CHAPTER

4 Human Physiology

- The food that we consume must be broken down into simpler absorbable forms so that they can be easily absorbed and transported to various parts of our body through blood. This task is accomplished by the digestive system.

Dental formula for adult human

$$\frac{\text{Upper jaw}}{\text{Lower jaw}} = \frac{\text{I C Pm M}}{\text{I C Pm M}} = \frac{\mathbf{2123}}{\mathbf{2123}}$$

Digestion of Food

Name of the Digestive	Name of the enzymes	Substrate	End product
Saliva	Ptyalin (Salivary amylase)	Starch	Maltose
Pancreatic iuice	Amylopsin (pancreatic amylase)	Starch, Glycogen	Maltose and Glucose
Intestinal juice	Sucrase (invertase), Maltase, Lactase	Sucrose; Maltose, Lactose	Glucose and fructose, Glucose, Glucose and galactose
Gastric iuice	Pepsin, Rennin	Proteins, Casein	Proteoses and peptones, Calcium caseinate
Pancreatic iuice	Trypsin, Chymotrypsin, Carboxyl peptidases	Proteins, Proteins Peptides	Proteoses and peptides Peptides Amino acid.
Intestinal juice	Amino peptidase, Dipeptidase	Peptides	Amino acids, Amino acids

Vitamin required by the body

Vitamin	Chemical Name	Function In Body	Deficiency Disease
B_1	Thiamine pyrophosphate	Part of coenzyme for respiration	**Beri-beri:** nerve and heart disorders
B_2	Riboflavin	Part of coenzyme FAD needed for respiration	**Ariboflavinosis:** skin and eye disorders
B_{12}	Cyanocobalamin	Coenzyme needed for making red blood cells, bone, blood and nerve changes	**Pernicious anaemia**
B_5	Nicotinic acid ('niacin')	Part of coenzymes NAD, NADP used in respiration	**Pellagra:** skin, gut and nerve disorders
C	Ascorbic acid	Not precisely known	**Scurvy:** degeneration of skin teeth and blood vessels.
A	Retinol	Not fully known but forms part of visual pigment, rhodopsin	**Xeropthalmia:** 'dry eyes'
D	Cholecalciferol	Stimulates calcium absorption by small intestine, needed for proper bone growth	**Rickets:** bone deformity
E	Tocopherol	Not precisely known	**Infertility**
K	Phylloquinone	Involved in blood clotting	**Possible haemorrage**

Inorganic Elements in the Human Diet

Element	Common ions	Functions in human body
Calcium	Ca^{2+}	Calcium ions are needed for stability of cell membranes, as cofactors for some enzymes and are involved in muscle contraction and blood clotting.
Phosphorus	H_2PO_4	Bones component of many organic molecules like DNA, RNA and ATP.
Potassium Sodium Chlorine	K^+ Na^+ Cl^-	These ions are important in determining the balance of electrical charges in body fluids.
Iron	Fe^{2+}, Fe^{3+}	Component of haemoglobin and cytochrome molecules.
Iodine	I^-	Component of hormone thyroxin.
Copper Manganes Zinc	Cu^{2+} Mn^{2+} Zn^{2+}	Trace elements as enzyme cofactors, for example, Cu^{2+} is co-factor for cytochrome oxidase.

- Marasmus is produced by a simultaneous deficiency of proteins and calories. In Marasmus, protein deficiency impairs growth and replacement of tissue proteins; extreme emaciation of the body and thinning of limbs results, the skin becomes dry, thin and wrinkled. Growth rate and body weight decline considerably.
- Kwashiorkar is produced by protein deficiency unaccompanied by calorie deficiency. Like marasmus, kwashiorkor shows wasting of muscles, thinning of limbs, failure of growth and brain development.

Human Respiratory System

- Human respiratory system consists of external nostrils, nasal cavity, nasopharynx, larynx, trachea, bronchiole and lungs.

Transport of gases

- 97% of oxygen is transported from the lungs to the tissues in combination with haemoglobin ($Hb + O_2 \longrightarrow HbO_2$, oxyhaemoglobin). 3% is transported in dissolved condition by the plasma.

