Chapter -2
Human System

The human body is a wonderful and complex structure of nature that operates by the interaction of its different structural units. The organization of the body begins with atoms, molecules and compounds and together with cells, tissues, organs and complex body systems forms the human body. The human body works with mutual coordination of its constituents. Cell is the basic structural and functional unit of the body. Different cells work for different body functions. Group of cells performing similar functions constitutes a tissue such as muscles, bones etc. Two or more type of tissues interacts with each other to discharge a function. Such group of tissues forms an organ (like stomach, liver, etc.). Various organ of the body interact with each other to perform a specific function and form a body system/organization. For example- digestive system, respiratory system etc. Various body systems work jointly in close coordination and form a human body. In this lesson, you will be given detailed information about various systems working in the human body.

2.1 Digestive System

Human beings receive the energy and raw organic substances necessary for their body from the food. The food is made from various components such as proteins, carbohydrates, fats, vitamins, minerals and salts etc. Most of these components present in the food are in complex form. For absorption in the body the complex food items are simplified.To accomplish this process, right from the intake of food to defecation, a system comprising of various organs and glands function in close coordination. This system is called as the **Digestive System**. In the process of digestion, with the help of various chemical processes and enzymes, the complex nutrients and larger food molecules are converted into simple, small and soluble substances. The various organs and glands involved in digestive system are as follows (Figure. 2.1).

(A) Organs

(1) Mouth
(2) Pharynx
(3) Esophagus
(4) Stomach
(5) Small Intestine
(6) Large Intestine
(7) Rectum

(B) Glands

(1) Salivary gland
(2) Liver
(3) Pancreas

All these organs together makes up **Alimentary canal** that starts from the mouth and goes down to the anus. It is about 8-10 meters long. It is also called as **Digestive Canal**.

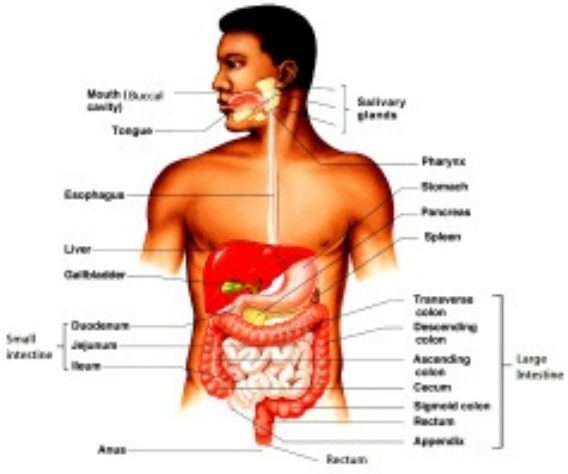


Figure 2.1 Human Digestive System

Alimentary canal performs three major functions-

(A) Digestion of food after its simplification.

(B) Absorption of the digested food.

(C) Movement of food from mouth to anus.

The digestive juices secreted by various glands present in the digestion canal or present elsewhere are responsible for the digestion of the food. These digestive juices simplify the complex food by various chemical processes and convert it to a form that could be taken up by the body. Many nutrients are found in the digested food juice such as proteins, carbohydrate, fats, minerals, salts, vitamins, water etc. These nutrients are absorbed with the help of specialized cells that are found in various parts of the alimentary canal. The mouth fed food in its long journey moves through the contraction and expansion of various muscles present in the alimentary canal.The sphincter muscles controls the movement of food, digested food juice and the food remnants at different levels.

2.1.1 Organs used in Digestive System

As is known to you that various organs staring from mouth to anus works for the digestive system (Figure 2.1). Now we will have a detailed discussion about these organs.

2.1.1.1 Mouth

The front portion of the alimentary canal starts from the mouth and opens in the **Buccal cavity**. It is a bowl shaped organ. The upper portion of mouth has a hard and lower portion has a soft Palate. A muscular tongue that can rotate all around is present within the Buccal cavity. The tongue is attached to the basal posterior part of the buccal cavity through **Frenulum lingual** and it goes up to the middle part of the buccal cavity.

The mouth is surrounded by two muscular lips, which helps to open and close the mouth and capture the food.

Both the Jaws which are found in upper and lower portion of the mouth have a set of 16 teeth (16-16 teeth). All teeth are located in a coop found in the jaw.Such a mold is called **Gum**. This position of jaw and teeth is called as Thecodont. Humans have **Diphyodont** type of teeth arrangement in which two different types of teeth *viz* temporary teeth (milk teeth) and permanent teeth are found in their life span.

There are four types of teeth -

(A) Incisors - These are the front teeth that carry out nibbling and cutting of food. They come out at six months of age.

(B) Canines- These teeth work to tear and chop the food. They oust at the age of 16-20 months. Both the jaws have 2-2 canines each. They are more developed in carnivorous animals.

(C) Premolars - They are helpful in chewing the food. Both the jaws have 4-4 premolars. They become fully developed at the age of 10-11.

(D) Molars - These teeth are helpful in chewing of food. Six molar teeth are present in every jaw.

