxygen from alveolar air diffuses into blood and carbon dioxide from blood into alveolar air.
3. Haemoglobin has greater affinity for carbon dioxide than oxygen.
4. Alveoli increase surface area for exchange of gases.

(a) 1 and 4 (b) 2 and 3
(c) 1 and 3 (d) 2 and 4

108. Consider the following statements:
1. Warm-blooded animals can remain active in cold environment in which cold-blooded animals can hardly move.
2. Cold-blooded animals require much less energy to survive than warm-blooded animals.

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

109.

	List-I		List-II
(A)	Mutation	(1)	Changes in population's allele frequencies due to chance alone
(B)	Gene flow	(2)	Differences in survival and reproduction among variant individuals
(C)	Natural selection	(3)	Immigration, emigration change allele frequencies
(D)	Genetic drift	(4)	Source of new alleles

(a) A – 1; B – 2; C – 3; D – 4
(b) A – 4; B – 2; C – 3; D – 1
(c) A – 3; B – 1; C – 4; D – 2
(d) A – 4; B – 3; C – 2; D – 1

110.

	List-I		List-II
(A)	Test cross	(1)	9 : 3 : 3 : 1
(B)	Monohybrid ratio	(2)	Tt × tt
(C)	Back cross	(3)	Tt × TT
(D)	Dihybrid ratio	(4)	3 : 1

(a) A – 2, B – 3, C – 1, D – 4
(b) A – 3, B – 4, C – 1, D – 2
(c) A – 2, B – 4, C – 3, D – 1
(d) A – 2, B – 4, C – 1, D – 3

111. Consider the following statements
1. The four nucleotide bases are not necessarily present in DNA in exact equal proportions.
2. The total amount of purines are equal to the total amount of pyrimidines.
3. DNA ligase enzyme act to hydrolyse or breakdown a polynucleotide chain into its component nucleotides.
4. Nuclease enzymes are capable of restoring an intact DNA duplex.

Which of these statements is/are correct?
(a) 2 is correct but 1, 3 and 4 are wrong.
(b) 1 and 2 are wrong but 3 and 4 are correct.
(c) 1, 2 and 3 are correct but 4 is wrong.
(d) 1 and 2 are correct but 3 and 4 are wrong.

112. Which of the following professionals are more likely to run the risk of a permanent change in their cell's DNA?
1. Researchers from carbon-14 isotope
2. X-ray technician
3. Coal miner
4. Dyer and painter

Select the correct answer from the codes given below:
(a) 2 only (b) 1, 2 and 3
(c) 1, 2 and 4 (d) 1, 3 and 4

113. Recombinant DNA technology (Genetic Engineering) allows genes to be transferred
1. across different species of plants
2. from animals to plants
3. from microorganisms to higher organisms

Select the correct answer using the codes given below.
(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

114.

	List-I		List-II
A.	Malaria	1.	Bone marrow
B.	Filaria	2.	Brain
C.	Encephalitis	3.	Muscle
D.	Leukaemia	4.	Lymph node
		5.	Blood cells

Codes:

	A	B	C	D
(a)	5	3	2	1
(b)	5	4	2	1
(c)	5	4	1	2
(d)	4	3	5	1

115.

	List-I (Disease)		List-II (Cause)
A.	Marasmus	1.	Prolonged starvation
B.	Kwashiorkor	2.	Protein deficiency
C.	T.B.	3.	Bacterial infection
D.	Hepatitis B	4.	Viral infection

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	2	1	3	4
(c)	4	2	3	1
(d)	2	4	1	3

116.

List-I (Disease)	**List-II (Cause)**
A. Night blindness	1. Vitamin D
B. Rickets	2. Vitamin C
C. Scurvy	3. Vitamin B
D. Beri-beri	4. Vitamin A

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	3	4	1	2
(c)	4	1	2	3
(d)	2	3	4	1

117.

List-I Disease	**List-II Causative agent**
A. Amoebiasis	1. *Trypanosoma gambiense*
B. Sleeping sickness	2. *Treponema pallidum*
C. Syphilis	3. *Entamoeba histolytica*
D. Bubonic plague	4. *Pasteurella pestis*

Codes:

	A	B	C	D
(a)	1	3	4	2
(b)	3	1	2	4
(c)	4	2	3	1
(d)	2	4	1	2

118. Choose the correct statements
1. *Entamoeba histolytica* is a protozoan parasite in the large intestine of human cause ascariasis.
2. *Wuchereria*, the filarial worms cause a slowly developing chronic inflammation of the organs, called elephantiasis or filariasis.
3. Bacteria like *Streptococcus pneumoniae* and *Haemophilus influenzae* are resonsible for the disease pneumonia in humans which infects the alveoli of the lungs.