There are three ways of transport of CO_2.

- 5%–7% (approximately) of CO_2 is transported, being dissolved in the plasma of blood.
- CO_2 react with the water to form *carbonic acid* (H_2CO_3) by the enzyme carbonic anhydrase (present in RBC).
- CO_2 reacts with amine radicals (NH_2) of haemoglobin molecule and forms a carbamino–haemoglobin ($HbCO_2$) molecule. Nearly 23% of CO_2 is transported through this mode.

Disorders of respiratory system

Bronchial Asthma : It is characterised by the spasm of smooth muscles of the wall of bronchiole.

Emphysema : It is an inflation of bronchiole, which results into loss of elasticity of these parts.

Occupational Lung Disease : It is caused because of the exposure of potentially harmful substances persuntion in the environment, where people work. Two common occupational diseases are – silicosis and asbestosis.

Blood Groups

- **ABO grouping :** It is based on the presence or absence of two surface antigens on the RBCs namely A and B.

Table : Blood Groups and Donor Compatibility

Blood Group	Antigens on RBCs	Antibodies in Plasma	Donor's Group
A	A	anti-B	A, O
B	B	anti-A	B, O
AB	A, B	nil	AB, A, B, O
O	nil	anti-A, B	O

Rh Grouping : Another antigen, the Rh antigen are also observed on the surface of RBCs of majority of humans (Rh^+ individuals). A special case of Rh incompatibility has been observed between Rh^- blood of a pregnant mother with Rh^+ blood of foetus.

Circulatory Pathways

The circulatory patterns are of two types –

- **Open circulatory system** is present in arthropods and molluscs in which blood pumped by the heart passes through large vessels into open spaces or body cavities called sinuses. Annelids and chordates have a **closed circulatory system** in which the blood pumped by the heart is always circulated through a closed network of blood vessels. All vertebrates possess a muscular chambered heart. Fishes have a 2-chambered heart with an atrium and a ventricle. Amphibians and the reptiles (except crocodiles) have a 3-chambered heart with two atria and a single ventricle, whereas crocodiles, birds and mammals possess a 4-chambered heart with two artia and two ventricles.

Heart Beat and Pulse

- The human heart beats at the rate of about 72-80 per minute in the resting condition.

Electrocardiograph

- ECG is the graphic record of electronic current produced by the excitation of cardiac muscles.
- A normal electrocardiogram is composed of a P wave, QRS complex and T wave. P wave indicate the depolarisation of the atria. QRS complex expresses the ventricular depolarisation. T wave indicate an repolarisation of ventrcle.

Disorders of Circulatory System

Hypertension

- A continuous or sustained rise in arterial pressure is known as hypertension. High blood pressure compels heart to work excessive and then can tend to congestive heart disease.

Atherosclerosis

- In this, calcium salts precipitated with cholesterol of the forming or formed opaque making the wall of arteries stiff and rigid and is referred to as the hardening of the arteries. It may lead to heart attack and death.

Excretion

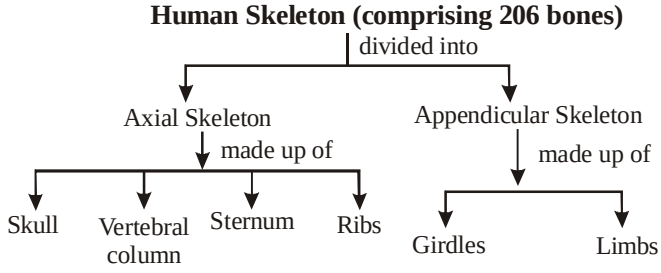
- The process of excreting ammonia is -**Ammonotelism**. Kidney plays a minor role in the elimination of ammonia *e.g.*, teleost fishes, tadpoles, aquatic soft bodied invertebrates. Organism undergoing ammonotelism are called **ammonotelic**.
- The process of excreting urea is - **Ureotelism**. Examples are mammals, many terrestrial adult amphibians and cartilaginous fishes (shark).
- The process of elimination of uric acid is -**Uricotelism** Examples are land snails, insects, birds and many reptiles.
- Each kidney has nearly one million complex tubular structures called **nephrons**, which are the functional units of kidney. These filter the blood to produce urine.

