CHAPTER

5

Animal Physiology

Nutrition

Nutrition is the sum of all those activities which are concerned with ingestion, digestion, absorption of digested food into blood or lymph followed by egestion. There are mainly two types of nutrition :

(a) **Autotrophic or Holophytic Nutrition** Preparation of organic food from inorganic material in organisms our body, *e.g.* All green plants, some unicellular organisms, *e.g.*, *Euglena*, *Chlamydomonas* and *Volvox* are autotrophs.

(b) **Heterotrophic Nutrition** Taking the readymade organic food material synthesized by autotrophs, is termed as heterotrophic nutrition, e.g., Parasites and saprophytes are heterotrophs.

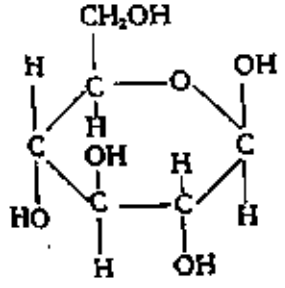
Food or Diet is the nutritive substance taken by an organism for growth, work, repair and maintaining life processes. It is a mixture of various components in which the quality and quantity of components may vary.

- The major seven components of food are as follows

(a) Carbohydrates (b) Lipids (c) Proteins
(d) Minerals (e) Vitamins (f) Water
(g) Roughage

Carbohydrates

- Carbohydrates are polyhydroxy aldehyde or ketones, usually composed of C, H and O in the ratio 1 : 2 : 1 with some exceptions.
- General formula of carbohydrates is $C_n(H_2O)_n$ (n = number of carbon atoms).
- 1 g of carbohydrate = 17 kilojoules of energy.
- Carbohydrates form about 1% of our body weight.
- Carbohydrates undergo oxidation to serve as a source of energy in the body.



Structure of Carbohydrate-Glucose

- **Categories of carbohydrates** on the basis of number of sugar units present :

Monosaccharides

Definition	Examples	Functions
These are the simple carbohydrates. They are made up of only one sugar molecule.	Glucose, fructose (honey) ribose, etc.	Glucose is the blood sugar ribose, 5-carbon monosaccharide forms the backbone of genetic molecule RNA.

Disaccharides

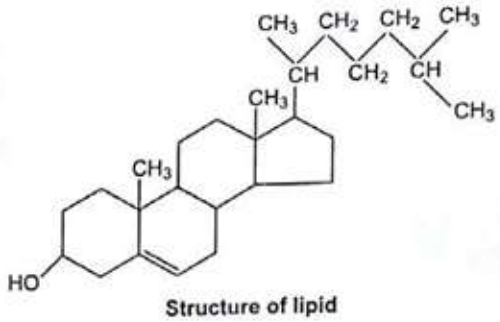
Definition	Examples	Functions
These are formed of two units of monosaccharides interlinked by glycosidic bonds.	Sucrose (Sugarcane) maltose, lactose, etc.	Sucrose is the table sugar. It is used in preparation of desserts and can also act as on food preservative.

Polysaccharides

Definition	Examples	Functions
These are formed of large number of monosaccharides interlinked by glycosidic bond.	Starch, glycogen, chitin, cellulose, hyaluronic acid, etc.	Polysaccharides serve for the storage of energy (*e.g.*, starch and glycogen) and as a structural component (*e.g.*, cellulose in plants and chitin in animals).

Lipids

- Lipids are esters of long chain fatty acids and an alcohol called **glycerol**.
- 2g of fat = 37 kj of energy.
- Animal fats are semi solid, while vegetable fats are oils.
- They are insoluble in water but soluble in non-polar solvents, *e.g.*, chloroform, benzene or ether.
- Hydrolysis of fats occurs by an pancreatic enzyme called **amylase**.



Structure of lipid

Sources of Lipids

Fats are supplied to our body by many foods as butter, ghee, cheese, milk, egg-yolk, meat, nuts, soyabean, etc.

Sources of Carbohydrates

Main sources of carbohydrates include potatoes, fruits, cereals (rice, wheat, maize), sugar, honey, bread, milk, etc.

Categories of Lipids

On the basis of presence/absence of fatty acids, lipids can be of two type :

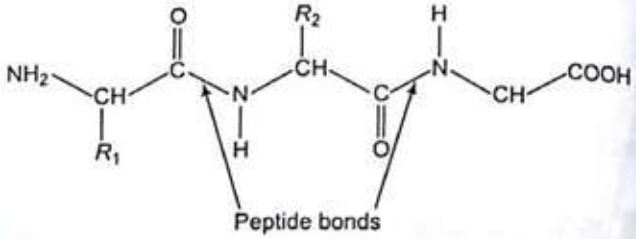
Lipids

Simple lipids	Complex lipids
(They do not contain fatty acids and are non-saponifiable).	They contain fatty acids and are saponifiable lipids as they yield soaps on alkaline hydrolysis).

- Excessive intake of fat can lead to obesity and high cholesterol level give rise to hyperchlorestrocemia resulting in cardiac damage.
- Fat deficiency results in drying of skin and deficiency of fat soluble vitamins.

Proteins

- The term proteins was given by **J Berzelius** (1938).
- Proteins are the biochemical compounds consisting of one or more polypeptides folded in a typical way.
- Polypeptide is a single linear polymer chain of amino acids bonded together by peptide bonds.
- Proteins are composed of carbon, hydrogen, oxygen and nitrogen. Some proteins also contain sulphur, phosphorus and iron.
- There are 20 essential amino acids.



Structure showing Peptide Bond between Amino Acids

Sources of Proteins

- Main sources of proteins are cereals, pulses, fishes, eggs, milk, leafy vegetables, fruits, soyabean, peas, beans, cheese, curd, etc. Deficiency of proteins causes two disease in children, *i.e.*, **Marasmus** and **Kwashiarkar**.
- Silk is protein fibre secreted by pupa of silk insect.

Some Essential Proteins

Body Proteins	Functions
Enzymes	Biocatalysts, help in biochemical reactions.
Hormones	Regulate body functions.
Transport proteins	Haemoglobin, transports oxygen throughout the body.
Structural proteins	Form cells and tissues.
Protective proteins	Antibodies, help to fight against infection.
Contractile proteins	Responsible for contraction of muscles and movements, *e.g.*, myosin, actin, etc.

- All enzymes are protein in nature.

Minerals (Inorganic Salts)

The metals, non-metals and their salt are called minerals.

- Minerals form about 4% of our body weight. In mineral nutrition, minerals are of two types :
  (a) **Macronutrients** (Needed by body in large amount), *e.g.*, calcium (Ca), phosphorus (P), potassium (K), sulphur (S), sodium (Na), chlorine (Cl) and magnesium (Mg).
  (b) **Micronutrients** (Needed by body in small amounts), *e.g.*, iodine (I), iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), cobalt (Co), fluorine (F), molybdenum (Mo) and selenium (Se).

Sources of Minerals

- Minerals are obtained from the food and drink consumed by animals. These are also present in milk, eggs, meat, fruits, vegetables and tables salts.
- Sources and functions of different minerals and their associated deficiency diseases.

Sources and Functions of Different Minerals and Their Associated Deficiency Diseases

Minerals	Daily Requirement	Sources	Functions	Deficiency Diseases
Sodium	Adequate amount in ordinary diet	Table salt, vegetables	Essential for nerve impulse conduction.	Nervous depression, improper muscle contraction.
Potassium	Adequate amount in ordinary diet	Vegetables	Required for muscle contraction and nerve impulse conduction.	Nervous disorder, poor muscles leading to paralysis.
Iron	18 mg	Leafy vegetables	Helps in oxygen transport as part of haemoglobin and myoglobin.	Anaemia.
Iodine	150 mg	Sea foods, water, onions	Essential for metabolic control as part of thyroid hormone thyroxine.	Goitre.
Calcium	1200 mg	Cereals, meat	Bone and teeth formation.	Nervous disorder.
Phosphorus	1200 mg	Meat, vegetables	Bone and teeth formation.	Tetany and rickets.
Magnesium	400 mg	Soyabean, green leafy vegetables	Activator of enzymes.	Heart disease in infants.
Zinc	15 mg	Beet, cheese	Cofactor of enzymes.	Retardation of growth and less of appetite.
Manganese	5 mg	Peanuts	Cofactor of enzymes.	Impairs glucose metabolism.
Copper	Adequate amount in ordinary diet	Peanuts, beet	Cofactor of enzymes.	Hematological and neurological disorder.
Cobalt	Traces	Meat, milk	Part of vitamin-B_{12}.	Leads to deficiency of vitamin- B_{12}.
Fluorine	Traces	Water	Prevention of dental carries.	Dental carries.
Molybdenum	Traces	Water	Part of enzyme system	Neurological damage.

Vitamins

- The term vitamin was coined by **Casimir Funk**.
- Vitamins are of two types :
  (a) **Fat soluble** Vitamin-A, D, E and K
  (b) **Water soluble** Vitamin-B complex and C
- Our body can synthesize vitamin-D and K.

Fat Soluble Vitamins

- Fat in diet is essential otherwise these vitamins will not absorbed

Vitamin-A (Retinol)

- **Steenbock** (1919) discovered the vitramin-A and **Karrear** (1931) determined the structure of vitamin-A.
- It is also called as 'anti-infective vitamin'.
- Necessary for healthy eye sight (normal vision).
- Sources are yellow or green leafy vegetables (spinach), carrot, papaya, ripe mango, maize, milk, ghee, cod liver oil, etc.
- It is destroyed by strong light.
- Deficiency causes **night blindness** (patient can not see the object in dim light) and **xeropthalmia** or **keratomalacia** (dryness and wrinkleness of outer layer of eye ball).

Vitamin-D (Calciferol)

- Also called **sun-shine** vitamin or **anti-ricket** vitamin.
- Its formation takes place under the skin in presence of sunlight.
- Needed for strong bones and teeth, helps in DNA synthesis, absorption of calcium and phosphorus.
- Sources are egg, milk, fish-liver oil, etc.
- Sunlight is the cheapest source of this vitamin.
- It affects the bones and causes **rickets** and **osteomalacia** in children and adults, respectively.

Vitamin-E (Tocopherol)

- It is also known as **beauty** vitamin.
- Acts as an oxidant, helpful in making RBCs.
- Necessary for normal functioning of reproductive system in male and female both.
- Sources are vegetable oils, wheat, cotton seed and animal food.
- Deficiency **destroys the muscles** and causes **abnormal functioning** of the **reproductive system** in males as well as in females.

Vitamin-K (Phylloquinone)

- **Henirk Dam** (1935) discovered it.
- Also called as **napthoquinone** and is synthesized in body by some bacteria.
- It is a coagulation vitamin.
- It helps in clotting of blood.
- Sources are cauliflower, spinach, tomatoes, soyabean, etc.
- Deficiency delays clotting of blood and causes haemorrhage.

Water Soluble Vitamins

Vitamin-B_1 (Thiamine)

- Name B_1 was given by **Funk**.
- Destroyed on cooking and dissolves in cooking water.
- Helps in normal functioning of nerve cells and metabolism.
- Helps in maintaning normal appetite and digestion.
- Sources are yeast, rice, wheat, grains, beans, soyabean, liver oil, milk, etc.
- Deficiency causes **beri-beri** (loss of appetite, paralysis of legs and head, etc).

Vitamin-B_2 (Riboflavin)

- Destroyed on cooking and in strong sunlight.
- It helps in protein and fat metabolism.
- It is necessary for normal growth of body.
- Sources are milk, eggs, liver, green leafy vegetables, pulses, cheese, etc.
- Deficiency causes inflammation of tongue, cornea, cracks appear at the corner of the mouth.

Vitamin-B_5 (Pantothenic acid)

- Sources include yeast, peas, liver, eggs, kidney, etc.
- It is a part of coenzyme-A required for cell respiration, normal nerves and skin.
- Deficiency can lead to anaemia, dermatitis and nerve degeneration.

Vitamin-B_3 (Niacin or Nicotinic Acid)

- Also known as **anti-pellagra** factor.
- Helps in oxidation of carbohydrates, proteins and fats.
- Sources are cereals, liver, maize, fruits, milk, egg, meat, yeast, kidney, etc.
- Deficiency causes **pellagra, dermatitis, diarrhoea.**

Vitamin-B_6 (Pyridoxine or Pyridoxal)

- Sources include meat, milk, liver, eggs, etc.
- It is an essential part of coenzymes for amino acid synthesis.
- Deficiency can lead to disturbance of central nervous system and anaemia.
- Extreme excess of this vitamin leads to poor control and coordination.

Vitamin-H (Biotin)

- Sources include fruits, vegetables, liver, milk, eggs, etc.
- Serves as coenzyme for fatty acid synthesis.
- Deficiency can lead to scaly and itchy skin, muscle pain and weakness.

Vitamin-B_9 (Folic Acid)

- Essential for growth and maturation of red blood cells.
- Sources are green leafy vegetables, yeast, banana, pulses, cauliflower, meat, liver, etc.
- Deficiency causes **macrocytic anaemia** in man.

Vitamin-B_{12} (Cyanocobalamine)

- Also known as **cobamide cyanide.**
- Helps in RBC formation and proper functioning of nerve tissues.
- Sources are liver, cheese, milk, meat, fish, eggs, kidney, etc.
- Deficiency leads to **pernicious anaemia.**

Vitamin-C (Ascorbic Acid)

- It is an earliest known vitamin.
- Essential for keeping teeth, gums and body joints healthy.
- It prevents the formation of stones in gall-bladder.
- It is quickly and easily destroyed by heat.
- It increases resistance of our body against infections, *i.e.*, viral infections and common cold.
- Sources are amla, citrus fruits (lime, lemon, orange), guava, tomatoes, peppers, etc.
- Deficiency leads to **scurvy** (bleeding and loosing of gums)

Water

- It is an inorganic compound made up of hydrogen and oxygen.
- Human body contains about 65% water.
- It regulates body temperature by sweating and evaporation.
- It helps in digestion, transportation and excreting body wastes.
- Sources are metabolic water, liquid food and drinking water.
- Abnormal depletion of body fluid leads to dehydration (loss of water).

Roughage

- It is fibrous material present in plants.
- It does not take part in growth as we can not digest it.
- It adds bulk in food item, to prevent constipation.
- It helps in retaining water in body and aids in proper working of digestive system.
- Sources are salads, outer layers of grains cereals vegetables and porridge (Dalia).

Balanced Diet

- A diet which contains all the essential nutrients in required quantity. It is related to state of one's age, health and occupation.
- Body requires carbohydrates, proteins and fats in the approximate ratio of 4 : 1 : 1.

- Growing child needs more protein than a grown up man. Person doing physical work (athelete, carpenter, rikshaw puller, etc) need more carbohydrates and fats.
- A pregnant woman needs more proteins, calcium, potassium in her diet. Person recovering from illness need more proteins, minerals and vitamins. The eating of a particular type of diet due to food habit leads to deficiency diseases.
- Balanced diet contains all essential components of food.

Digestive System

- Parts of body concerned with digestion, absorption and assimilation of food followed by elimination of undigestible remains is called digestive system.
- Digestion involves splitting of food molecules by hydrolysis into smaller molecules that can be absorbed through the epithelium of the gastro-intestinal tract.
- Man and other animals have holozoic nutrition (i.e., solid form of food).

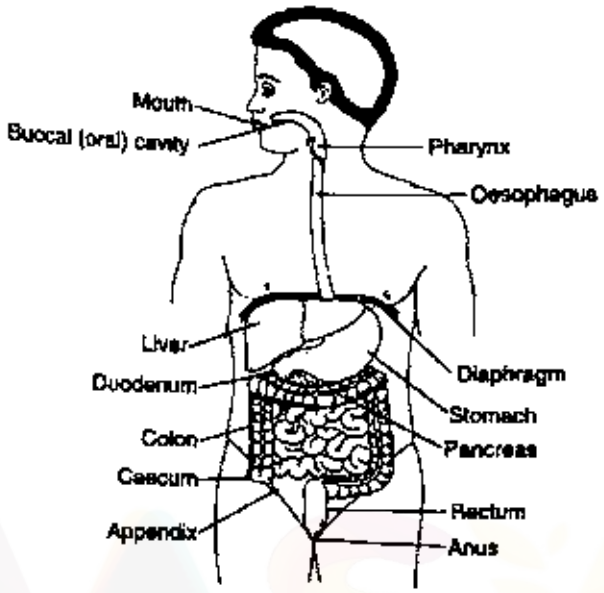
Dentition

- There are 32 permanent teeth in man.
- These are of four type
  Incisors (for cutting) four in numbers.
  Canines (for tearing) two in numbers.
  Premolars (for grinding) four in numbers.
  Molars or **check teeth** (for grinding) six in numbers.
- In elephants, the tusks are the incisors of upper jaw.
- Maximum number of teeth are present in **horse** and **pig**.
- Hardest part in the body is tooth enamel.
- Main bulk of tooth is formed of dentine.