(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) All of these

119. AIDS is transmitted by
1. Sexual intercourse
2. Blood transfusion
3. Mosquitoes and other blood sucking insects
4. Across the placenta

Select the correct answer from the codes given below:
(a) 1, 2 and 3 (b) 1 and 2
(c) 1, 2 and 4 (d) 1, 3 and 4

120. Consider the following diseases :
1 . Diphtheria
2. Chickenpox
3. Smallpox

Which of the above diseases has/have been eradicated in India?
(a) 1 and 2 only (b) 3 only
(c) 1, 2 and 3 (d) None

Hints & Explanations

ANSWER KEY

Level-1

1	(d)	16	(b)	31	(a)	46	(d)	61	(d)	76	(d)	91	(c)	106	(c)	121	(d)
2	(c)	17	(c)	32	(c)	47	(b)	62	(b)	77	(b)	92	(a)	107	(a)	122	(a)
3	(b)	18	(c)	33	(d)	48	(a)	63	(d)	78	(d)	93	(b)	108	(c)	123	(b)
4	(b)	19	(c)	34	(c)	49	(c)	64	(d).	79	(b)	94	(b)	109	(d)	124	(c)
5	(c)	20	(a)	35	(a)	50	(a)	65	(b)	80	(c)	95	(b)	110	(d)	125	(b)
6	(c)	21	(c)	36	(d)	51	(c)	66	(c)	81	(b)	96	(a)	111	(c)		
7	(c)	22	(b)	37	(b)	52	(b)	67	(d)	82	(c)	97	(b)	112	(a)		
8	(c)	23	(a)	38	(d)	53	(b)	68	(c)	83	(d)	98	(c)	113	(a)		
9	(d)	24	(b)	39	(d)	54	(b)	69	(d)	84	(a)	99	(b)	114	(c)		
10	(b)	25	(a)	40	(c)	55	(d)	70	(c)	85	(b)	100	(b)	115	(b)		
11	(b)	26	(a)	41	(b)	56	(d)	71	(c)	86	(c)	101	(b)	116	(c)		
12	(d)	27	(b)	42	(b)	57	(c)	72	(a)	87	(a)	102	(c)	117	(b)		
13	(c)	28	(b)	43	(a)	58	(b)	73	(d)	88	(c)	103	(c)	118	(d)		
14	(a)	29	(b)	44	(b)	59	(b)	74	(c)	89	(d)	104	(b)	119	(a)		
15	(a)	30	(a)	45	(d)	60	(c)	75	(a)	90	(d)	105	(d)	120	(d)		

Level-2

1	(a)	21	(d)	41	(d)	61	(b)	81	(c)	101	(c)
2	(c)	22	(c)	42	(c)	62	(c)	82	(a)	102	(d)
3	(c)	23	(c)	43	(d)	63	(c)	83	(b)	103	(b)
4	(b)	24	(a)	44	(d)	64	(c)	84	(d)	104	(c)
5	(a)	25	(d)	45	(b)	65	(a)	85	(b)	105	(b)
6	(c)	26	(A) → s; (B) → r, p; (C) → q; (D) → q	46	(d)	66	(a)	86	(a)	106	(c)
7	(d)	27	(A) → q; (B) → p; (C) → r; (D) → s	47	(b)	67	(c)	87	(b)	107	(d)
8	(c)	28	(A) → q; (B) → p; (C) → r; (D) → p	48	(c)	68	(d)	88	(c)	108	(b)
9	(a)	29	(A) → q; (B) → p; (C) → s; (D) → r	49	(d)	69	(b)	89	(a)	109	(d)
10	(c)	30	(A) → q; (B) → r; (C) → p; (D) → s	50	(b)	70	(d)	90	(b)	110	(c)
11	(a)	31	(c)	51	(a)	71	(c)	91	(d)	111	(d)
12	(b)	32	(A) → (q); (B) → (s); (C) → (p); (D) → (r)	52	(b)	72	(c)	92	(c)	112	(b)
13	(a)	33	(b)	53	(a)	73	(a)	93	(a)	113	(c)
14	(b)	34	(b)	54	(d)	74	(b)	94	(a)	114	(b)
15	(a)	35	(a)	55	(a)	75	(c)	95	(c)	115	(b)
16	(a)	36	(a)	56	(b)	76	(a)	96	(c)	116	(c)
17	(a)	37	(a)	57	(b)	77	(a)	97	(c)	117	(b)
18	(d)	38	(c)	58	(d)	78	(c)	98	(a)	118	(b)
19	(b)	39	(c)	59	(b)	79	(a)	99	(a)	119	(c)
20	(a)	40	(d)	60	(a)	80	(b)	100	(a)	120	(b)