Disorders of the Excretory System

- Malfunctioning of kidneys can lead to accumulation of urea in blood, a condition called **uremia**, which is highly harmful and may lead to kidney failure.

- In such patients, urea can be removed by a process called **hemodialysis**. Blood drained from a convenient artery is pumped into a dialysing unit called **artificial kidney**.
- **Renal calculi :** Stone or insoluble mass of crystallized salts (oxalates, *etc*.) formed within the kidney.
- **Glomerulonephritis :** Inflammation of glomeruli of kidney.

Skeletal System



Axial Skeleton : Skeleton which occurs in the mid axial or longitudinal part of the body.

(i) **Skull** is made up of 29 bones. It is composed of
- **Cranium (8 bones)** : Frontal - 1; Parietal - 2; Occipital - 1; Temporal - 2; Sphenoid - 1; Ethmoid - 1.
- **Facial bones (14 in number)** : Nasal - 2; Maxillae - 2; Zygomatic - 2; Lacrymals - 2; Mandibles - 1; Inferior turbinals - 2; Vomer - 1; Palatines - 2. Hyoid Tongue bone - 1
- **Ear ossicles (6 bones)** : Malleus -2; Incus - 2; Stapes - 2.

(ii) **Vertebral column :** 33 in babies, 26 in adults. Grouped into 5 categories :
Cervical - 7; Thoracic - 12; Lumber - 5; Sacral - 5; Coccygeal - 4 (fused in adults).

(iii) **Sternum** : Composed of 3 parts → Manubrium, body of sternum and xiphoid process .

(iv) **Ribs** : They are twelve pairs. First seven pairs are true ribs. The 8th, 9th and 10th ribs are called false ribs or vertebrochondrial ribs. The last 11th and 12th pairs are called floating ribs.

Appendicular Skeleton : Present laterally or attached to the axial skeleton.

(i) **Girdles :** 2 types - pectoral and pelvic.
Pectoral girdle : made of two parts - clavicle and scapula.
Pelvic girdle : made of three bones - ilium, pubis and ischium.

(ii) **Limb bones** : Hind limbs and fore limbs - both made up of 30 bones each.
Fore limbs : Humerus (1); Radius-Ulna (2); Carpals (8); Metacarpals (5); Phalanges (14); Phalanges formula = 2, 3, 3, 3, 3. **Hind limbs** : Femur (1); Tibia-Fibula (2); Patella (1); Tarsals (7); Metatarsals (5); Phalanges (14).

Joints

- A joint is a location at which two bones make contact and is essential for all types of movements, involving the bony parts of the body.

Synovial Joints - Movable Joints : They are characterised by the presence of a closed space or **cavity** between the bones.

- This kind of joint are classified into six major categories.
  - **Plane** (gliding joint) : Present between carpals. Only sliding motion in all direction is allowed.
  - **Hinge joint** : Present between Knee joint
  - **Pivot joint** : Present between atlas and axis
  - **Saddle joint** : Present between carpal and metacarpal
  - **Ball and Socket joint** : Present between humerus and pectoral girdle.

Disorders of Muscular and Skeletal System

- **Myasthenia gravis** - Autoimmune disorder. It affects neuromuscular transmission.
- **Muscular dystrophy** - Progressive skeletal muscle weakness, defects in muscle proteins, the death of muscle cells and tissue.
- **Rheumatoid Arthritis :** Inflammation of synovial membrane.
- **Osteoarthritis :** Degeneration of articular cartilage.
- **Gout :** Caused by excess formation of uric acid and their deposition in the joints.
- **Osteoporosis :** Low bone mass, increased fragility and proneness to fracture.

Neural Control and Coordination

- The neural sysem is the control system of the body which consists of highly specialized cells called **neurons**.
- A neuron consists of main cell body and cytoplasmic processes arising from it.