Dental Formula of Some Common Mammals

Mammal	Dental Formula	Total Number of Teeth
Man (child)	2102/2102	20
Man (adult)	2123/2123	32
Horse	3143/3143	44
Dog	3142/3143	42
Cow and sheep	0033/3133	32
Cat	3121/3121	30
Rabbit	2033/1023	28
Mouse	1003/1003	16

- Salivary glands secrete mucus to moist the food and to digest starch.
- pH of saliva = 6 – 7.4
- pH of gastric juice = 4.5
- The opening of stomach into small intestine is called pylorus. Alcohol is easily diffusible across the plasma membrane.
- Digestion process takes place in following five steps :
  (a) Ingestion of food
  (b) Digestion of food
  (c) Absorption of digested food
  (d) Assimilation
  (e) Egestion of unwanted food



Structure of Digestive System

Ingestion of Food

- Food is taken through mouth cavity.
- Ingestion takes place in buccal cavity.
- Salivary glands lubricate the food and bind the food particles together to form bolus.
- Salivary gland have starch splitting enzyme ptyalin.
- It is masticated by teeth and swallowed.

Digestion of Food

- Process of converting complex, insoluble food particles into simple soluble and absorbable form is called **digestion.**

Digestion in Mouth

- In mouth, salivary amylase acts on starch.

Starch (Complex form) $\xrightarrow{\text{Ptyalin}}$ Maltose (Simple form)

Digestion in Stomach

- The food passes down through the oesophagus into stomach.
- Now food is mixed with gastric juice and hydrochloric acid which disinfect the food and creates acidic medium.
- Pepsin digests proteins and converts them into peptones.
- Renin converts milk to curd.
- Digested food now is called **chyme.**

Digestion in Small Intestine

- Chyme moves to duodenum.
- In small intestine, food receives three alkaline secretions-bile from liver pancreatic juice from pancreas and intestinal juice from intestinal glands.

Bile

- In small intestine, food receives three alkaline secretions bile from liver, pancreatic juice from pancreas and intestinal juice from intestinal glands.
- Food is mixed with bile (liver) to breakdown fats into smaller globules.

Pancreatic Juice

- Swallowing means passage of food bolus from the oral cavity to stomach.
- Trypsin acts upon proteins and breaks them into peptides.
- Amylase converts starch into simple sugar.
- Lypase converts fats into fatty acids and glycerol.

Intestinal Juice

- Food passes into ileum and mixes with intestinal juice.
- Maltase converts maltose into glucose.
- Lactase converts lactose into glucose.
- Sucrase converts sucrose into glucose.
- Food now is called **chyle.**

Absorption and Assimilation of Digested Food

- Ileum's internal surface has finger-like folds called villi.
- There is a dense network of blood capillaries and lymph capillaries in each villus. It helps in absorption of food.
- Absorption occurs by two types of processes–**Passive** and **active absorption**.
- **Passive absorption** occurs down the concentration gradient and **active absorption** is independent of concentration gradient.
- Assimilation is followed thereafter, i.e., the absorbed food materials are in corporated into tissue cells.

Egestion of Unwanted Food

- Digested food passes into large intestine.
- Large intestine can not absorb food, but absorbs much of the water.
- The remaining semi solid waste is called faeces and is passed into rectum. It is expelled out through anus.

Respiration

- Respiration is an oxidizing and energy liberating process, during which complex organic compounds are broken down into simple substances.
- It is brought about by respiratory organs.
- Respiratory organs are different in different animals :

Lungs In man, frog, birds, lizards, camel and cattles, etc

Skin In frog, earthworm.

Gills In fishes, prawn.

Trachea In insects.

General body surface In *Amoeba, Euglena, Chlamydomonas, Spirogyra.*

Types of Respiration

Aerobic Respiration

- The process in which respiratory substrate are oxidized into CO_2, water and energy, in the presence of oxygen.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 2870\ kJ$$

- This is common in higher organisms.
- 1 molecule of glucose is converted into 2 molecules of pyruvic acid, the process is known as **glycolysis.** It takes place in cytoplasm of cells.
- Pyruvic acid releases energy + CO_2 + H_2O (Krebs' cycle).
- 1 molecule of glucose = 36 ATPs in eukaryotic cell.
- 1 molecule of glucose = 38 ATPs in prokaryotic cell.

Anaerobic Respiration (Fermentation)

- The process in which the respiratory substrate are incompletely oxidized into CO_2 and alcohol.

$$C_6H_{12}O_6 \xrightarrow{\text{Yeast}} 2CO_2 + 2C_2H_5OH + 56\ kcal.$$

- It occurs in lower organisms as bacteria and fungi and in higher organisms under the condition when O_2 is limiting.

Respiratory Quotient (RQ)

The ratio of volume of CO_2 evolved to volume of O_2 consumed in respiration is called RQ.

$$RQ = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ consumed}}$$

R Substrate	RQ
Carbohydrates	1
Fats	0.7
Organic acids	4

Respiration in Man

- Respiration in animals takes place in two phases:

(i) External respiration (Breathing) → Ventilation of lungs.

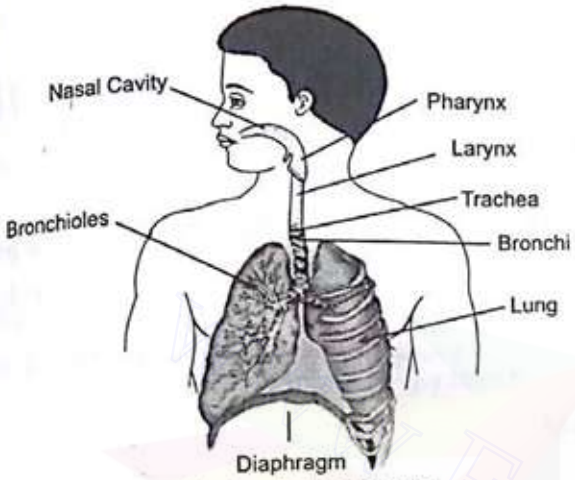
(ii) Internal respiration → Oxidation of food.

External Respiration (Breathing)

- It comprises of **inspiration** and **expiration** of air.

Inspiration

- In this process, intake of air takes place. Muscle of the diaphragm contract and diaphragm flattens.
- The lower ribs are raised upward and outwards.
- The chest cavity enlarges, the air pressure in the lungs is decreased, air rushes into the lungs.



Human Respiratory System

Expiration

- Breathing out of air.
- Relaxation of muscles of the ribs and diaphragm takes place. Diaphragm again become dome-shaped.
- Chest cavity is reduced and air is forced outward through nose and trachea.
- Breathing rate man = 18-20/min

Internal Respiration

- Complex process in which food is broken down to release energy.
- Biochemical phase takes place inside the cell.
- Overall passage of air in man is as follows :
- Nostrils → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Alveoli → Cells → Blood.

Circulatory System

- Circulation of body fluids is also referred to as **circulatory system** or **internal transport.**
- In higher and multicellular organisms, there is no direct supply of the useful materials and the removal of wastes from the body cells so they need a transport system called, circulatory system.
- It transports nutrients like glucose, fatty acids, vitamins, etc., from the site of absorption to the different parts of the body.
- It transports nitrogenous wastes like ammonia, urea, uric acid, etc., from different part of the body to organ of direction.
- It transports hormone from the endocrine glands and target organs.
- It transports water and other chemical substances all over the body.
- It transports oxygen to different cells and tissues of the body from the lungs.

Blood Vessels

- These are elastic musular tubes that carry blood. These are:

Arteries

- Thick walled blood vessels.
- Carry the blood away from the heart to various body parts.
- Deep seated in body and have no valves in them.
- Carry oxygenated blood in them, except the pulmonary artery which carries deoxygentated blood to the lungs.
- Blood flows at high pressure and high speed.

Veins

- Thin walled blood vessels.
- Carry blood away from various body parts to the heart. Superficial in position and have valves in them to prevent back flow of blood in them, blood flows at low pressure and lower speed.
- Carry deoxygenated blood in them, except the pulmonary vein which carries oxygenated blood to the heart.

Capillaries

- These are the thinnest blood vessels.
- Capillaries connect arteries to the veins.
- Each capillary is lined by a single layer of flat cells.
- These help in exchange of materials like the nutrients, gases, waste products, etc., between blood and cells.

Types of Blood Vascular System

- Blood vascular system is of two types :

Open Circulatory System

- Blood may be present in blood vessels for sometimes, but finally comes out from the blood vessels in open spaces called sinuses.
- Found in leeches, among the annelids, cockroach, prawns, insects, spiders, starfish, etc.
- Blood flows with very slow velocity and at low pressure.
- In cockroach, blood circulation is completed in 5-6 minutes.
- Blood is in direct contact with the tissues.
- Respiratory pigment if present is dissolved in plasma.

Closed Circulatory System

- Blood flows in closed vessels.
- It is found in earthworm, *Neries*, molluscs and all vertebrates.
- Blood flows with high speed and at high pressure.

- Exchange of materials occur through the tissue fluids.
- Blood does not comes in direct contact with tissue cells.
- Respiratory pigment is present in RBCs.

Blood Vascular System

- Blood vascular system consists of three components :
  (a) Blood (b) Blood vessels and (c) Heart

Blood

- Blood is red vascular connective tissue.
- An average adult person has about 4-6 litres of blood.
- It forms 6-10% of body weight and 30-35% of extracellular fluid.
- The study of blood is called haematology.
- People at higher altitudes have more blood than those at lower altitudes. This extra blood supplies the additional oxygen to body cells.
- Blood have specific gravity of 1.06.
- It has a saltish taste and is mildly alkaline with a pH =7.4
- It is bright red when oxygenated and purple when deoxygenated.
- It is sticky and opaque fluid with a viscosity of 4.7.

The blood is formed of two parts :
(a) Plasma (b) Blood corpuscles

Plasma

- Plasma is faint yellow coloured non-living fluid.
- It is slightly alkaline and viscous.
- It constitutes about 55-60% of the blood volume.
- It is composed of :

Water	— 90-92%
inorganic salt	— 1-2%
Plasma protein in colloidal state	— 6-7%
Other organic compounds	— 1-2%

Functions

- It transports simple food components (glucose, amino acids etc.) from intestine and liver to other body parts.
- It transports metabolic wastes like urea, uric acid, etc., from body tissues to the kidneys or their excretion.
- It transports hormones from endocrine glands to the target organs.
- It helps in keeping a constant pH of blood.
- Blood proteins and fibrinogen, present in plasma, help in blood clotting at the injury.
- It forms the tissue fluid which keeps the tissue moist and helps in exchange of material in between the blood and cells.

Blood Corpuscles or Blood cells

- Blood contains certain floating bodies called formed elements. These floating elements includes blood corpuscles or blood cells.
- These form 40-45% of blood.
- The percentage of blood cells is called **haematocrit value** of packed cell volume.
- They are of three type :
  (i) Red Blood Corpuscles (RBCs) or **erythrocytes.**
  (ii) White Blood Corpuscles (WBCs) or leucocytes.
  (iii) Blood **platelets.**

Red Blood Corpuscles (RBCs) Shape

- In all vertebrates except mammals, these are oval, biconvex and nucleated.
- In mammals except camel and lama, the mature RBCs are circular, biconcave and non-nucleated.

Number

- The RBCs are much more in number than WBCs.
- Normal RBC count is slightly lower in a woman (*i.e.*, 4500000/cu mm) than a man (*i.e.*, 5000000/ cu mm).
- The instrument used to determine RBC count is **haemocytometer.**
- Physiological state and high altitudes increase the RBC count.
- RBC count decreases due to haemorrhage, haemolysis, etc., and is called **anaemia.** If RBC increases much more than the normal level, it is called polycythemia.

Life Span

- Average life span of human RBC is 120 days while 100 days in frog and 50 to 70 days in rabbit.
- **Haemoglobin** (*Haem* = Iron containing pigment, *globin* = protein). One RBC has about 280 haemoglobin molecules.

Structure

- A red blood cell is bounded by elastic semipermeable membrane.
- It do not possess cell organelles. This feature enable it to hold more haemoglobin die to, availability of space.

Erythrocytes

Colour

- RBC appears yellow when seen singly but these appear red when in bulk due to haemoglobin.

Formation

- In the developing foetus, the formation of RBC takes place in liver and spleen while after the birth, RBCs are mainly produced in the bone marrow.

- Maturation of RBC is controlled by folic acid and vitamin-B_{12}. The excess of RBCs are stored in the spleen which acts as a blood bank of the body.

Functions

- Haemoglobin helps in maintaining a constant pH.
- Haemoglobin also transports carbon dioxide from the tissues to the lungs.
- Haemoglobin carries oxygen from the lungs to body tissues.

White Blood Corpuscles (WBCs)

Shape

- These are rounded or amoeboid (irregular), nucleated, non-pigmented cells. WBCs are larger in size than RBCs.

Number

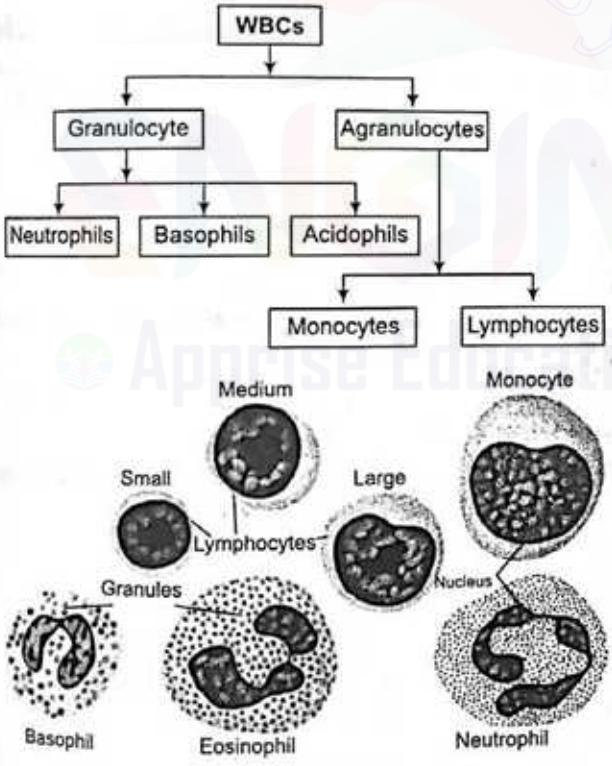
- WBCs are much less in number than RBCs (1 : 6).
- Leukemia (Blood cancer) is a pathological increase in number of WBCs.
- Fall in WBC count is termed as leucopenia

Colour WBC's are colourless.

Formation WBC's are formed in red bone marrow.

Life span WBC's survive for 8-96 hours only.

Classification of WBC's



Structure of WBC

Granulocytes

- These are about-65% of total leucocytes.
- These are sub-divided on the basis of shapes of their nuclei and the staining reactions of their granules.

Neutrophils

- These are about 62% of total number of WBCs.
- The cytoplasm of these contains fine granules which stain with both acidic and basic dyes and thus, appears violet in colour.
- The nucleus is 3-5 lobed.
- Their life span is of 10-12 hours.
- These also help in sex-differentation.
- These act as soldiers of body.

Basophils

- These take up the basic stain such as methylene blue.
- These are also called cyanophils.
- The cytoplasm granules are coarse which appear blue in colour.
- The nucleus is 2 or 3 lobed or S-shaped.
- Their life span is 8-12 hours.
- These secrete heparin and histamine thus, help in local anti-coagulation.

Acidophils

- These stain with acidic dyes such as eosin.
- These are also called eosinophils.
- Their life span is of 14 hours.
- These increase in number in allergic diseases.
- These help in healing of wounds.

Agranulocytes

- Agranulocytes are also called mononuclear cells.
- These form about 35% of the total WBCs.
- These are divided in two sub-types.
- Formation of agranulocytes is also called agranulopoiesis.

Monocytes

- These are the largest sized leucocytes.
- These form about 5.3% of all the leucocytes.
- The nucleus is oval, kidney or horse shoe-shaped and is excentric.
- These are formed in the lymph-nodes and the spleen.
- These are highly motile.
- Their life span is of 3-4 days.

Lymphocytes

- These form about 30% of leucocytes.
- Their nucleus is large and rounded so that cytoplasm forms a thin peripheral layer. These are formed in the thymus, lymph nodes, spleen, tonsils, etc.
- Their life span is of 3-4 days.

- These produce antibodies and opsonin so plays an important role in immune system.

Blood Platelets

- **Shape** These are oval-shaped and possess discoidal cytoplasmic fragments.
- **Number** Their number varies from 250000-5000000.
  A decrease in the number of platelets in the blood is called thrombocytopenia.
  Increase in number of blood platelets is called **thrombocytosis**.
- **Structure** Platelets are flat, non-nucleated large cells in the bone marrow.
  They are bounded by a membrane and contain few organelles in cytoplasm. These play an important role in blood clotting.
- **Colour** They are colourless.
- **Formation** They are formed in red bone marrow.
- **Life span** Their life span is of about one week.

Blood Groups

- **Landsteiner** recognized three kinds of blood groups 'A', 'B' and 'O'. Fourth and most rare 'AB' blood group was discovered by **Von Decastello** and **Sturle** (1902).
- **Landsteiner** (1900) discovered two kinds of antigens called A and B. Antigens A and B are not proteins but are mucopolysaccharides.

Characteristics of Human Blood Groups

Blood Group	Antigens in RBCs	Antibodies in Plasma	Can Donate to Groups	Can Receive from Groups
A	A	Anti-b	A, AB	O, A
B	B	Anti-a	B, AB	O, B
AB	A and B	None	AB	O, A, B, AB
O	None	Anti-a Anti-b	O, A, B, AB	O

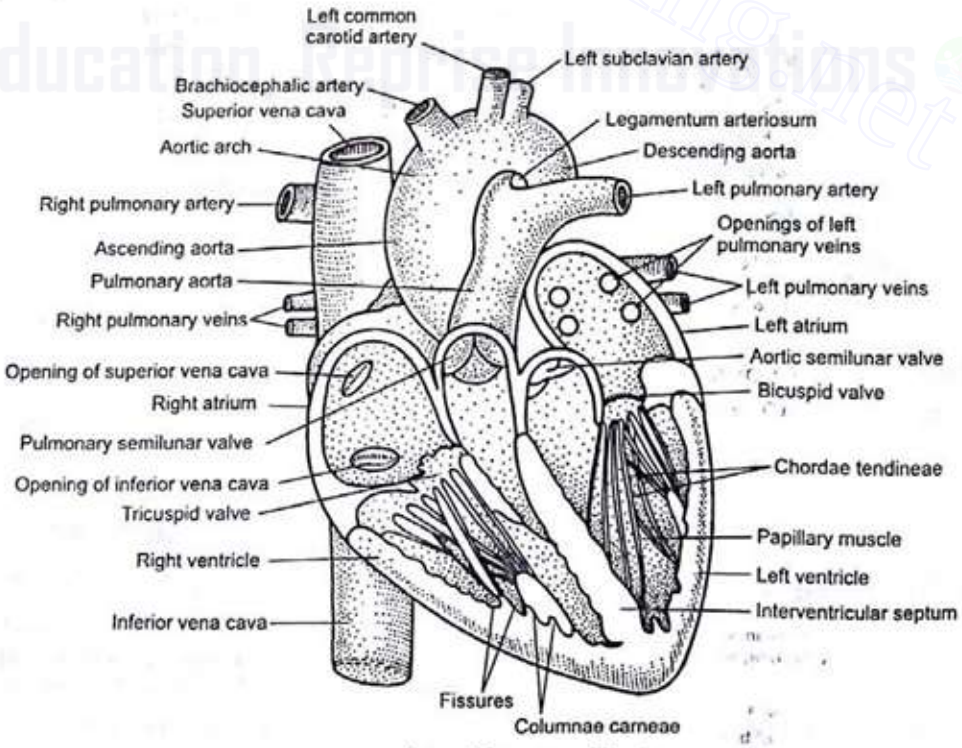
- Persons of 'O' blood group are called as **universal donors,** as they can donate blood to all. Persons of 'AB' blood group are called as **universal recipients,** as they can receive blood.

Rh Factor

- Rh factor was first of all reported in RBCs of a monkey by **Landsteiner** and **Weiner** in 1940.
- Rh factor is actually the Rh antigen present on the surface of red blood cells. Person having Rh factor is called Rh^+ and without Rh factor is Rh^-. For an example if person of blood group A has Rh antigen on surface of RBC, then he is A^+/A positive. About 85% of world's people are Rh^+ and of Rh^-.
- Percentage of Rh^+ people in India is 97% of the population.
- Rh factor is found in man and rhesus monkey, it not reported from other animals.
- Human do not produce the and the body naturally.

Heart

In amphibians, heart is three chambered. Reptilian heart is structurally three chambered but is functionally four chambered (i.e., incompletely four chambered) except in crocodile.



Internal Structure of Heart

- In crocodile, brids and mammals the heart is divided into four chambers (two auricles and two ventricles).
- Every perosn's heart is of about the same size as that of person's fist. The human heart is four chambered–two auricles and two ventricles.
- A thin, muscular wall called the inter-atrial septum separates the left and right atria whereas thick walled inter-ventricular septum separates the right and left ventricles.
- The atrium and ventricle of same side are separated by atrio-ventricular septum.
- Opening between right atrium and right ventricle is tricuspid valve, formed of 3 cusps.
- Opening between left atrium and left ventricle is called bicuspid/mitral valve.
- Pulmonary artery and aorta are provided with semilunar valves to prevent back flow of blood.
- Sino-Atrial Node (SAN) is present in right upper corner of right atrium. Atrio-Ventricular Node (AVN) is present in lower left corner of right atrium.

Cardiac Cycle

- The sequence of events, which occur from the beginning of one heart beat to the beginning of next is called cardiac cycle. Systole refers to contraction and diastole to relaxation.
- Single cardiac cycle involves four steps :

Atrial Systole

- Right atrium receives deoxygenated blood from superior and inferior vena cava.
- Left receives oxygenated blood through pulmonary veins.
- This is followed by atrial systole.

Ventricular Filling

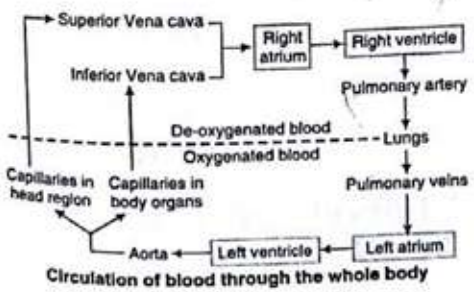
Nearly 1/3 of ventricle is filled following atrial systole.

Ventricular Systole

- Action potential pass from SAN to AVN leading to ventricular systole. Right ventricle supplies blood to pulmonary arteries carrying deoxygenated blood to lungs.

Ventricular diastole

- Semilunar valves close to prevent back flow of blood.
- AV valve opens to allow blood to pass from atria to ventricles again.
- Left ventricles supply oxygenated blood to aorta which in turn supplies blood to various body parts.



Circulation of blood through the whole body

Blood Pressure (BP)

- The pressure created by the blood on the walls of the blood vessels due to the repeated pumping of heart is called blood pressure.
- It can be felt at certain places in our body *viz.* wrist of the hands, etc.
- The rate of pulsation increases during excitement.
- Blood pressure is recorded as systolic/diastolic.
- Blood pressure in a normal person = 120/80 mm Hg.
- Factors affecting blood pressure are age, cardiac output, total peripheral resistance, etc.
- If a person has persistent high blood pressure then it is called hypertension and persistent high blood pressure is 150/90 mm Hg. Factors responsible are over eating, fear, worry, anxiety, sorrow, etc.
- Hypotension is condition of low blood pressure, *i.e.*, presistent 100/50 mm Hg.
- ECG or Electrocardiogram is graphic record of the electric current produced by the excitation of cardiac muscles.
- The normal rate of heart beat at rest is about 72-80 times per minute.
- In a newly born baby, heart beat rate is about 140 times per minute.
- During heavy exercises, it may be high as 170-200 times per minute.
- Sphygmomanometer measure BP. It is composed of an inflatable cuff to restrict blood flow and a manometer or mercury to measure pressure.

Excretory System

- The process of removal of nitrogenous wastes from the body is called excretion. The organs of excretion are called excretory organs.
- The nature of nitrogen containing wastes and their excretion varies among the species depending upon the availaibility of water.

Excretory Organs in Different Animals

- **Plasmalemma** Protozoans like *Amoeba*.
- **General body surface** Porifera (sponges), coelenterates (*Hydra*).
- **Flame cells** Platyhelminthes (*Taenia*, Fasciola).
- **Nephridia** Annelida
- **Malpighian tubules** Arthropods (cockroach)
- Coxal gland Spiders
- **Kidney** Main excretory organ in all vertebrates.
- Antennal gland or green gland Crustaceans crayfish.

Types of Excretion

Depending upon the form of nitrogenous waste excreted there are three modes of excretion:

Ammonotelism

- Main nitrogenous end product (waste) is ammonia.
- Ammonotelic excretion is found in aquatic animals like protozoans, *e.g., Amoeba, Paramecium*, sponges (*e.g., Sycon*) colenterates (*e.g. Hydra*), aquatic arthropods (*e.g., Prawn*), most aquatic molluscs (*e.g., Pila*), bony fishes (*e.g., Labeo*) and frog's tadpole.
- Organisms showing ammonotelism are ammonotelic.

Ureotelism

- Main nitrogenous waste is urea.
- Ureotelic excretion is found in those animals which can take in water and can retain considerable amounts of urea in their blood.
- It is a common method of excretion in man, whales, seals, camels, kangaroo, toads, frogs, sharks, etc.
- Urea is formed in liver by detoxification of ammonia *via* urea cycle.
- Urea is transported in the blood by blood plasma.

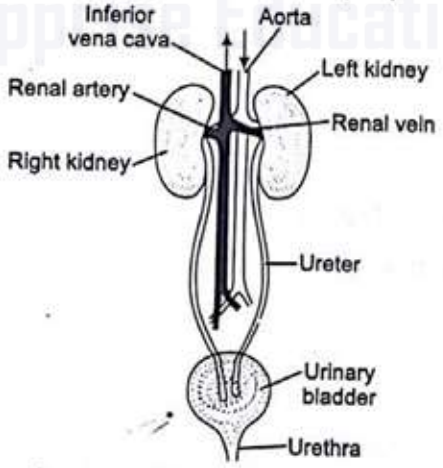
Uricotelism

- Main nitrogenous waste is crystals of uric acid.
- It is common in birds, land reptiles (snakes and lizards), insects, snails, etc.
- Uric acid is least soluble in water and is less toxic.
- Formed from ammonia in the liver of urecotelic animals and Malpighian tubules in insects.
- Organisms showing uricotelism are uricotelic.

Excretory System of Man

Excretory system of man consists of the following parts.

(a) Kidneys (two) (b) Ureter (two)
(c) Urinary bladder (one) (d) Urethra (one)



Structure of Human Excretory System

Kidneys

- It is bean-shaped, chocolate brown structure lying in the abdomen, one on each side of the vertebral column just below the diaphragm.
- The left kidney is placed a little higher than the right kidney (but reverse in rabbit).
- Concavity of kidney called hilum or hilus, is always inward directed.
- These form the urine and controls osmotic pressure within the organism with respect to external environment.

Ureters

- A pair of narrow tube arising from the hilum is called ureter.
- It is about 30 cm in length.
- There bring the urine down wards and open into urinary bladder.

Urinary Bladder

- Each ureter opens in urinary bladder.
- It temporarily stores the urine.
- It can hold about 0.5-1.0 litre of urine.
- It is absent in birds.
- In both reptiles and birds, ureters and rectum open into a common sac called cloaca.

Urethra

- It is a muscular and tubular structure which extends from neck of bladder to outside.
- In females, this tube is small and servers as a passage of urine only.
- In males, it is long and functions as a common passage for urine and spermatic fluids.

Structure of a Nephron

- It is structural and functional unit of kidney.
- These are also called as renal tubules or uriniferous tubules.
- These are one million in each kidney.
- Each nephron is about 6 cm long.
- It is differentiated into four regions.
  (a) Bowman's capsule.
  (b) Proximal Convoluted Tubule (PCT).
  (c) Henel's loop 'U'-shaped.
  (d) Distal Convoluted Tubule (DCT).

Bowman's Capsule

- It is double walled cup and is lined by thin flat cells called podocytes.
- It contains group of capillaries called glomerulus.
- Glomerulus in the kidney acts as a dialysing bag.

Proximal Convoluted Tubule (PCT)

- It is highly coiled (convoluted) tubular strucutre.

- It is about 12-24 mm in length.
- Almost whole of vitamins, glucose, amino acids, sodium and potassim, etc., is reabsorbed by active transport.

Henle's Loop

- It is 'U'-shaped segment. Loop of Henle is long in mammals and birds which secrete hypertonic urine, but short in other vertebrates like reptiles, etc.

Distal Convoluted Tubule (DCT)

- It is connected to the collecting duct.
- Active reabsorption of some Na^+ takes place.
- It is impermeable to H_2O.

Urine

- Urine is formed by glomerular filtration, reabsorption and secretion. It is pale yellow coloured fluid due to presence of urochrome pigment.
- It is acidic in nature and is slightly heavier than water.
- It has a faint aromatic odour due to urinod.
- Daily urine output in normal adult is 1.5-1.8 litres.
- **Chemical composition of urine** Water is 95-96%, urea is 2% and some other substance like uric acid, creatinine, etc., are 2-3%.

Skeleton System

The human skeleton consists of both fused and individual bones supported and supplemented by ligaments, tendons, muscles and cartilage. It is divided into two parts:

Axial Skeleton (80 Bones)

- It includes skull, vertebral column and bones of chest.
- Vertebral column is responsible for the upright position of the human body.
- Most of the body weight is located in back of the spinal column. It provides flexibility to the neck and protection to spinal cord. The total number of bones of head 29.
- The total number of bones in vertebral column, initially 33 and after development 26.
- The total number of bones of ribs 24.

Appendicular Skeleton (126 Bones)

- Their functions are to make locomotion possible and to protect the major organs of locomotion, digestion, excretion and reproduction.

Nervous System

- The nervous system provides the fastest means of communication within the body so that suitable response to stimuli can be made at once.
- Nervous system is found only in animals and absent in plants.
- Nervous system controls the body by using a series of tissues throughout the body formed by a network of electrically conducting cells called neurons or nerve cells.

Neurons are of three types :

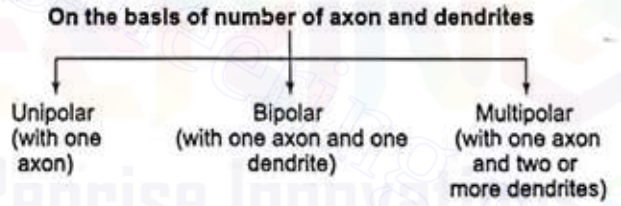
- **Motor** Conducts messages from central nervous system to effector organs.
- **Sensory** Conducts information from sensory organ to cental nervous system.
- **Mixed** Works both as sensory and motor neuron.

Structure of Neuron

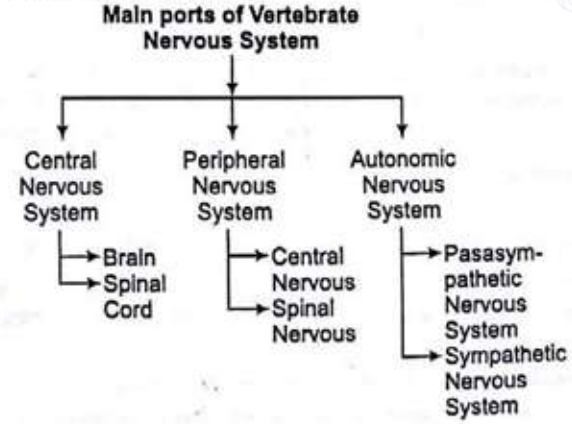
- A neuron is a microscopic structure composed of three major parts namely, cell body, dendrites and axon.
- **Dendrites** Cytoplasmic processes from cell body. They carry impulses towards cell body.
- **Cell body** Also called cyton or soma.
- It contains cytoplasm and certain granular bodies called Nissl's granules.
- **Axon** Single long extension of cell body and are protected by neurilemma.
- Synapse is the junction between the dendrites of one neuron with axon terminal knobs of other neuron.

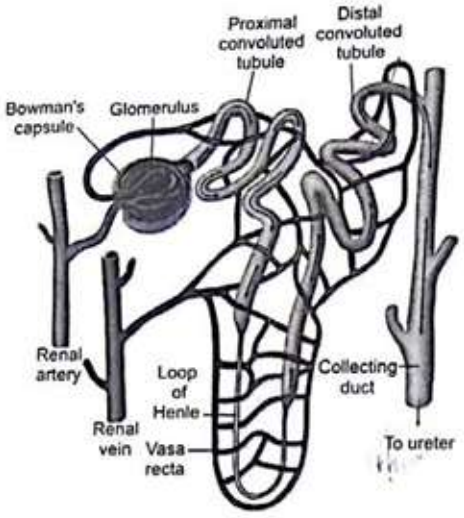
Classification of Neuron/Nerve Cell

- **Myelinated** Axon is composed of Schwann cell coated by myelin sheath. The gap between adjacent myclin sheath is called nodes of Ranvier.



- **Non-myelinated** Axon is composed of Schwann cells not enclosed by myclin sheath.