The human brain is divisible into three parts:

- **Forebrain :** It comprises the olfactory lobes, cerebrum and diencephalon.
  Cerebrum is the largest and complex part. It consists of the left and right hemispheres connected by a bundle of myelinated fibres, called corpus callosum. The outer layer of the cerebrum is called the cortex.
- **Diencephalon :** The main parts of the diencephalon are epithalamus, thalamus and hypothalamus.
- The hypothalamus is the highest centre of autonomic nervous system. It governs emotional reactions and exercise control over sleep mechanism.
- **Midbrain :** It is formed of corpora quadrigemina and cerebral peduncles. Cerebral penduncles are bundles of fibres connecting the cerebral cortex with other parts of brain and spinal cord.
- **Hind brain :** It comprises of :
  - **Cerebellum :** It controls the balance and posture of the body.
  - **Pons varolii -** The pons is concered with maintenance of normal rhythm of respiration.
  - **Medulla oblongata -** Medullary centres (reflex centres) are present for controlling the functions of important organs, *e.g.*, cardiac centres (heart), respiratory centre, vasomotor centre (for regulating diameter of blood vessels) and reflex centres (for swallowing, vomiting, peristalsis, secretion and activity of alimentary canal, salivation, coughing etc.)

Chemical Coordination in Animal (Hormones)

Endocrine Gland	Hormone	Principal action	Disorders
Thyroid	Thyroxine (T_4) and Triiodothyronine (T_3) Calcitonin	Maintains calcium level normal in the body. Increases rate of metabolism in the body.	Cretinism, myxoedema goiter
Parathyroid	Parathormone (PTH)	Increases plasma calcium	Parathyroid tetany osteoporosis
Adrenal gland (medulla)	Adrenaline and Noradrenaline	Increases heart beat, blood sugar and also constricts blood vessel	
Adrenal cortex	Mineralocorticoids (aldosterone)	Increases reabsorption of sodium and excertion of potassium	Addison's disease Adrenal virilism
	Glucocorticoids (cortisol)	Increases blood sugar and affects carbohydrate, fat and protein metabolism	Cushing's syndrome
Hypothalamus	ARH	Regulates corticotropin secretion	
	TRH	Thyrotropin secretion	
	SRH	Stimulates secretion of gonadotropins	
	(Growth hormone releaing factor)	Regulates secretion of prolactin	
	(Prolactir releasing hormone) and (Prolactin inhibitory hormone)	Control secretion of MSH	
Pituitary gland anterior lobe	Pituitary gland anterior lobe	Stimulates general growth	Pituitary dwarfism, gigantism, Acromegaly
	Prolactin	Stimulates milk production and secretion	
	(Follicle stimulating hormone)	Stimulates ovarian follicle and spermatogenesis	
	(Lutemizing hormone)	Stimulates corpus luteum and ovulation in females and interstitial cell in males	
	(Thyroid stimulating hormone)	Stimulates thyroid gland to secrete hormones	
	Adrenocorticotropic hormone	Stimulates adrenal cortex to secrete glucocorticoids	
Intermediate lobe	Melanocyte stimulating hormone	Growth and development of melanocyte	
Posterior lobe	Oxytocin	Contraction of uterine muscles and mammary gland cells	
	Vasopressin (ADH)	Promotes reabsorption of water from collecting ducts of kidneys	Diabetes insipidus

Pancreas

- Located posterior to stomach, close to duodenum.
- **Endocrine Pancreas :** Consists of islets of Langerhans. The islet of Langerhans have two main types of cells.

ENDOCRINE PANCREATIC SECRETIONS :

	NAME OF THE CELLS	PRODUCT	FUNCTION
1.	Beta (β) cells	Insulin and Amylin	Lower blood sugar level.
2.	Alpha (α) cells	Glucagon	Raise blood sugar level.

Testes

Function : Produces a group of hormones called androgens mainly testosterone.

- Androgen regulates the development, maturation and functions of the male accessory sex organs.

Ovary

Functions : Ovary produces one ovum during each menstrual cycle. It produces 2 groups of steroid hormones called.

(i) **Estrogen**

(ii) **Progesterone**

- Stimulating growth and activities of female secondary sex organs.
  - Supports Pregnancy.
  - Also regulates female sexual behaviour.
  - Production of milk.