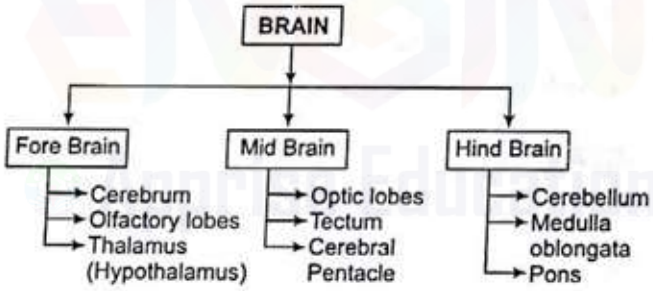


Nervous System

Central Nervous Nervous System

- It consists of brain and spinal cord.
- Gray matter is made up of cell bodies of neuron and white matter has only nerve fibres.
- Brain lies in the cranial cavity of skull.
- Brain and spinal cord are covered by two meninges in frog and three meninges in mammals. Cerebrospinal fluid is present in and around brain and spinal cord.

Human Brain



- **Olfactory lobes** are pair of small sized structure, completely covered by cerebrum. These are the centre of skull.
- **Cerebrum** is the largest part of the brain covered by cerebral hemispheres. The roof of cerebrum is cerebral cortex. Cerebrum leads to consciousness, storage of memory of information.
- **Thalamus** is for integrity of sensory impulses sent from sense organ like eyes, ears and skin.
- Thalamus deals with pain, pressure and temperature.
- **Broca's area** is present in brain and is related with speech while wernick's area of brain is related with understanding speech.
- **Hypothalamus** deals with water balance in body, behavioural patterns of sex, sleep, stress empotions etc. It also regulates pituitary hormones and metabolism of fat, carbohydrate and water.
- **Mid brain** deals with visual analysis, auditory, etc.
- **Cerebellum** is in the bottom part of the head and back of it.
- **Cerebellum** controlls coordination of accurate movements and balancing.
- **Medulla oblongata** is long connecting part of brain to spinal cord. It deals with control of heart beats, blood vessels, breathing, salivary secretion and most of reflex and involuntary (uncontrolled) movements.
- Pons varolii is an oral mass that lies above medulla oblongata. It interconnects two cerebrellar hemispheres and also join the medulla with higher brain centres.

Spinal Cord

- It is long cord-like structure at the back, centrally located and well protected by bony vertebral column.
- It give out 31 pairs of spinal nerves in man.
- It deals with impulses to and from the brain and is the centre for reflex actions.

Reflex Action

- It is unconditional, inborn, unlearned reflex to a stimulus.

  Examples Blinking of the eye when and object comes near to our eyes suddenly; rapid withdrawl of hand while burned; sneezing coughing, yawining, knee jerk reflex, etc.
- Reflex actions are quick and fast.
- They follow the shortest route for quick response.
- These are mostly protective in function.

Acquired Reflex Action

- It is also called as conditioned reflex and dependent on past experience, training and learning.
- First demonstrated by **Ivan Petrovitch Pavlov** in hungry dog.

  Examples Learning of dancing, cycling, swimming, singing and driving, etc.
- These are under cerebral control during learning.

Peripheral Nervous System

- It is composed of 12 pairs of cranial nerves and 31 pairs of spinal nerves.
- Cranial nerves emerge from brain while spinal nerves arise from spinal cord.
- 10 pairs of cranial nerves are present in fishes and amphibians.
- Number of cranial nerves found in rabbit is 12 (Same as man) but 37 spinal nerves are present in rabbit.
- The first 10 pairs are common for frog and rabbit.

Cranial	Number	Function	Distribution
Olfactory	I	Sensory	Nose
Optic	II	Sensory	Retina of eye
Oculomotor	III	Motor	4 muscles of eye balls
Trochlear (smallest)	IV	Motor	Superrior oblicue muscle
Trigeminal (biggest)	V	Mixed	
Opthalmic	..		Snout
Maxillary	..		Upper jaw
Mandibular	...		Lower jaw
Abducens	VI	Motor	External rectus
Facial	VII	Mixed	Neck, Pirma, tongue, lower jaw
Auditory	VIII	Sensory	Internal ear
Glossopharyngeal	IX	Mixed	Tongue, pharynx
Vagus	X	Mixed	Larynx, heart lungs, stomach etc.
Spinal accessory	XI	Motor	Neck
Hypoglossal	XII	Motor	Neck andtongue

Autonomous Nervous System

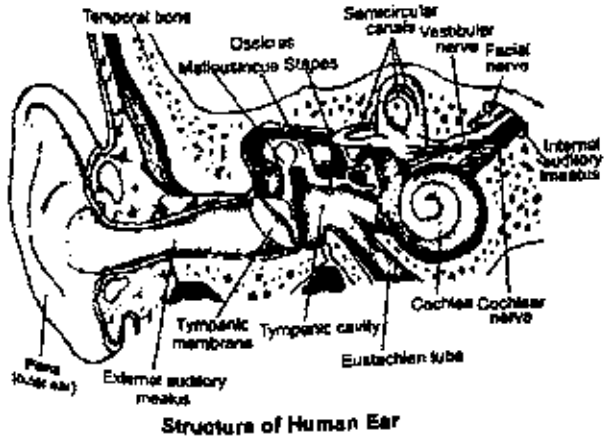
- It was discovered by **Langley.**
- It is entirely motor and operates without concious control
- Auronomic nervous system consists of two division :
  (a) Sympathetic nervous system
  (b) Parasympathetic nervous system
- Sympathetic nervous system increases defence system of body against adverse conditions. It is active in stress condition, e.g., pain, fear and anger. Parasympathetic nervous system provides relaxation comfort, pleasure at the time of rest. It helps in the restoration and conservation of energy.

Sense Organs

Human Ear

The organs of hearing and equillibrium.

- **Otology** The study of structure, function and disease of ear is called otology.
- **Location** Ears are located on sides of head.



Structure of Human Ear

- Ears are meant for both balancing and hearing.
- It can be divided into three parts as :
  External ear (pinna + external auditory meatus) **Middle ear** (tympanic cavity) and **Internal ear** (membranous labyrinth).

External Ear

- Pinna leads into auditory canal which terminates at the ear drum (tympanic membrane).
- Pinna is designed to collect sound waves.
- Auditory canal contain few hairs and specialized sebaceous glands called ceruminous gland.
- Ceruminous glands secrete cerumen (ear wax), it prevents foreign particles from entering the ear.
- Pinna is a vestigeal organ so it is mostly immovable, but in some animals like dogs, cattle, cats, rabbit and elephants, it is movable and moves towards the source of sound.

Middle Ear

- Tympanic membrane (ear drum) separates middle ear from external ear.
- Three auditory ossicles in the middle ear are :
  Malleus Outer and hammer-shaped.
  Incus Middle and oval-shaped.
  Stapes Inner and stirr up shaped attached on outer surface of fonestra ovalis membrane.
- The smallest bone (1.2 mg) in human body is **stapes.**
- The passage connecting the middle ear with pharynx is eustachian tube.
- Eustachian tube equalizes are pressure in both sides (external and middle ear) or tympanic membrane.

Internal Ear

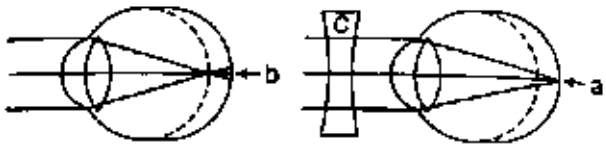
- Labyrinth consists of two main divisions bony labyrinth and membranous labyrinth.
- Bony labyrinth is filled with a fluid called perilymph, while membranous labyrinth contains endolymph.
- Membranous labyrinth is concerned with both balancing and hearing.
- Internal ear is formed of three parts :
  (a) Body proper (utricules and sacculus)
  (b) Semicircular canals.
  (c) Cochlea
- Cochlea is small snail-shaped structure. It makes $2\frac{1}{2}$ turns in rabbit and $2\frac{2}{4}$ turns in man. Three chambers in cochlea are scala vestibuli, scala media and scale tympani.
- Scala media contains the organ of hearing named organ of Corti (discovered by Alfanso Corti).

Human Eye

- **Ophthalmology** The study of structure, functions and diseases of eye is called ophthalmology.
- **Location** Eyes are situated in deep bony cavities called orbits sockets of eye.
- Eyes are the sensitive detectors of light.
- Eye ball is made basically of three layers :
  Sclera Outermost, tough and opaque part.
  Choroid Chocolate coloured, pigmented (with melanin) present along inner side of sclera.
  Retina Inner most and incomplete layer.
  Conjunctive Cornea is covered by a thin transparent layer called conjunctiva. It refracts the incident light rays to focus on the retina.
- Iris consists of circular sphincter and radial dilators.
- Iris adjusts the size of pupil.
- Pupil is the black hole in the centre of the iris, through it light enters the eye ball. It also controls the light entering into the eye.
- Lens is a biconvex, transparent, circular, solid structure and is proteinaceous in nature.
- Aqueous humor is filled between cornea and lens.
- Vitreous humor is filled in space between the lens and the retina.
- Retina consists of a nervous tissue layer and a pigmented layer. Image of object is formed on retina.
- Retina is composed of two types of cells rod cells and cone cells.
- Rods are longer, slender and filamentous while cones are shorter and thicker.
- Rods are highly sensitive of dim light, contains a reddish purple pigment called rhodopsin.
- Cones are sensitive to bright light, hence differentiate the colours. (*i.e.*, Red, green, blue).
- Yellow spot is in the exact centre of the retina also called macula lutea.
- The fovea centralis is the area of sharpest vision due to high concentration of cones.
- The blind spot (optic disc) has no rods and cones cells, hence no image is from in this region.
- Tapetum increase the sensibility of vision.
- Tapetum lucidum is made up of zinc, cysteine and guanin.
- Atropine is a chemical used by doctors to dilate the pupil.
- Night blindness is caused by deficiency of rhodopsin in rods.
- The visual pigments for colour are :
- Erythropsin (sensitive to red)
- Chloropsin (sensitive to green)
- Cyanopsin (sensitive to blue).

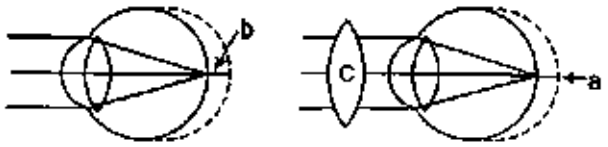
Diseases of Eyes

- **Myopia** (Short sightedness) Image is formed in fornt of retina. It is corrected by using concave lens.



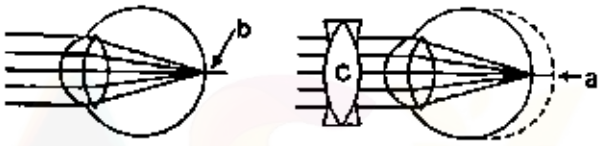
Short Sightedness Eye

- **Hypermetropia** (Long sightedness) Image is formed behind the retina, corrected by using convex lens.



Long Sightedness Eye

- **Astigmatism** Due to irregular cornea or lens, corrected by using cylindrical lens.



A Stigmatism Sightedness Eye

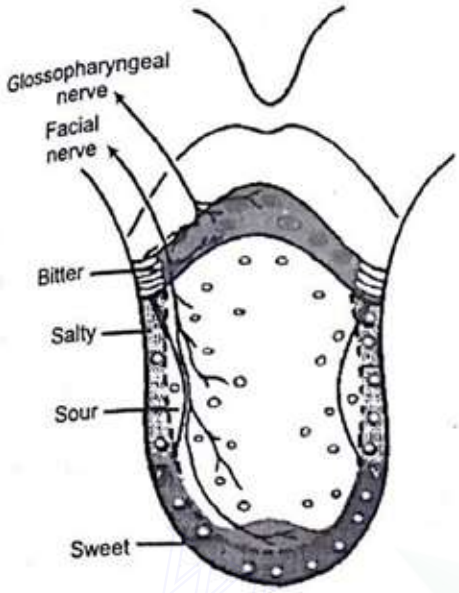
- **Cataract** Lens becomes opaque and can be corrected by operation and using biconvex glasses.
- **Conjunctivitis** Inflammation of conjunctiva by bacteria.

Nose (Olfactory Organ)

- Nose is a sense organ for smell or olfaction.
- The nose contains mucus coated olfactory (smell) receptors.
- Olfactory epithelium lines the nasal cavity.
- Olfactory epithelium have three principal kinds of cells :
- Olfactory bipolar neurons.
- Columnar epithelial cells.
- Bowman's gland
- In addition to smell receptors, nose, tongue and mouth, also contain trigeminal nerve or dentist's nerve. This nerve reacts to messages of pain.

Tongue (Gustatory Organ)

- Organs for gustation are taste buds which are present mainly in the mucosa of taste papilae present on upper surface of tongue. Taste buds are numerous on the tongue, but also found on the soft palate, pharynx and epiglottis.
- A papila may contains a few to many hundred taste buds.
- Taste buds are more numerous in children than in adults.
- Location of taste buds for basic tastes :
  Sweet On the tip of tongue.
  Salty On upper surface of anterior half.
  Sour Lateral side of tongue.
  Bitter Near the base of tongue.
  Bitter taste is evoked by many organic substances like quinine, morphine, caffeine and urea.



Tip of Tongue

Endocrine System

Endocrine Glands

- These glands do not have ducts (tubes) to carry their secretion to the target organs.
- The science dealing with the study of endocrine gland and their secretion is called Endocrinology.
- These glands secrete their secretion into the blood for their transportation to the sites of action. *e.g.*, Thyroid; pituitary, pancreas, hypothalamus, adrenal, etc.
- They are also called ductless glands. Their secretion is called hormones or internal secretions.

Exocrine Glands

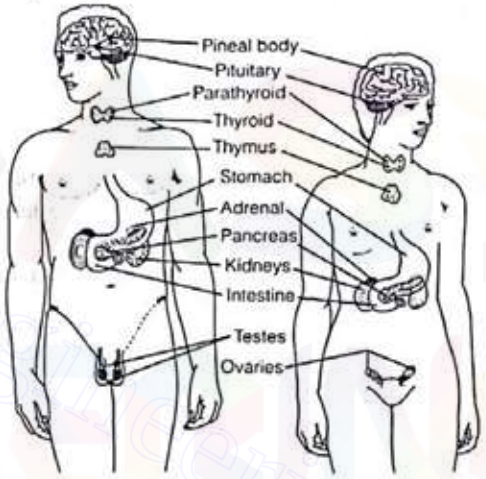
- These glands have ducts.
- These glands secrete their secretions in ducts to carry them to sites of action, *e.g.*, sweat and oil glands of skins, salivary gland, liver, etc.

Hormones

- They can act as coenzymes.
- These are organic compounds secreted in small amount by endocrine glands of body. These are the chemical messengers that can regulate biological processcs. They are steroids, proteins, peptides on amino acids derivatives.
- Hormone was discovered by Bayless and **Ernst H Starling** in 1903 and it was secretin.

Endocrine Glands of Human

- There are total nine endocrine glands in human beings.
- Most of them are common to male and female.
  1. Pituitary (master gland)
  2. Thyroid
  3. Parathyroid
  4. Thymus
  5. Adrenals (supra-drenals)
  6. Pancreas
  7. Pineal gland
  8. Gonads



Human Endocrine Glands

Pituitary Gland

- Also called master gland.
- It is slightly larger in woman than in man.
- It is located in region of fore brain.
- Hormones secreted by it are given in table.

Parts of Pituitary	Hormones	Target Organs	Actions/Effects
Anterior pituitary	Growth Hormone (GH)	All tissues	Normal body growth.
	Adreno Corticotropin Hormone (ACTH)	Adernal cortex	Glucocorticoid secretion.
	Thyrotropin Stimulating Hormone (TSH)	Thyroid gland	Thyroxine secretion.
	Prolactin	Alveolar cells of mammary glands	Milk secretion.
	Follicle Stimulating Hormone (FSH)	Ovarian follicles	Growth of ovarian follicle and estrogen secretion in females and spermatognes is in male.
	Leuteinizing Hormone (LH)	Testes or ovaries	Development of corpus luteum and progesterone secretion in females, testosterone secretion in males.

Parts of Pituitary	Hormones	Target Organs	Actions/Effects
Intermediate pituitary	Melanocyte Stimulating Hormone (MSH)	Skin	Synthesis of melanin of skin.
Posterior pituitary	Oxytocin	Uterus, mammary glands	Milk ejection, uterine contraction, contraction of smooth muscles.
	Vasopressin (ADH)	Kidneys and arteries	Hypertonic urine, absorption of water, arterioler constriction.

Thyroid

- It is largest endocrine gland. It is found on ventral and lateral sides of upper part of the trachea in the neck.
- It is brownished red, shield-shaped, bilobed gland.
- Hormones secreted by it are given in table :

Hormones	Target oragans	Actions/Effects
Calcitonin (CT)	Bones, kideny	Fall in blood calcium, excretion of Ca^{++}
Thyroxine	Heart, liver, kidney, skeletal muscles, mast cells	Tissue metabolism, growth, IQ, differentation of gonads, metamorphosis in amphibians.

Parathyroid

- These are four in number which are embedded in thyroid glands. It is oval-shaped and yellow coloured.

Hormones	Target organs	Actions / Effects
Parathormone (PTH)	Bones, kindey	Rise in blod calcium level, phosphorus check of calcium secretion

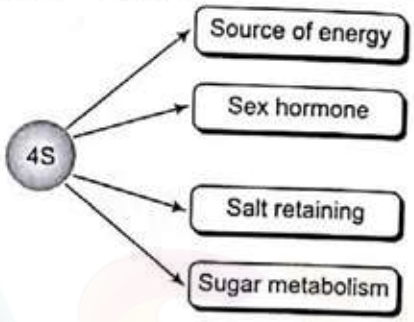
Pancreas

- Located within the curve of duodenum.
- It is a mixed endocrine gland with both exocrine and endocrine portion.
- Three kinds of cells are found in islets of Langerhans namely alpha, beta and delta cells.
- α-cells Larger and peripheral cell, produce glucagon hormone.
- β-cells Central and smaller cell, produce insulin hormone.
- δ-cells Middle cells produce somatostatin hormone.

Hormones	Target organs	Actions / Effects
Insulin	All cells	Decreases blood sugar level, stimulates glycogenesis, increases stored protein in tissue. Hypersecretion results into diabetes mellitus.
Glucagon	Liver	Rise in blood sugar.

Adrenal

- Paired endocrine glands, located superior to kidneys.
- It is structurally and functionally divided into adrenal cortex and adrenal medulla.
- It is also called as 4S gland.



Hormones	Target organs	Actions / Effects
Glucocortiooids	Tissues, mast cells	Carbohydrate, fat and protein metabolism
Mineral corticoids	Kidney	Sodium and potassium metabolisms, water absorption.
Sex corticoids	Body cells	External sex characters
Adrenaline and nor-adrenaline	Mast cells	Heart beat, blood pressure rise, contraction and relaxation of muscles.

Pineal Gland

- In man, it starts to degenerate at about age of 7 years, in adult, it is largely fibrous tissue.
- It secretes hormones in duct response to nervous activity.

Hormone	Target Organ	Action / Effect
Melatonin	Melanophores	Dispersion of melanin.

Thymus

- Situated in front of the heart.
- Thymus is active in young ones but gradually becomes inconspicuous after sexual maturity.
- It consists of peripheral cortex and central medulla.

Hormones	Target Organ	Action / Effect
Thymosin	—	Immune system of body produces lymphocytes.

Hypothalamus

- Located in the floor of fore-brain.
- Neurohormones were first discovered by **Guillenin** and **Schally**.

Hormones	Target Organs	Actions / Effects
Thyrotropin releasing hormone	Thyroid, Adrenal gland	Thyrotropin secretion Corticotropin secretion
Corticotropin releasing hormone	Pituitary	Secretion of pituitary gonadotropin
Somatostatin	Pituitary	Initiation of growth hormone secretion

Gonads

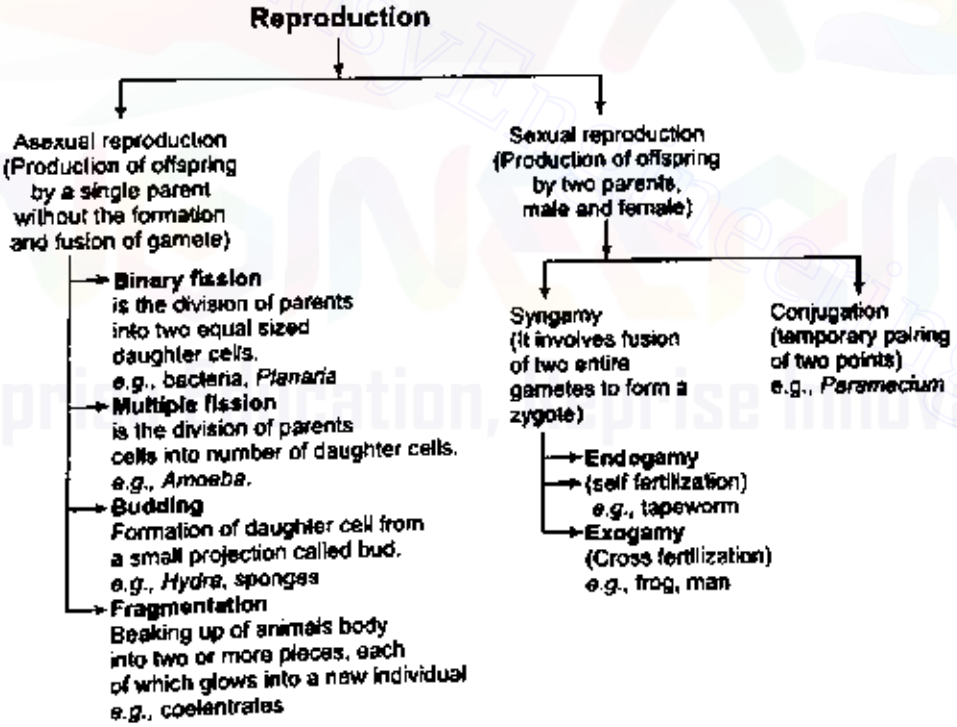
- The main function is to produce gametes.
- They also secrete sex hormones.
- Sex hormones are mostly steroids.
- There are testes in male and ovaries in females.

Endocrine Gland	Hormones	Target organs	Action / Effects
Testes	Testosterones	Mast cell	Male secondary sex organs and external male characters.
Ovaries	Oestrogen	Mast cell	Female secondary sex organ and external female characters.
Corpus luteum (ovaries)	Progesterone	Uterus, mammary glands	Pregnancy changes in female sex organs.

Animal Reproduction

- The process by which new individuals are produced from their parents is called reproduction.

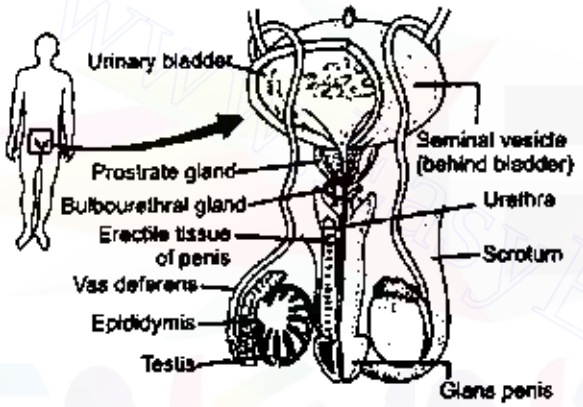
Reproduction is of two kinds :



Male Reproductive System

- Testes are suspended in thin skin bag called scrotal sacs.
- Epididymis is highly coiled thin tube formed by union of seminiferous tubules.
- Penis is muscular organ, richly supplied with the blood.
- Externally, the penis has a bulge called glans penis which is covered by prepuce (a skin fold).
- Male can produce spermatozoa (sperm) throughout their life from age of 13-14 years.
- The growth of hairs on body is due to masculine (male sex hormones).

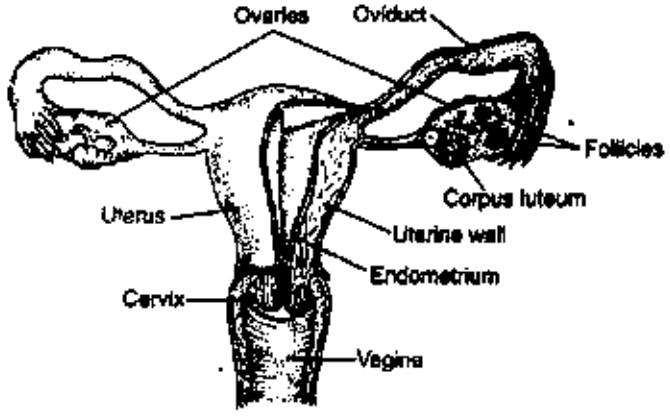
Reproductive Organs of Male	Number	Function Performed
Testes	2	To produce sperm and testosterone.
Sperm duct	2	To conduct the sperm from the testes to urethra.
Seminal vesicles	2	To secrete seminal plasma.
Epididymis	2	To temporarily store sperm and provide mobility.
Urethra	1	To conduct urine, sperms.
Prostate gland	2	To secrete an alkaline fluid to neutralize the acidity of urethra.
Cowper's gland	2	To secrete an alkaline white fluid.
Penis	1	To pass urine and deposite sperm in female genital tract.
Ovaries	2	To produce ova and hormones.
Oviducts	2	To move ovum towards uterus.
Uterus	1	To provide space for developing child.
Vagina	1	To receive the sperms.



Male Reproductive System

Female Reproductive System

- After maturity, the ovary releases an ovum (egg cell) after every 28 day.
- The connection between developing embryo and mother is by placenta. It supplies blood nutrition, etc.
- The embryo develops for nine months in uterus. It is called gestation period.



Female Reproductive System

- Child is delivered after its development and mother produces milk to nourish the child (lactation).
- Reproductive period of a human female extends from puberty (10-14 years) to menopause (40-50 years).
- The periodic vaginal bleeding during menstrual cycle is called menstruation.
- On an average menstrual cycle is complete in 28 days.
- It is absent during pregnancy, may be suppressed during lactation and permanently stops at menopause. About 13 mature eggs are released from two ovaries of female in one years.
- Menopause is characterized by hot flushes.

Reproductive Organ of Female	Number	Function Performed
Ovaries	2	To produce ova and hormones
Oviducts	2	To move the ovum towards uterus.
Uterus	1	To provide space for developing child.
Vagina	1	To receive the sperms.

Menstrual Cycle

- Reproductive period of a human female extends from puberty (10-14 years) to menopause (40-50 years).
- Menopause is stopping of ovulation and menses. It normally occurs between the ages of 45 and 55. In this stage, woman lose the ability to reproduce.
- The periodic vaginal bleeding during menstrual cycle is called **menstruation**.
- On an average menstural cycle is completed in 28 days.
- It is absent during pregnancy, may be suppressed during lactation and pemanently stops at menopause. About 13 mature eggs are released from two ovaries of female in a year.
- Menstrual cycle is controlled by FSH, LH, oestrogen and progesterone.

Contraception Methods

- Contraception is prevention of union of sperm and ovum.
- **Natural contraception** Avoid copulation during ovulation.
- **Mechanical contraception** Use devices to avoid union of sperm and ovum, *e.g.*, condoms, diaphragm, Intra Uterine Devices (IUD).
- **Chemical contraception** Fertilization is avoided by the use of drugs, spermicidal creams, tablets, foam, etc.
- **Vasactomy** Removal of sperm duct (vas deferens) in male.
- **Tubectomy** Removal of Fallopian tube in female.

Human Growth

- Human population is growing fast and its present rate is about 2% per annum. **Malthus** (1798) gave the concept, human population.
- Study of human population is called demography.
- The physiological capacity of organisms is called biotic potential. The maximum number of individuals, which an environment can support of sustain is called carrying capacity.
- Population growth is determined by the number of organisms added to the population (through birth) minus the number of organisms lost (through death).
- When the number of individuals lost, is called zero population growth curves are of two types.

J-shaped Curve

- When there is no environmental resistance, a population grows exponentially and a J-shaped curve is obtained.

S-shaped Curve

- When environment resistance does not allow population growth to soar towards infinitely.

Human Diseases

A 'disease' is an abnormal condition affecting the body of an organism. It is often continued to be specific condition associated with specific symptoms and signs.

- The factors which affect human health can be categorized into two groups.
  (a) **Intrinsic Factors** The disease causing factors which are within the human body are intrinsic factors, *e.g.*, malfunctioning of organs (like heart, kidney, etc.) genetic diseases, hormonal balance, etc.
  (b) **Extrinsic Factors** The disease causing factors which come from outside the human body are called extrinsic factors, *e.g.*, disease caused by microorganism, tobacco, alcohol, narcotics and inadequate diet.

Classification of Diseases

Diseases may be broadly classified into two types :

Congenital Diseases

These are anatomical or physiological abnormalities present from birth. These diseases can be caused by genetic mutations or environmental factors. Diseases by genetic mutation can be transmitted to next generation whereas by environmental factors are non-transmissible.

Acquired Diseases

These diseases develop after birth they are of two types :

(a) **Communicable Diseases** (Infectious) They are caused by pathogens, namely, virus, bacteria, fungi, protozoans, etc.
(b) **Non-communicable** (Non-infectious) Diseases These diseases are confined to the person who develops them.

- They can be of four types :
  1. Organic (Degenerative) diseases caused due to organ malfunctioning.
  2. Deficiency diseases deficiency of mineral, hormones, vitamins and nutrients.
  3. Allergies disease caused due to hypersensitivity of body to foreign particle.
  4. Cancer disease caused due to uncontrolled division of certain tissue of body.

Deficiency Diseases Due to defect in production of hormones

- **Cretinism** In children due to deficiency of thyroxine hormone makes a child mentally retarded.
- **Diabetes** Due to deficiency of insulin.
- **Dwarfism** Due to the sluggish activity of the pituitary gland, the person has diminished growth of the bones.
- **Gigantism** Due to the excessive activity of the pituitary gland, the person has excessive growth of the bones.
- **Goitre** It is caused by deficiency of iodine in diet. It is characterized by swelling of thyroid gland.
- **Anaemia** It is a decrease in number of RBCs or less than the normal quantity of haemoglobin in the blood. Anaemia leads to hypoxia (lack of oxygen) in organs.

Acquired Diseases

Diseases of Malfunctioning Diseases caused by malfunctioning of organs are :

(a) Diseases caused by improper functioning of heart : **Cardiac failure.**
(b) Disease caused by improper functioning of kidney : **Kidney failure.**
(c) Disease caused by improper functioning of bones : **Osteoporosis.**
(d) Disease caused by improper functioning of eyes : **Myopia, hypermatropia** and **cataract.** Uncontrolled growth of some body cells causes cancer.

Types of cancers are

- **Carcinomas** *e.g.*, Lungs cancer, breast cancer, cancer of pancreas and stomach.
- **Sarcomas** *e.g.*, Bone cancer.
  Leukaemia *e.g.*, Blood cancer.
- Breast cancer is common among women while lungs cancer is common among smokers.
- **Radiations** Causes cancer, leukaemia and skin injuries damages genes and chromosomes, induces unmarked cell division, destroys tissues, cells and blood cells.

Allergic Diseases

- The unfavourable response of the body to certain things like dust, serum, drugs, fabrics and pollen, etc., is called allergy.
- Sneezing, irritation of throat, itching and skin rashes, etc., are the symptoms.
- Asthma is caused by allergy.

Diseases Caused by Addictive Substances

- **Alcohol** Reduces alertness of mind and causes liver damage.
- **Narcotic drugs** Narcotic drugs are morphine, cocaine, herion, hashih, ganja, opium, marijuana, barbiturates and LSD (Lysergic acid diethylamide).

Diseases Caused due to Pollution

Chemical Pollution Pneumoconiosis is caused by inhaling coal dust. Silicosis is caused by inhaling stone dust (silica). Asbestosis is caused by inhaling asbestos dust. Lung disease and bronchitis is caused by smoke.

Communicable Disease

- **Bacterial** Pneumonia (*Streptococcus*), Cholera (*Vibrio cholerae*, Tuberculosis (*Mycobacterium*) *tuberculosis*), Tetanus (*Clostridium tetani*), Leporsy (*Mycobacterium lepreae*), Food poisoning (*Salmonella*), Plague (*Yersinia pestis*), etc.
- Bacteria *Staphylococcus* present in the nasal passage causes food poisoning by producing a heat resistant toxin in the food.
- Bacteria *Salmonella typhi* is a pathogenic bacterium causes typhoid fever in human beings. It affects liver, pancreas, nervous system, gastro intestinal tract, kidney, heat, etc.
- Bacteria *Clostridium botulinum* causes food poisoning in canned food.
- Bacteria like *Streptococcus pneumoniae* and *Haemophillcus influenzae* are responsible for pneumonia in human beings and infects alveolli of lungs.

Baterial Disease

- **Anthrax** is an infectious disease due to a type of bacteria called *Bacillus anthracis*. Anthrax can't directly spread from one individual to other but can cause infection by spores.
- **Diphtheria** It is an upper respiratory tract illness caused by *Cornybacterium diphtheriae* and characterized by sore throat, low fever and an adherent membrane on the tonsils, pharynx and nasal cavity.

Viral

- Poliomyelitis (Polio) Mumps (*Paramyxo* virus), Chiken pox (Variola viurs), Measles (*Paramyxo* virus), AIDS (HIV).