Reproduction

- It is the ability of living organisms to produce a new offspring similar to themselves.
- The major reproductive events in human beings are
  (i) **Gametogenesis** – Formation of gametes.
  (ii) **Insemination** – Transfer of sperms into female genital tract.
  (iii) **Fertilisation** – Fusion of male and female gametes leading to formation of zygote.
  (iv) **Implantation** – Formation and development of blastocyst and its attachment to the uterine wall.
  (v) **Gestation** – Embryonic development; gestation is the time from conception to birth.
  (vi) **Parturition** – Delivery of baby (the process of birth).

EXERCISE

1. Which part of the alimentary canal does not secrete any enzyme?
   (a) Mouth (b) Oesophagus
   (c) Stomach (d) Duodenum
2. The food that gives more calories per unit mass of food is
   (a) protein (b) carbohydrates
   (c) fat (d) water
3. Percentage of oxygen supplied by haemoglobin is
   (a) 97% (b) 100%
   (c) 49% (d) 3%
4. Which one of the following correctly represents the normal adult human dental formula ?
   (a) $\frac{3}{3},\frac{1}{1},\frac{3}{2},\frac{1}{1}$ (b) $\frac{2}{2},\frac{1}{1},\frac{3}{2},\frac{3}{3}$
   (c) $\frac{2}{2},\frac{1}{1},\frac{2}{2},\frac{3}{3}$ (d) $\frac{3}{3},\frac{1}{1},\frac{3}{3},\frac{3}{3}$
5. In expiration, diaphragm becomes
   (a) flattened (b) relaxed
   (c) straightened (d) arched
6. Elbow joint is an example of
   (a) hinge joint (b) gliding joint
   (c) ball and socket joint (d) pivot joint
7. The toxic effect of CO is due to its greater affinity for haemoglobin as compared to O_2 approximately by
   (a) 2 times (b) 20 times
   (c) 200 times (d) 1000 times
8. A patient is generally advised to specially, consume more meat, lentils, milk and eggs in diet only when he suffers from
   (a) Scurvy (b) Kwashiorkor
   (c) Rickets (d) Anaemia
9. In which of the following reptiles four chambered heart is present ?
   (a) Lizard (b) Snake
   (c) Scorpion (d) Crocodile
10. Melatonin is produced by
    (a) thymus (b) skin
    (c) pituitary (d) pineal gland
11. Child death may occur in the marriage between
    (a) Rh^+ man and Rh^+ woman
    (b) Rh^+ man and Rh^- woman
    (c) Rh^- man and Rh^- woman
    (d) Rh^- man and Rh^+ woman
12. Which one of the following organs in the human body is most affected due to shortage of oxygen?
    (a) Intestine (b) Skin
    (c) Kidney (d) Brain
13. The pH of blood is
    (a) between 7-8 (b) between 2-4
    (c) between 12-14 (d) between 2-5
14. Antibodies are
    (a) carbohydrates (b) immunoglobulins
    (c) globular proteins (d) extrinsic proteins
15. Air is breathed through
    (a) Trachea — lungs — larynx — pharynx — alveoli
    (b) Nose — larynx — pharynx — bronchus — alveoli — bronchioles
    (c) Nostrils — pharynx — larynx — trachea — bronchi — bronchioles — alveoli
    (d) Nose — mouth — lungs
16. Which of the following disease is not concerned with disorders of circulatory system?
    (a) Heart failure
    (b) Angina
    (c) Coronary artery disease
    (d) Uremia

17. Neurons receive signals through their _____ and send signals to other neurons through their _____.
(a) dendrites ... receptors
(b) end feet ... cell bodies and dendrites
(c) cell bodies and dendrites ... axons
(d) transmitter vesicles ... axons

18. Functional and structural unit of kidney is
(a) nephron (b) seminiferous tubule
(c) acini (d) None of these

19. Asthma is caused due to
(a) Infection of lungs
(b) Spasm in bronchial muscles
(c) Bleeding into pleural cavity
(d) infection of trachea

20. Dialysis is done in the condition when person is suffering from
(a) diabetes (b) uremia
(c) polyuria (d) haemoptysis

21. Which part of human brain is concerned with the regulation of body temperature?
(a) Cerebellum (b) Cerebrum
(c) Hypothalamus (d) Medulla Oblongata