Viral Diseases

- Dengue fever virus (DENN) is an RNA virus of the family *Flavi viridae* cause dengue fever also called as breakbone fever. Symptoms include headache, muscle and jointpain.
- **Conjunctivitis** (aslo called pink eye or mardras eye) is inflammation of the conjunctiva (the outermost layer of eye and inner surface of eyelids).
- Caused by Adenoviruses sometimes can also be caused by bacterial infection.
- **Rabies** It is a viral disease that cauise acute excephalitis (inflammation of brain). Roughly 97% of human rabies cases come from dog bites but rabid bats are also capable of causing the disease.
- **Hepatitis** is a medical condition defined by inflammation of liver. It can be caused by hepatitis viruses.
- **Influenza**, commonly called as flu, is an infectious disease caused by RNA viruses of family—Orthomyxoviridae.
- **Measles** also known as rubeola or morbilli is an infection of the respiratory systlm caused by a virus, specifically a paramyxovirus of the genus *Morbillivirus*. Symptoms include fever, cough, runny nose, red eyes, etc.
- **Mumps** is a viral disease of human species caused by mumps virus. Painful swelling of salivary glands (parotid gland) is the most typical presentation.

Diseases Caused by Protozoa and Worms

- Malaria is caused by *Plasmodium sp.*
- Kala-azar sandfly of genus *Phlebotomus argentipse*. Amoebiasis (*Amoeba*), Giardiasis (*Giardia*), Elephantiasis (Filarial worm), Abdominal pain (tapeworm), Anaemia (Hook worm), etc.

Diseases Caused by Fungi

- Ringworm (Skin problems), Food poisoning (*Aspergillus*).

Congenital Diseases

Disease due to Single Gene Mutation

(a) **Alkaptonuria** is a rare inherited genetic disorder of phenylalanine and tyrosine metabolism.

(b) **Phenylketonuria** is an autosomal recessive metabolic genetic disorder characterized by mutation in the gene for hepatic enzyme phenylalanine hydroxylase.

(c) **Haemophilia** is a group of genetic disorders that impairs the body's ability to control blood clotting.

(d) **Sickle cell anaemia** Blood cells becomes sickle-shaped due to defective type of haemoglobin and so oxygen carrying capacity is greatly reduced. It occuss in parts of Madhya Pradesh, Bihar and Maharashtra.

(e) **Progeria** Caused due to point mutation in position 1824 of LMNA gene, replacing cytosine for thymine. Creating a truncated from progenin of prelamin A protein.

Symptoms Early ageing, small face and jaw, pinched nose loss of eyesight, hair loss.

Chromosomal Aberrations

(a) **Down's syndrome or trisomy 21.**

Cause due to presence of extra 21^{st} chromosome or its part due to translocation (*i.e.*, an genetic abnormality).

Symptoms

- Impairment of cognitive ability.
- Impairment of physical growth.
- Low intelligence.
- Microgenia (small chin).
- Round face (macroglossia).
- Almond-shaped eyes.
- Furrowed tongue with open mouth.

(b) **Turner's Syndrome** (Gonadal dysgenesis) 45, XO. It is chromosomal abnormality in which all or part of one of the sex chromosomes is absent. Girls with Turner's syndrome experience gonadal distinction, sterility.

(c) Congenital diseases can also be caused by environmental factors but these are not heritable.

- **Blue baby syndrome** It is used to describe new borns with cyanotic heart lesions. It is caused basically due to high nitrate contamination in ground H_2O resulting in decreased O_2 carrying capacity of haemoglobin in babies leading to death. Also called as methaemoglobinemia.

Diseases of Animals

Diseases	Aminal Affected	Caused by	Organ Affected
Pox	Cattle, sheep, goat	Virus	Skin
Tuberculosis	Cattle, birds	Bacteria	Lungs, intestine
Rinderpest	Cattle, sheep, goat	Bacteria	Spleen
Anthrax	Cattle, sheep, goat	Bacteria	Skin, lungs, intestine
Foot and mouth	Cattle, pigs	Virus	Pharynx
Dermatitis	Goat, sheep, cattle	Virus	Skin
Mastitis	Cattle	Bacteria	Swollen udders
Ringworm	Cattle	Fungus	Body
Trypanosomiasis	Cattle	Protozoa	Body
Helminthic	Cattle	Worms	Body
Aspergillosis	Poultry birds	Fungus	Body
Cholera	Poultry birds	Bacteria	Body
Diarrhoea	Poultry birds	Bacteria	Body
Ranikhet	Poultry birds	Virus	Body
Fowl pox	Poultry birds	Bacteria	Skin

Points to be Remember

- **Thrombocytes**, also called **spindle cells**. These are spindle-shaped and found in blood of vertebrates other than mammals. Their nucleus is oval-shaped. These cells help in blood clotting in vertebrates
- Midbrain of rabbit consists of four optic lobes.
- The recording of spontaneous activity of brain can be done with electroencephalogram (ECG)
- **Berger** in 1929 was first to record (EEG).
- The smallest cranial nerve is trochlear in human beings.
- The largest cranial nerve is trigeminal in human beings.
- Hearing is controlled by auditory area of temporal lobe of cerebral cortex.
- Human ear can listen the sound of 60-80 decibel.
- Human ear is sensitive to sound frequency 50-20000 cycles/sec.
- Ear is most sensitive to frequency 1000-3000 cycles/sec
- The measuring unit of sound frequency is decibel.
- Defects of ear are :
  Otalgia Ear ache (pain in ear)
  Otitis media
  Acute infection of middle ear.
  Labyrinthine disease : Malfunciton of inner ear.
- Colour blindness (also called daltonsim) is caused due to deficiency of cones.
- Human beings, apes, monkeys, birds, lizards, turtles and some fishes possess colour vision.
- Retina of owl contains rods and of owl contains only cones
- The eyes of carnivores like cat, dog, lion seal, etc., glown in night due to tapetum lucidum.
- Eyes are most sensitive to yellow green colour
- Bees can see ultraviolet light while acute vision is found in vulture
- Deer has biggest eyes in proportion to body size.
- The image formed on retina is real and inverted.
- Amniocentesis A technique to detect chromosomal abnormalities, if any, in the developing foetus by analysis the cells trust in the amniotic fluid.
- A body born from the ovum fertilized in *vitro* and then implanted in the womans uterus.
  AIDS (Acquired Immuno Deficiency Syndrome)
- It weakens the immunity of body.
- It spreads through sexual contact, transfusion of blood infected by AIDS virus, through infected needles, child gets diseases from mother's milk
- Best way to avoid it is to adopt safe sex, use sterilized syringes.
- Insects that can transmit diseases to humans are referred to as vectors, *e.g.*, *Anopheles* serve as a vector for Malaria *Culex* for filaria, *Aedes* for dengue and sandfly for kala-azar.

Exercise

1. A colourblind person has difficulty in distinguishing between which colours?
   (a) Black and blue (b) Green and violet
   (c) White and yellow (d) Green and red
2. The yellow colour of urine is due to the presence of
   (a) bile (b) lymph
   (c) cholesterol (d) urochrome
3. Wisdom teeth normally grow during the age of
   (a) 12-15 years (b) 17-30 years
   (c) 34-40 years (d) 40-45 years
4. Life of RBCs in human blood is of
   (a) 30 days (b) 60 days
   (c) 120 days (d) 15 hours
5. Saliva in man is
   (a) acidic (b) alkaline
   (c) neutral (d) None of these
6. Convex lenses are used for the correction of
   (a) artigmatism (b) short sightedness
   (c) cataract (d) long sightedness
7. Which of the following makes skin layer impervious to water?
   (a) Callogen (b) Melanin
   (c) Keratin (d) Chitin
8. Element that is not found in blood is
   (a) iron (b) magnesium
   (c) copper (d) chromium
9. The amount of light entering the eye is regulated by
   (a) cornea (b) pupil
   (c) iris (d) schlera
10. The first organ to be transplanted was
    (a) kidney (b) lung
    (c) heart (d) liver
11. SA-node of mammalian heart is known as
    (a) autoregulator (b) pacemaker
    (c) time controller (d) beat regulator
12. The normal temperature of the human body is
    (a) 90°F (b) 98°F
    (c) 98.4°F (d) 96.4°F
13. The blood pressure is the pressure of blood in
    (a) arteries (b) veins
    (c) auricles (d) ventricles
14. Which of the following has the smallest egg?
    (a) Ostrich (b) Humming bird
    (c) Pigeon (d) *Homo sapiens*
15. The largest cell in the human body is
    (a) nerve cell (b) muscle cell
    (c) liver cell (d) kidney cell
16. Sweat glands occur in maximum number in the skin of the
    (a) forehead (b) armpits
    (c) back (d) palm of hands
17. Silk worms are feed on
    (a) insects (b) mulberry leaves
    (c) grasses (d) None of these
18. Silk is produced by
    (a) egg of silk worm (b) pupa of silk worm
    (c) larva of silk worm (d) insect itself
19. Which of the following is a non-poisonous snake?
    (a) Krait (b) Python (c) Naja (d) viper
20. The largest bird is
    (a) duck (b) dodo (c) ostrich (d) peacock
21. Hormones are normally absent in
    (a) rat (b) monkey (c) bacteria (d) cat
22. The gestation period of cows is
    (a) 150 day (b) 280 day (c) 300 day (d) 365 day
23. Which of the following is an egg laying mammal?
    (a) Bat (b) Penguin
    (c) Whale (d) Spiny anteater
24. A reptile with a four-chambered heart is
    (a) crocodile (b) turtle (c) snake (d) lizard
25. Which of the following animals has the longest life span?
    (a) Elephant (b) Crocodile
    (c) Dog (d) Tortoise
26. DPT is a vaccine for
    (a) diarrhoea, polio and typhoid
    (b) diphtheria, whooping cough and tetanus
    (c) diarrhoea, polio and tetanus
    (d) Diphtheria, whooping cough and typhoid
27. Which of the following cannot be controlled by vaccination?
    (a) Small pox (b) Diabetes
    (c) Polio (d) Whooping cough
28. Which of the following diseases is caused due to allergic reaction?
    (a) Leprosy (b) Typhoid
    (c) Asthma (d) Tetanus
29. Vitamin-B complex represents a group of how many vitamins?
    (a) 5 (b) 6 (c) 9 (d) 11
30. The richest source of vitamin-D is
    (a) cod liver oil (b) spinach
    (c) milk (d) cheese
31. Malaria spreads through the vector
    (a) Tse-tse fly (b) *Culex* mosquito
    (c) *Aedes* mosquito (d) *Anopheles* mosquito
32. Cow milk is a rich source of
    (a) vitamin-A (b) vitamin-B
    (c) vitamin-C (d) vitamin-D
33. Amnesia is related to
    (a) sleeping sickness (b) Loss of sight
    (c) loss of hearing (d) loss of memory
34. Which milk contain more fat?
    (a) Cow (b) Buffalo
    (c) Camel (d) Reindeer
35. Protein-calorie malnutrition causes
    (a) malaria (b) hepatitis
    (c) typhoid (d) kwashiorkor

36. Which of the following is not a mosquito borne disease?
(a) Dengue fever (b) Malaria
(c) Sleeping sickness (d) Filariasis

37. A person with stones in the kidneys is advised to avoid
(a) lemon (b) vinegar (c) tomato (d) lentils

38. Which disease cannot be prevented by immunization?
(a) Polio (b) Diphtheria
(c) Angina (d) Tuberculosis

39. Only snake that builds its nest is
(a) krait (b) king cobra
(c) chain viper (d) saw scaled viper

40. Ornithology is the study of
(a) worms (b) birds
(c) insects (d) amphibians

41. Entamology deals with the study of
(a) minerals (b) fossils
(c) insects (d) birds

42. Which of the following is the science dealing with tumour?
(a) Carcinology (b) Serology
(c) Oncology (d) Chronology

43. Which of the following does not belong to vitamin-B group?
(a) Riboflavin (b) Tocopherol
(c) Cyanocobalamin (d) Nicotin

44. Which one secretes fright and flight hormone?
(a) Pineal gland (b) Thyroid gland
(c) Pituitary (d) Adrenal gland

45. In which form CO_2 is carried in blood?
(a) Magnesium carbonate (b) Sodium carbonate
(c) Potassium carbonate (d) Sodium bicarbonate

46. *Cholera bacillus* was discovered by
(a) Louis Pasteur (b) Ronald Ross
(c) Robert Koch (d) Joseph Lister

47. Insulin was discovered by
(a) Alexander Fleming (b) Edmond Fischer
(c) Dr. FG Banting (d) Joseph E Murray

48. Respiratory enzymes in bacteria are present in
(a) mitochondria (b) Golgi complex
(c) plasma membrane (d) endoplasmic reticulum

49. Blood grouping was discovered by
(a) William Harvey (b) Landsteiner
(c) Robert Koch (d) Louis Pasteur

50. Ammonia is the chief nitrogenous waste in
(a) mosquitoes (b) tadpole of frog
(c) cartilaginous fishes (d) desert mammals

51. Ultrafiltration occurs in
(a) Bowman's capsule
(b) proximal convoluted tubules
(c) Henle's loop
(d) distal convoluted tubules

52. Total number of bone in the human skeletons
(a) 208 (b) 300
(c) 206 (d) 218

53. Match list I (Vitamins) with list II (Chemical names) and select the correct answer using the codes given below the lists.

List I (Vitamins)	List II (Chemical Names)
A. Vitamin-A	1. Riboflavin
B. Vitamin-B_2	2. Niacin
C. Vitamin-B_5	3. Retinol
D. Vitamin-C	4. Ascorbic acid

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	4	3	2	1
(c)	3	1	2	4	(d)	2	3	1	4

54. The largest gland of the body is
(a) liver (b) pancreas (c) thyroid (d) pituitary

55. Beri-beri is caused by deficiency of
(a) vitamin-A (b) vitamin-B_1
(c) vitamin-B_{12} (d) vitamin-K

56. Which one of the following helps in air conditioning?
(a) Nasal chambers (b) Nostrils
(c) Pharynx (d) Alveoli

57. How many molecules of O_2 can associate with a molecule of haemoglobin in man?
(a) One (b) Two
(c) Three (d) Four

58. Which of these contains vocal cords?
(a) Larynx (b) Pharynx
(c) Glottis (d) Primary bronchus

59. Anaerobic respiration occurs in
(a) ants (b) earthworms
(c) tapeworms (d) echinoderms

60. Oxygen content in inspired air is
(a) 4% (b) 20%
(c) 16% (d) 25%

61. Which is the main form in which CO_2 is transported by blood?
(a) Carbonic acid (b) Oxyhaemoglobin
(c) Bicarbonates (d) Carboxyhaemoglobin

62. The largest quantity of air that can be expired after a maximal inspiration is
(a) residual volume (b) tidal volume
(c) lung volume (d) vital capacity of lungs

63. Respiratory organ in insects are
(a) lung (b) trachea
(c) bronchi (d) pharynx

64. Right lung of man is
(a) two lobed (b) four lobed
(c) three lobed (d) None of these

65. Respiratory organ of leech is
(a) lung (b) trachea (c) skin (d) gill

66. Second heart sound is
(a) 'Lub' at the end of systole
(b) 'Lub' at the beginning of systole
(c) 'Dup' at the end of diastole
(d) 'Dup' at the beginning of diastole

67. Open type circulatory system is found in
(a) insects (b) leeches
(c) mollusc's (d) All of these

68. The ECG is employed to detect
(a) heart beat (b) blood pressure
(c) heart attack (d) arteriosclerosis

69. Membrane surrounding the heart is
(a) peritoneum
(b) pleura
(c) pericardium
(d) mucus membrane

70. The blood pressure is measured by
(a) haemoglobinometer (b) stethoscope
(c) sphygmomanometer (d) pulse rate

71. In a normal adult man, the blood pressure is
(a) 80/120 mm Hg (b) 120/80 mm Hg
(c) 150/90 mm Hg (d) 90/150 mm Hg

72. Heart with single circulation is found in
(a) mammals (b) reptiles
(c) fishes and amphibians (d) fishes only

73. Increase in the number of WBC is referred as
(a) anaemia (b) polythaemia
(c) leukopenia (d) leukaemia

74. The life span of human WBC is about
(a) less than 10 days (b) 24 hours
(c) 120 days (d) 100 hours

75. Pacemaker in heart, is
(a) AV node (b) SA node
(c) Purkinje fibres (d) Bundles of His

76. Veins carrying oxygenated blood is called
(a) pulmonary (b) all capillaries
(c) aorta (d) None of these

77. Nissel's granules are found in
(a) cartilage cells (b) nerve cells
(c) muscle cells (d) bone cells

78. The junction of two neurons is called
(a) synapsis (b) synapticula
(c) synapse (d) synaptic cleft

79. The fibrous sheath that connects the bones is called
(a) tendon (b) aponeuroses
(c) periosteum (d) ligament

80. The white fibres are chemically formed of
(a) collagen (b) elastin
(c) myosin (d) reticulin

81. Consider the following statements regarding human nutrition.
I. Spinach is a good sources of vitamin-A.
II. Excess vitamin-D in diet promotes high calcium absorption.
III. One of the causes of pain in the joints is due to vitamin-C deficiency.
IV. Diarrhoea is one of the symptoms of pellagra.
Which of the above statements are correct?
(a) I and II (b) I, III and IV
(c) II, III and IV (d) I, II, III and IV

82. There is different parts of brain in the figure. The darken portion of the figure represents

(a) cerebrum (b) cerebellum
(c) cerebral hemisphere (d) spinal cord

83. Match list I (Gland in the human body) and list II (Body function controlled) and select the correct answer using the codes given below the lists.

List I (Glands)	List II (Body Functions Controlled)
A. Adrenal	1. Growth of bones
B. Pancreas	2. Level of blood calcium
C. Parathyroid	3. Salt and water balance in the body
D. Pituitary	4. Level of blood sugar

Codes

	A	B	C	D		A	B	C	D
(a)	1	4	3	2	(b)	3	1	2	4
(c)	3	4	2	1	(d)	4	2	3	1

84. A band of white fibres which joins muscles to bone.
(a) Ligament (b) Tendon (c) Elastin (d) Actin

85. The colour of lymph is
(a) red (b) yellow (c) white (d) blue

86. The longest bone in human body is
(a) femur (b) skull bone (c) patella (d) fibula

87. The protein present in bone is
(a) chondrin (b) ossein (c) actin (d) myosin

88. Second largest gland of the body is
(a) pancreas (b) liver (c) pituitary (d) thyroid

89. Bleeding and rupturing of blood vessels is prevented by
(a) vitamin-E (b) vitamin-C
(c) vitamin-K (d) vitamin-B_2

90. Oxyntic cells of gastric gland secrete
(a) gastric lipase (b) gastric pepsin
(c) gastric renin (d) gastric HCl

91. Wisdom teeth are
(a) incisors (b) canines (c) premolars (d) molars

92. Which one of the following enzyme is present in saliva?
(a) Pepsin (b) Ptyalin
(c) Trypsin (d) Chymotrypsin

93. Which one of the following is true stomach?
(a) Rumen (b) Reticulum
(c) Omasum (d) Abomasum

94. Goitre is caused due to deficiency of
(a) calcium (b) iodine
(c) florine (d) phosphorus

95. Which enzyme is present in bile juice?
(a) Bilin (b) Bilirubin
(c) Biliverdin (d) None of these

96. Digestive gland of prawn is
(a) hepatopancreas (b) liver
(c) thyroid (d) pancreas

97. Omasum is absent in
(a) goat (b) cow (c) camel (d) buffalo

98. Coagulation of milk is done by
(a) casein (b) rennin (c) pepsin (d) trypsin

99. Dental formula of human baby is
(a) 2102/2102 (b) 2103/2103
(c) 2100/2100 (d) 2123/2123

100. Consider the following substances.
I. Ascorbic acid II. Folic acid
III. Nicotinic acid IV. Pantothenic acid
Which of the above are vitamins?
(a) I and III (b) I, II, III and IV
(c) II, III and IV (d) I, II and IV

101. Match list I (Diseases) with list II (Type of causative organism) and select the correct answer using the codes given below the lists.

List I	List II
A. Ascariasis	1. Bacteria
B. Giardiasis	2. Nematode
C. Hepatitis	3. Protozoan
D. Tetanus	4. Virus

Codes

	A	B	C	D		A	B	C	D
(a)	2	3	4	1	(b)	4	3	2	1
(c)	2	1	4	3	(d)	4	1	2	3

102. Match list I (Vitamins) with list II (Deficiency diseases) and select the correct answer using codes given below the lists.

List I	List II
A. Vitamin-C	1. Night blindness
B. Vitamin-A	2. Scurvy
C. Vitamin-D	3. Ricket
D. Vitamin-B_{12}	4. Anaemia
	5. Beri-beri

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	5	4	(b)	4	3	2	1
(c)	2	1	3	4	(d)	2	1	4	5

103. Match list I with list II and select the correct answer using the codes given below the lists.

List I	List II
A. Enzyme	1. Carotene
B. Vitamin	2. Keratin
C. Protein	3. Maltase
D. Hormone	4. Adrenalins

Codes

	A	B	C	D		A	B	C	D
(a)	3	1	4	5	(b)	2	3	1	5
(c)	4	1	3	2	(d)	3	1	2	4

104. Match list I (Scientific research) using with list II (Scientists) and select the correct answer using the codes given below in the lists.

List I	List II
A. One gene-one enzyme theory	1. Watson and Crick
B. Coupling and repulsion hypothesis	2. Beadle and Tatum
C. Transduction in bacteria	3. Bateson and Punett
D. Semiconservative method of DNA replication	4. Lederberg and Zinder
	5. Meselson and Stahl

Codes

	A	B	C	D		A	B	C	D
(a)	2	3	4	1	(b)	4	2	3	5
(c)	2	3	4	5	(d)	5	3	2	1

105. The abnormal rise in RBC count is called
(a) lukaemia (b) leukopenia
(c) thrombocytosis (d) polycythmia

106. Nucleated RBC are found in
(a) Ostrich (b) Frog
(c) Goat (d) All of these

107. Which of the following endocrine gland is shown in the adjoining figure.

(a) Pituitary gland (b) Thymus gland
(c) Adrenal gland (d) Pineal body

108. Consider the following respiratory pigments.
I. Haemoglobin II. Haemocyanin
III. Haemoerythrin IV. Haemocyanoglobin
Iron is contained in
(a) I, II, III and IV (b) I and III
(c) I and II (d) I, II and IV

109. The following statements are pertaining to green revolution in India
Green revolution is most successful in the area of
I. Controlled and assured source of irrigatoin.
II. Where chemical fertilizer (NPK) is adequately applied.

III. Where hydel power is adequately available.
IV. Where farmers are more receptive to innovation.

Select the correct answer using the codes given below
(a) I, II and III (b) I, II and IV
(c) I, III and IV (d) I, II, III and IV

110. Muscle fatigue is due to accumulation of
(a) pyruvic acid (b) lactic acid
(c) glycogen (d) succinic acid

111. Minamata disease is caused by
(a) automobile exhausts containing lead
(b) water pollution from sewage
(c) industrial wastes having mercury compounds
(d) water from tanneries

112. Match the following lists.

List I (Protein)	List II (Type)
A. Haemoglobin	1. Structural proteins
B. Collagen	2. Contractile proteins
C. Albumin and glutalin	3. Transport proteins
D. Actin and myosin	4. Storage proteins

Codes

	A	B	C	D
(a)	1	3	4	2
(b)	2	1	3	4
(c)	3	1	4	2
(d)	1	2	4	3

113. Artificial insemination involves the use of
(a) natural semen and natural diluent
(b) natural semen and artificial diluent
(c) artificial semen and natural diluent
(d) artificial semen and artificial diluent

114. Which of the following is a water borne disease?
(a) Tuberculosis (b) Cholera
(c) Influenza (d) Malaria

115. Mother's milk is preferred to cow's milk because it contains
(a) more fats and more lipids (b) less fats and less lipids
(c) less fats and more lipids (d) more fats and less lipids

116. A girl ate sweets contaminated with flies, due to this she suffered from a disease diagnosed as
(a) kwashiorkar (b) tuberculosis
(c) diphtheria (d) cholera

117. Honey has the largest percentage of
(a) water (b) starch
(c) glucose (d) sucrose

118. Which disease is not caused by insect bite?
(a) Plague (b) Arthritis
(c) Filaria (d) Malaria

119. Which fruit can diabetic patients eat freely?
(a) Banana (b) Guava (c) Orange (d) Mango

120. Which of the following statements is true with respect to leukaemia?
(a) Number of RBCs increases in blood
(b) Number of WBCs increase in blood
(c) Number of both RBCs and WBCs decreases
(d) Deficiency of minerals

121. Man cannot survive without taking minimum amount of
(a) carbohydrates (b) fats
(c) proteins (d) minerals

122. Which of the following vitamins and deficiency diseases is not correctly matched?
(a) Vitamin-A – Night blindness
(b) Vitamin-B_1 – Pelagra
(c) Vitamin-D – Deformitis in bones
(d) Vitamin-K – Haemorrhage

123. A pregnant woman is advised to undergo abortion if she contracts a disease called
(a) measles (b) small pox
(c) chicken pox (d) German measles

124. The protein content of edible portion of egg is
(a) 15% (b) 13.3% (c) 10.3% (d) 5%

125. Which of the following diseases was prevalent among red Indians?
(a) Fibrosis (b) AIDS
(c) Syphilis (d) Gonorrhoea

126. Antiacids curve
(a) headache (b) stomach aches
(c) asthma (d) hormonal deficiency

127. Which of the following shows autotomy?
(a) Starfish (b) Prawn (c) Lizard (d) All of these

128. What is site of fertilization in human being?
(a) Vagina (b) Uterus
(c) Fallopian tube (d) Ovary

129. Type of cleavage found in the egg of bird is
(a) holoblastic and equal (b) diploblastic
(c) meroblastic (d) None of these

130. Implantation of blastocyst occurs on
(a) 5^{th} day (b) 4^{th} day (c) 6^{th} day (d) 7^{th} day

131. The release of seminal fluid in the vagina of female is called
(a) ejaculation (b) insemination
(c) coition (d) implantation

132. The ovum released from the ovary is received by
(a) uterus (b) vagina (c) isthmus (d) ostium

133. Sperm entry in the ovum is assisted by
(a) hyaluronidase (b) hyaluronic acid
(c) fertilizin (d) antifertilizin

134. The cavity present in the Graafian follicle is
(a) amniotic cavity (b) archenteron
(c) antrum (d) ostium

135. Most serious form of mental illness is
(a) neurosis (b) psychosis (c) epilepsy (d) cancer

136. Any chemical which causes loss of sensation is
(a) sedative (b) analgesic (c) anaesthetic (d) stimulant

137. LSD is derived from
(a) hemp plants (b) fungus
(c) coca plants (d) poppy plants

138. Down's syndrome is also called
(a) 18-monosomy (b) 18-trisomy
(c) 21-monosomy (d) 21-trisomy

139. Myocardial infaraction is a serious disease of
(a) heart (b) brain (c) lungs (d) kidneys

140. Rh-factor was first discovered in
(a) human male (b) human female
(c) dog (d) monkey

141. Cancer located in connective tissues is called
(a) carcinoma (b) sarcoma (c) leukaemia (d) metastasis

142. BCG is used against
(a) tuberculosis (b) typhoid
(c) hydrophobia (d) measles

143. The air borne disease is
(a) tuberculosis (b) diphtheria
(c) pneumonia (d) All of these

144. Which of the following is not an infectious disease?
(a) AIDS (b) Lock jaw
(c) Arthritis (d) Sleeping sickness

145. The immunity developed after the body has recovered from a disease is called
(a) active immunity (b) passive immunity
(c) Both (a) and (b) (d) None of these

146. Fever causing substance is called
(a) pathogen (b) pyrogen
(c) interferon (d) antigen

147. Match list I (Diseases) with list II (Causative agents) and select the correct answer using the codes given below the lists.

List I (Diseases)	List II (Causative agents)
A. Syphilis	1. *Vibrio*
B. Sore throat	2. *Bacilli*
C. Cholera	3. *Spirulla*
D. T.B. (Tuberculosis)	4. *Cocci*

Codes

	A	B	C	D		A	B	C	D
(a)	3	4	2	1	(b)	2	4	3	1
(c)	3	4	1	2	(d)	4	2	1	3

148. Fusion of male and female gametes is called
(a) polygamy (b) amphimixis (c) ejaculation (d) syngamy

149. Testosterone is secreted by
(a) Leydig's cells (b) Sertoli cells
(c) corpus luteum (d) oxyntic cells

150. Consider the following statements keratin is
I. A protein II. A hormone
III. Present in hair IV. Present in nail
Which of the above statements is/are correct?
(a) I only (b) I and III
(c) II and III (d) I, III and IV

151. Progesterone and relaxin are secreted by
(a) testes (b) pituitary (c) thyroid (d) ovary

152. Oxytocin is secreted by
(a) hypothalamus (b) adrenaline
(c) thyroid (d) pituitary

153. The cells of pancreas that produce glucagon are
(a) α-cells (b) γ-cells
(c) Both (a) and (b) (d) β-cells

154. Metabollic rate in mammals is controlled by
(a) pancreas (b) liver
(c) pituitary (d) thyroid

155. Spermatogenesis in mammalian testes is controlled by
(a) FSH (b) LH
(c) Progesterone (d) ICSH

156. Only mammalian ear can have
(a) tympanic cavity (b) ear ossicle
(c) internal ear (d) pinna

157. Myopia can be corrected by
(a) convex lens (b) concave lens
(c) cylindrical lens (d) cornea replacement

158. Cones are with a pigment
(a) iodopsin (b) rhodopsin
(b) Both (a) and (b) (d) None of these

159. Rods and cones are present in
(a) iris (b) cornea (c) sclerotic (d) retina

160. Number of spinal nerves in man is
(a) 10 pairs (b) 12 pairs (c) 21pairs (d) 31 pairs

161. Outermost covering of brain of man is
(a) duramater (b) piamater
(c) arachnoid (d) choroid

162. Heart is innervated by
(a) trigeminal (b) vagus
(c) facial (d) glossopharyngeal

163. Second vertebra in man is called
(a) atlas (b) axis
(c) sacral (d) lumbar

164. Match list I with list II and select the correct answer using the codes given below in the lists.

List I (Sources)	List II (Rich in)
A. Fish liver oil	1. Vitamin-C
B. Egg	2. Vitamin-B complex
C. Lettuce	3. Vitamin-D
D. Cow milk	4. Vitamin-A

Codes

	A	B	C	D		A	B	C	D
(a)	2	4	3	1	(b)	2	4	1	3
(c)	3	2	1	4	(d)	4	2	3	1

165. Match the following lists.

List I	List II
A. Shoulder and joints	1. Ball and socket joints
B. Ankle, knee and elbow	2. Hinge joints
C. Toe bones	3. Ellipsoid joints
D. Bones in palm	4. Gliding joints

Codes

	A	B	C	D		A	B	C	D
(a)	2	4	3	1	(b)	1	3	4	2
(c)	1	2	3	4	(d)	2	1	4	3

166. Match the following lists.

List I	List II
A. Rods	1. Nervous coat of eye
B. Cones	2. Photoreceptor cells
C. Iris	3. Regulate amount of light entering the eye
D. Retina	4. Receive stimulus of light

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	1	3	4	2
(c)	4	3	2	1	(d)	2	4	3	1

167. Match the following lists.

List I (Vaccines)	List II (Diseases)
A. BCG vaccine	1. Malaria
B. BPL vaccine	2. Sore throat
C. Chloroquine	3. Tuberculosis
D. Penicillin	4. Rabies

Codes

	A	B	C	D		A	B	C	D
(a)	3	4	1	2	(b)	3	4	2	1
(c)	4	3	2	1	(d)	4	3	1	2

168. Match the following lists.

List I (Diseases)	List II (Causative agent)
A. Typhoid	1. Bacteria
B. Malaria	2. Virus
C. AIDS	3. Worms
D. Ringworm	4. Protozoa
	5. Fungi

Codes

	A	B	C	D		A	B	C	D
(A)	2	3	5	1	(b)	1	4	2	5
(c)	3	1	2	5	(d)	1	2	3	4

Direction *The following question consists of two statements one labelled Assertion (A) and the other labelled Reason (R). Select the correct answers to these questions from the codes given below.*

(a) Both A and R are true and R is the correct explanation os A
(b) Both A and R are true but R is not correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

169. Assertion (A) Balanced diet is one which gives us correct proportion of carbohydrates proteins, fats, minerals and vitamins to provide enough material for growth and other activities.
Reason (R) The amout of each substance required depends on age, sex, occupation of the individuals and on the climatic conditions of the place where one lives.

170. Assertion (A) Antibody reacts specifically with an antigen.
Reason (R) Antibodies are synthesized in an animal in response to an antigen for which it has a high affinity.

171. Assertion (A) A particular type of bacteria causes AIDS.
Reason (R) AIDS is sexually transmitted disease.

172. Assertion (A) A person with blood group 'O' is a universal donor.
Reason (R) Blood group 'O' has both antigen A and B.

173. Assertion (A) Epidermis of skin in the vertebrates is characterized by keratinization.
Reason (R) Stratum corneum is too thick in Rana to facilitate the inflow of water from outside into the body.

174. Assertion (A) The function of the hormone oxytocin is to contract uterus muscles and to expel milk from mammary gland.
Reason (R) Oxytocin is absent in man.

175. Assertion (A) Sucrose is sweet in taste.
Reason (R) Sucrose is converted by the enzyme invertase present in living system to glucose and fructose.

176. Assertion (A) Goitre is endemic in mountainous region.
Reason (R) The diet of the people in mountains lack iodine content.