22. Which of the following organs can be called as a sort of "blood bank" ?
(a) Lungs (b) Heart
(c) Liver (d) Spleen

23. Universal blood recipient is
(a) blood group O (b) blood group AB
(c) blood group A (d) blood group B

24. Bones are mainly made up of
(a) calcium and phosphorous
(b) calcium and sulphur
(c) calcium and magnesium
(d) calcium and iron

25. ECG records
(a) rate of heart beat
(b) potential difference
(c) ventricular concentration
(d) volume of blood pumped

26. During strenuous exercise, glucose is converted into
(a) glycogen (b) pyruvic acid
(c) starch (d) lactic acid

27. In human testosterone is produced by
(a) tunica albuginea (b) leydig cell
(c) seminiferous tubule (d) sertoli cell

28. In adult, normal blood pressure is
(a) 80/120 mm Hg (b) 100/80 mm Hg
(c) 120/80 mm Hg (d) 100/120 mm Hg

29. Thoracic cage is made up of
(a) ribs, vertebral column & diaphragm
(b) ribs, diaphragm & sternum
(c) vertebral column, diaphragm & sternum
(d) ribs, vertebral column & sternum

30. The junction between an axon and dendrite is called
(a) cyton (b) synapse
(c) relay (d) conduction zone

31. A certain road accident patient with unknown blood group needs immediate blood transfusion. His one doctor friend at once offers his blood.What was the blood group of the donor?
(a) Blood group B (b) Blood group AB
(c) Blood group O (d) Blood group A

32. Which one is not a reflex action?
(a) Closing of eye lids against fricking
(b) Release of saliva on seeing sweets
(c) Perspiration due to heat
(d) Obeying the order to run

33. Which one is not correct ?
(a) Humans - Uriotelic (b) Birds - Uricotelic
(c) Lizards - Uricotelic (d) Whale - Ammonotelics

34. Main similarity between hormone and enzyme is
(a) both act at particular pH
(b) both are proteins
(c) both are required in small amounts
(d) both can be used again and again

35. Which of the following commonly called emergency gland of body?
(a) Thymus (b) Testis
(c) Adrenal (d) Pituitary

36. Other function performed by kidney apart from excretion is
(a) Osmoregulation (b) Temperature regulation
(c) Hormonal regulation (d) Spermatogenesis

37. Appearance of facial hairs in a woman may be due to the effect of
(a) temperature (b) ultraviolet radiation
(c) hormone (d) pollution

38. Glucagon is secreted by
(a) β (beta) cells of islets of langerhans
(b) α (alpha) cells of islets of langerhans
(c) β cells of pancreas
(d) adrenal cortex

39. Parathormone deficiency produces muscle ramps or tetany as a result of
(a) lowered blood Ca^{2+}
(b) enhanced blood Na^{+}
(c) enhanced blood glucose
(d) enhanced blood Ca^{2+}

40. Thymosin stimulates
(a) milk secretion (b) erythrocytes
(c) T-lymphocytes (d) melanocytes

ANSWER KEY															
1	(b)	**6**	(a)	**11**	(b)	**16**	(d)	**21**	(c)	**26**	(d)	**31**	(c)	**36**	(a)
2	(c)	**7**	(c)	**12**	(d)	**17**	(c)	**22**	(d)	**27**	(b)	**32**	(c)	**37**	(c)
3	(a)	**8**	(b)	**13**	(a)	**18**	(a)	**23**	(b)	**28**	(c)	**33**	(d)	**38**	(b)
4	(c)	**9**	(d)	**14**	(b)	**19**	(b)	**24**	(a)	**29**	(d)	**34**	(c)	**39**	(a)
5	(d)	**10**	(d)	**15**	(c)	**20**	(b)	**25**	(b)	**30**	(b)	**35**	(c)	**40**	(c)

HINTS AND SOLUTIONS

3. (a) About 97% of oxygen is carried in combination with haemoglobin of the erythrocytes to form oxyhaemoglobin.

4. (c) The adult dental formula of human is Incisor $\frac{2}{2}$, Canine $\frac{1}{1}$, Premolar $\frac{2}{2}$, Molar $\frac{3}{3}$.