177. Assertion (A) The main source of energy in most of the Indian diet is carbohydrate.
Reason (R) Carbohydrates provide more energy per gram than proteins and fats.

178. Assertion (A) The air is purified in the nose.
Reason (R) The nasal cavity contains hairs and mucous membrane.

179. Assertion (A) Urine of some insects and birds contains uric acid.
Reason (R) Uric acid is more poisonous than urea.

180. Assertion (A) Mating of the cow and a bull at any wide not be useful for breeding purposes.
Reason (R) Fertilization may not take place.

181. Assertion (A) Obesity is not problem for a sportsman even through his diet contains more carbohydrates and fats than an average man.
Reason (R) A sportsman is able to expend more calories through steroids.

182. Which one among the following will be absorbed fastest through the wall of digestive system? **(CDS 2011 II)**
(a) Black coffee as a hot beverage
(b) DDT taken as a poison
(c) Raw alcohol taken as a drink
(d) Ice-cream as a desert

183. If we sprinkle common salt on an earthworm, it dies due to **(CDS 2011 II)**
(a) osmotic shock
(b) respiratory failure
(c) toxic effect of salt
(d) closure of pores of skin

184. Development of goitre (enlarged thyroid gland) is mainly due to deficiency of **(CDS 2011 II)**
(a) sodium (b) iodine (c) calcium (d) iron

185. To suspect HIV/AIDS in a young individual, which one among the following symptoms is mostly associated with? **(CDS 2011 II)**
(a) Long standing jaundice and chronic liver disease
(b) Severe anaemia
(c) Chronic diarrhoea
(d) Severe persistent headache

186. When we eat something we like, our mouth waters. This is actually not water but fluid secreted from **(CDS 2011 I)**
(a) nasal glands (b) oval epithelium
(c) salivary glands (d) tongue

187. Dog bite can cause rabies. Which among the following other animals can also cause rabies? **(CDS 2011 I)**
(a) Donkey (b) Bat
(c) Horse (d) Crocodile

188. Which one among the following is not correct about Down's syndrome? **(CDS 2011 I)**
(a) It is a genetic disorder
(b) Effected individual has early ageing
(c) Effected person has mental retardation
(d) Effected person has furrowed tongue with open mouth

189. Which one among the following elements/ions is essential in small quantities for development of healthy teeth but causes mottling of the teeth if consumed in higher quantities? **(CDS 2011 I)**
(a) Iron (b) Chloride
(c) Fluoride (d) Potassium

190. White blood cells act **(CDS 2011 I)**
(a) as a defence against infection
(b) as source of energy
(c) for clotting blood
(d) as a medium for oxygen transport from lung to tissues

191. Which of the following diseases are transmitted from one person to another? **(CDS 2011 I)**
I. AIDS II. Cirrhosis
III. Hepatitis-B IV. Syphilis
Select the correct answer using the codes given below
(a) I, II, III and IV (b) I, III and IV **(CDS 2011 I)**
(c) I and II (d) II, III and IV

192. Insects that can transmit diseases to human are referred to as
(a) carriers (b) reservoirs (c) vectors (d) incubators

193. Due to contraction of eyeball, a long-sighted eye can see only **(CDS 2011 I)**
(a) farther objects which is corrected by using convex lens
(b) farther objects which is corrected by using concave le.
(c) nearer objects which is corrected by using convex lens
(d) nearer objects whichi s corrected by using concave lens

194. Which among the following is the correct increasing order of pH found in human body? **(CDS 2010 II)**
(a) Gastric juice, saliva, blood
(b) Blood, saliva, gastric juice
(c) Saliva, blood, gastric juice
(d) Gastric juice, blood, saliva

195. Which one among the following animal tissues transport hormones and heat and maintains water balance? **(CDS 2010 II)**
(a) Connective tissue (b) Muscular tissue
(c) Blood (d) Nervous tissue

196. Human body's main organ of balance is located in **(CDS 2010 II)**
(a) inner part of ear
(b) middle part of ear
(c) front part of brain
(d) top part of vertebral column

197. What is the most conspicuous salient feature of people with 'Progeria'? **(CDS 2010 II)**
(a) More hair on body
(b) Less immunity to opportunistic infections
(c) Faster rate of ageing
(d) Suffer from infertility

198. A deficiency of which one of the following minerals is most likely to lead to an immunodeficiency? **(CDS 2010 II)**
(a) Calcium (b) Zinc
(c) Lead (d) Copper

199. Consider the following statements. **(CDS 2010 II)**
I. Warm-blooded animals can remain active in cold environment in which cold-blooded animals can hardly move.
II. Cold-blooded animals require much less energy to survive than warm-blooded animals.
Which of the statements given above is/are correct?
(a) Only I (b) Only II
(c) Both I and II (d) Neither I nor II

200. Mosquito can be a vector for following disease except **(CDS 2010 II)**
(a) yellow fever (b) dengue fever
(c) filaria (d) kala-azar

201. Consider the following statements. **(CDS 2010 I)**
I. Iodine is necessary for the thyroid gland to make adrenaline.
II. Iodine deficiency leads to goitre in human beings.
III. Iodine is secreted by pancreas and helps in regulating cholesterol level.
Which of the statements given above is/are correct?
(a) I, II and III (b) I and II
(c) I and III (d) II only

202. Consider the following statements. **(CDS 2010 I)**
I. A person with myopia can see distant objects distinctly but cannot see nearby objects clearly.
II. A person with hypermetropia cannot see distant objects clearly.
III. A person with presbyopia can see nearby objects without corrective glasses.
Which of the statements given above is/are not correct?
(a) I, II and III (b) I and II
(c) I and III (d) III only

203. The vitamin(s), which is/are generally excreted in urine, is/are **(CDS 2010 I)**
(a) vitamin-A (b) vitamin-B
(c) vitamin-C (d) vitamin-D and K

204. Itching due to insect bite is caused by **(CDS 2010 I)**
(a) formic acid (b) acetic acid
(c) lactic acid (d) maleic acid

205. For which one among the following diseases no vaccine is yet available? **(CDS 2009 II)**
(a) Tetanus (b) Malaria (c) Measles (d) Mumps

206. Which one of the following animals breathe through the skin? **(CDS 2009 II)**
(a) Fish (b) Pigeon (c) Frog (d) Cockroach

207. Anthrax is a disease of human and cattle with a potential for biological warfare. It is caused by **(CDS 2009 II)**
(a) bacterium (b) virus (c) protozoan (d) fungus

208. Which one of the following is considered normal blood pressure in man? **(CDS 2009 II)**
(a) 120/80 mm water (b) 120/80 mm blood
(c) 120/80 mm mercury (d) 120/80 mm air

209. Anaemia is a common health problem especially in women. Which one of the following deficiencies is most frequently responsible for anaemia in India? **(CDS 2009 II)**
(a) Calcium (b) Iron
(c) Iodine (d) Zinc

210. Primary source of vitamin-D for human beings is **(CDS 2009 II)**
(a) citrus fruit (b) green vegetables
(c) yeast (d) sun

211. Match list I with list II and select the correct answer using the codes given below the lists. **(CDS 2009 II)**

List I (Agent of Transmission)	List II (Disease Transmitted)
A. *Anopheles* mosquito	1. Kala-azar
B. *Culex* mosquito	2. Dengue
C. *Aedes*	3. Malaria
D. Sandfly	4. Filaria

Codes

	A	B	C	D		A	B	C	D
(a)	3	2	4	1	(b)	1	4	2	3
(c)	1	2	4	3	(d)	3	4	2	1

212. **Assertion (A)** The safety air bags fitted in some cars inflate during head-on impact of the car.
Reason (R) The inflation is due to pumping of air into the balloon during the impact. **(CDS 2009 II)**
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually 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

213. Match list I with list II and select the correct answer using the codes given below the lists. **(CDS 2009 I)**

List I (Vitamin)	List II (Chemical Compound)
A. Vitamin-A	1. Thiamine
B. Vitamin-B_1	2. Retinol
C. Vitamin-C	3. Ascorbic acid
D. Vitamin-E	4. Tocopherol

Codes

	A	B	C	D		A	B	C	D
(a)	4	1	3	2	(b)	2	3	1	4
(c)	4	3	1	2	(d)	2	1	3	4

214. In human beings, the opening of the stomach into the small intestine is called **(CDS 2009 I)**
(a) caecum (b) ileum
(c) oesophagus (d) pylorus

215. Between which one of the following sets of blood groups, is the blood transfusion possible? **(CDS 2008 II)**
(a) A and O (A donor) (b) B and A (B donor)
(c) A and AB (A donor) (d) AB and O (AB donor)

216. Which one of the following diseases is caused by virus? **(CDS 2008 II)**
(a) Tuberculosis (b) Typhoid
(c) Influenza (d) Diphtheria

217. Malaria in the human body is caused by which one of the following organisms? **(CDS 2008 II)**
(a) Bacteria (b) Virus
(c) Mosquito (d) Protozoan

218. Sweating during exercise indicates operation of which one of the following processes in the human body? **(CDS 2008 II)**
(a) Enthalpy (b) Homeostasis
(c) Phagocytosis (d) Osmoregulation

219. Which chamber of human heart pumps fully oxygenated blood to aorta and hence to the body? **(CDS 2008 II)**
(a) Right auricle (b) Left auricle
(c) Right ventricle (d) Left ventricle

220. Which of the following is a rich source of energy? **(CDS 2008 II)**
(a) Protein (b) Lipid
(c) Carbohydrate (d) Vitamin

221. In human body, what is the number of cervical vertebrae? **(CDS 2008 II)**
(a) 5 (b) 7 (c) 8 (d) 12

222. The terms lubb and dup relate to which one of the following? **(CDS 2008 II)**
(a) Heart (b) Eyes (c) Teeth (d) Lungs

223. In normal adult human, what is the rate of heart beat per minute? **(CDS 2008 II)**
(a) 72-80 (b) 70-75 (c) 80-97 (d) 82-87

224. Which one of the following is considered as the easily digestible source of protein? **(CDS 2008 II)**
(a) Egg albumin (b) Soyabean
(c) Fish flesh (d) Red meat

225. What does airbag, used for safety of car driver, contain? **(CDS 2008 II)**
(a) Sodium bicarbonate (b) Sodium azide
(c) Sodium nitrite (d) Sodium peroxide

226. **Assertion (A)** Red blood cells burst when placed in water.
Reason (R) Due to osmosis, water enters into red blood cells rich source of energy. **(CDS 2008 II)**
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually 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

227. Dim-vision in the evening and night results from the deficiency of which one of the following? **(CDS 2008 II)**
(a) Vitamin-A (b) Vitamin-E
(c) Vitamin-B_{12} (d) Vitamin-C

228. The persons working in textile factories such as carpet weavers are exposed to which of the following occupational diseases? **(CDS 2008 II)**
(a) Asbestosis (b) Asthma and tuberculosis
(c) Silicosis (d) Siderosis

229. In the human body, Cowper's glands form a part of which one of the following? **(CDS 2008 I)**
(a) Digestive system (b) Endocrine system
(c) Reproductive system (d) Nervous system

230. Which one of the following glands produces the growth hormone (somatotrophin)? **(CDS 2008 I)**
(a) Adrenal (b) Pancreas (c) Pituitary (d) Thyroid

231. Which one of the following is not an insect borne disease? **(CDS 2008 I)**
(a) Beri-beri (b) Kala-azar
(c) Malaria (d) Plague

232. Match list I with list II and select the correct answer using the codes given below the lists. **(CDS 2008 I)**

List I (Disease)	List II (Part of Human Body Affected)
A. Conjunctivitis	1. Eyes
B. Dermatitis	2. Joints
C. Gout	3. Skin
D. Meningitis	4. Spinal cord

Codes

	A	B	C	D
(a)	2	4	1	3
(b)	1	3	2	4
(c)	2	3	1	4
(d)	1	4	2	3

233. Which of the following parts of blood carry out the function of body defence? **(CDS 2008 I)**
(a) Red blood cells
(b) White blood cells
(c) Platelets
(d) Haemoglobins

234. Match the following lists.

List I (Scientist)	List II (Work)
A. FG Banting	1. Vaccination for small pox
B. J Lister	2. Germ theory
C. Louis Pasteur	3. Use of carbolic acid as an antiseptic
D. E Jenner	4. Discovery of insulin

Codes

	A	B	C	D
(a)	4	3	2	1
(b)	4	2	1	3
(c)	3	4	2	1
(d)	1	4	3	2

235. Which of the following diseases are preventable by vaccine?
I. Tetanus II. Polio
III. Leprosy IV. Pertusis
Select the correct answer using the code given below
(a) I and III (b) II and IV
(c) I, II and IV (d) I, II, III and IV

236. Which one of the following glands in the human body stores iodine?
(a) Parathyroid (b) Thyroid (c) Pituitary (d) Adrenal

237. Which one of the following vitamins helps in clotting of blood?
(a) Vitamin-A (b) Vitamin-B_6 (c) Vitamin-D (d) Vitamin-K

238. Which one of the following causes the chikungunia disease?
(a) Bacteria (b) Helminthic worm
(c) Protozoan (d) Virus

239. What does sphygmomanometer measure?
(a) Blood pressure
(b) Velocity of fluids
(c) Temperature
(d) Curvature of spherical surfaces

240. A mother of blood group 'O' has a group 'O' child. What could be father of the child?
(a) 'O' only (b) 'A' or 'B' or 'O'
(c) 'A' or 'B' only (d) 'AB' only

Answers

1. (d)	2. (d)	3. (b)	4. (c)	5. (a)	6. (d)	7. (c)	8. (c)	9. (c)	10. (c)
11. (b)	12. (c)	13. (a)	14. (d)	15. (a)	16. (b)	17. (b)	18. (c)	19. (b)	20. (c)
21. (c)	22. (b)	23. (d)	24. (a)	25. (d)	26. (b)	27. (d)	28. (c)	29. (d)	30. (a)
31. (d)	32. (a)	33. (d)	34. (d)	35. (d)	36. (c)	37. (c)	38. (c)	39. (b)	40. (b)
41. (c)	42. (c)	43. (b)	44. (d)	45. (a)	46. (c)	47. (c)	48. (c)	49. (b)	50. (b)
51. (a)	52. (c)	53. (c)	54. (a)	55. (b)	56. (a)	57. (d)	58. (a)	59. (c)	60. (b)
61. (c)	62. (d)	63. (b)	64. (c)	65. (c)	66. (d)	67. (d)	68. (c)	69. (c)	70. (c)
71. (b)	72. (d)	73. (d)	74. (a)	75. (b)	76. (a)	77. (b)	78. (c)	79. (d)	80. (a)
81. (c)	82. (b)	83. (c)	84. (b)	85. (c)	86. (a)	87. (b)	88. (a)	89. (c)	90. (d)
91. (d)	92. (b)	93. (d)	94. (b)	95. (d)	96. (a)	97. (c)	98. (b)	99. (a)	100. (b)
101. (a)	102. (c)	103. (d)	104. (c)	105. (d)	106. (b)	107. (b)	108. (b)	109. (b)	110. (b)
111. (c)	112. (c)	113. (b)	114. (b)	115. (b)	116. (d)	117. (c)	118. (d)	119. (c)	120. (b)
121. (c)	122. (b)	123. (b)	124. (b)	125. (c)	126. (b)	127. (b)	128. (c)	129. (c)	130. (d)
131. (b)	132. (d)	133. (a)	134. (c)	135. (b)	136. (c)	137. (b)	138. (d)	139. (a)	140. (d)
141. (b)	142. (a)	143. (d)	144. (c)	145. (a)	146. (b)	147. (c)	148. (d)	149. (a)	150. (d)
151. (d)	152. (a)	153. (a)	154. (d)	155. (a)	156. (d)	157. (b)	158. (a)	159. (d)	160. (d)
161. (a)	162. (b)	163. (b)	164. (c)	165. (c)	166. (d)	167. (a)	168. (b)	169. (a)	170. (a)
171. (d)	172. (c)	173. (d)	174. (b)	175. (d)	176. (a)	177. (c)	178. (a)	179. (c)	180. (a)
181. (d)	182. (c)	183. (a)	184. (b)	185. (d)	186. (c)	187. (b)	188. (b)	189. (c)	190. (a)
191. (b)	192. (c)	193. (c)	194. (a)	195. (c)	196. (a)	197. (c)	198. (b)	199. (c)	200. (d)
201. (d)	202. (a)	203. (b)	204. (a)	205. (b)	206. (c)	207. (a)	208. (c)	209. (b)	210. (d)
211. (d)	212. (b)	213. (d)	214. (d)	215. (c)	216. (c)	217. (a)	218. (b)	219. (d)	220. (c)
221. (b)	222. (a)	223. (a)	224. (a)	225. (b)	226. (a)	227. (a)	228. (b)	229. (c)	230. (c)
231. (a)	232. (b)	233. (b)	234. (b)	235. (b)	236. (b)	237. (d)	238. (d)	239. (a)	240. (b)