6. (a) Elbow joint is an example of hinge joint. The elbow is a hinge joint; it can open and close like a door. Hinge joint allows angular movement in one plane only, increasing or decreasing the angle between the bones *e.g.* elbow joint, knee joint etc.

8. (b) A child may have a diet containing sufficient carbohydrates and fats but still suffers a serious form of malnutrition. This form of malnutrition is known as Kwashiorkar. It develops in children whose diets are deficient in protein.

10. (d) Melatonin is secreted by pineal gland present between the cerebral hemispheres. Melatonin concentration in blood follows a diurnal cycle, it rises in the evening and drops at noon. Melatonin lightens skin colour in certain animals and regulates working of gonads.

11. (b) Rh factor was discovered by Karl Landsteiner. A child of Rh^+ man will be Rh^+ whether the mother is Rh^+ or Rh^-. If the mother is Rh^+ then there will be no problem but if mother is Rh^- so when the blood of Rh^+ child (in womb) mixes with the blood of Rh^- mother then some antibodies in mother's blood are formed against Rh^+ factor which coagulate the womb blood causing death. If birth takes place then there is a possibility of child death in early years. This in known as *erythroblastosis foetalis.* In most cases the first pregnancy may succeed but after that it fails.

12. (d) Brain is the most vital organ. It stops functioning in the absence of O_2.

13. (a) Blood is an opaque, mobile connective tissue fluid which has salty taste. pH of blood is between 7-8. Hence, the blood possesses slightly alkaline pH.

14. (b) Antibodies are immunoglobulins (Igs) which are produced in response to antigenic stimulation.

15. (c) The pathway of inhaled air is - Nostrils - pharynx (common passage for food & air) - larynx (voice box) - trachea (the wind pipe) - bronchi (2 for each side lungs) - bronchioles (give arise to alveolar ducts) - alveoli (the exchange site for gases in the form of small sacs or pouches).

17. (c) Dendrites generally receive inputs and conduct signals toward the cell body, whereas axons conduct signals away from the cell body.

23. (b) Blood group AB individuals have both A and B antigens on the surface of their RBCs, and their blood plasma does not contain any antibodies against either A or B antigen. Therefore, an individual with type AB blood can receive blood from any group with AB being preferable. Hence, blood group AB is known as universal recipient.

24. (a) Bone is the solid rigid strong connective tissue. Its matrix consists of ossein protein and mineralization of matrix occurs by calcium- phosphate salts. This gives rigidity and strength to bones.

29. (d) Rib cage consists of vertebral column (dorsal), sternum (ventral) and ribs (lateral).

30. (b) The junction between an axon and dendrite is known as synapses through which nerve impulse is transmitted from one neuron to other. A synapse consists of swelling at the end of nerve fibre called synaptic knob and small synaptic vesicle containing neuro-transmitter–acetylcholine for the transmission of nerve impulse.

31. (c) Blood group O acts as universal donor.

32. (c) Reflex action is the immediate involuntary response to stimulus. It includes sudden action of body parts due to heat stimulus, burn stimulus, pricking, sneezing, coughing yawning, etc. Perspiration is not a reflex action. It is also known as sweating. Sweating is loss of water from sweat glands of the skin. Sweat includes some salts and urea. Its for temperature regulation.

33. (d) Whale is ureotelic.

35. (c) Adrenal or suprarenal glands are called emergency gland of the body. The medullary portion of these glands secretes hormones adrenaline and nor adrenaline. Their secretion is stimulated by the sympathetic nervous system. These hormones are secreted in emergancy conditions like anger, injury, cold, emotional stress, fear etc, hence also called hormones for fight or flight.

36. (a) Besides removing the metabolic wastes and impurities from the blood the kidney also perform the important function of osmoregulation (regulation of osmolality) by regulating the amount of water in body fluids.

39. (a) Parathormone released by the parathyroid gland elevates the level of Ca^{2+} in blood. The deficiency of this hormone lowers blood Ca^{2+}. As a result, the excitability of muscles and nerves increases producing tetany sustained contraction.