2.1.1.2 Pharynx

Buccal cavity on the posterior part of tongue and palate is joined with a sac/ flask shaped Pharynx. It is through the pharynx that food moves to the esophagus or food pipe and air to the trachea or wind pipe. Pharynx through its structure ensures that in no condition food can enter in the wind pipe and air in the food pipe. Both these pipes have openings on the lower part of the pharynx - wind pipe is present on the front

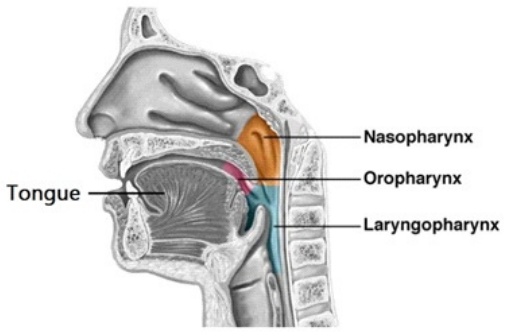


Figure 2.2 Different divisions of Pharynx

while food pipe is found on the posterior side. The structure of the pharynx is divided into three parts (Figure 2.2) -

(A) Nasopharynx

(B) Oropharynx

(C) Laryngopharynx or Hypopharynx

2.1.1.3 Esophagus

It is a narrow muscular tube that is about 25 centimeters long. It starts from the lower part of the pharynx, moves through the cervix, thoracic region and the diaphragm and enters in the upper part of the abdomen.The main work of esophagus is to bring the food from the mouth cavity to the stomach.

Some mucus glands are found in the esophagus. Mucus excreted from these glands makes the food slimy and sticky. The muscles present in the esophagus provide a special movement called **Peristalsis movement** to the food. Through this movement food moves to the stomach. A flap or lid made up of special tissues is present at the top of the esophagus.This flap is called **epiglottis**. At the time of swallowing of food, the epiglottis closes and prevents food from entering the trachea.

2.1.1.4 Stomach

The portion of the alimentary canal past the esophagus is stomach. It is muscular J shaped structure, which is located between the esophagus and the duodenum, left of the abdominal cavity and posterior of the diaphragm.It is a flexible organ that can hold one to three liters of food. The stomach can be divided into three parts-

(A) Cardiac portion: This is the larger left portion where the esophagus enters in the stomach.

(B) Pylorus: This is the smaller right portion through which the stomach joins with the small intestine and its contents flows out of the stomach and goes into the duodenum.

(C) Fundus Portion: This is the portion which lies in between the above two portions. It is present just under the diaphragm.

Two muscular sphincters are also found in the stomach. These two muscles control the passage of the contents present in the stomach are -

(A) Cardiac or lower esophageal sphincter - This divides the pharynx and the stomach and do not allow the movement of acidic food from the stomach back to the esophagus and pharynx.

(B) Pyloric Sphincter- This divides the stomach and the small intestine and controls the movement of food from stomach to the small intestine.

2.1.1.5 Small Intestine

Small intestine is a very important organ of the digestive system which starts from the pyloric part of the stomach and ends at the large intestine. The average length of the small intestine in humans is seven meters.This organ of the alimentary canal is responsible for the maximum digestion and absorption. Small intestine is divided in three different parts -

(A) Duodenum - It is the first and the smallest part of the small intestine attached to the stomach, which plays the most important role in the biochemical digestion of the food (by the enzymes) (table 2.1).

(B) Jejunum- It is the central part of the small intestine. Here, dietary juices digested in the duodenum are absorbed. The function of absorption is mainly conducted by special type of cells called enterocytes.

(C) Ileum - This is the terminal portion of the small intestine which opens in the large intestine. This part absorbs those nutrients (extensively bile salts and vitamins) which are not absorbed in the Jejunum.

2.1.1.6 Large Intestine

The Ileum is further connected to the large intestine. Some special bacteria are found here. These bacteria helps in the digestion of residual undigested food received from the small intestine by simplifying it through fermentation. The main function of the large intestine is to absorb water and mineral salts and to evacuate the undigested food through the anus. In humans, the large intestine is divided into three parts-

(A) Caecum - This part is associated with Ileum. Here, further absorption of the digested food that comes from the Ileum takes place and the remaining waste is passed to the colon. Slightly underneath the first part of the caecum (which is attached to the Ileum), a four-five inch long tube-shaped organ projecting inwards is found and is called as **Vermiform Appendix**. It is present near the junction of the small intestine and the large intestine

(B) Colon - The portion of the large intestine ahead of the cecum is called as Colon. It is about 1.3 meter long inverted U shaped duct like structure. It can be divided into four parts-

(1) Ascending Colon -about 15 cm long duct.

(2) Transverse Colon -about 50 cm long duct.

(3) Descending Colon - about 25 cm long duct.

(4) Sigmoid Colon - about 15 cm long duct.

(C) Rectum - Rectum is the terminal end of the Alimentary canal. It is about 20 cm long. The terminal 3 cm portion of the rectum is called **Anal Canal**.The anal canal opens outside through the **anus**. The alimentary canal ends at the anus. Two sphincter - external sphincter and internal sphincter are found in the anal canal. These sphincter muscles control the outwards movement of the waste products remained after the absorption of digested food juices.

2.1.2 Digestive Glands

In humans, in addition to the glands/secretary tissues present in the alimentary canal, three major glands viz Salivary gland, Liver and Pancreas are also found.

2.1.2.1 Salivary Gland

This gland produces saliva in the mouth. Saliva is a mixture of a serum like fluid and a sticky mucosa. The liquid part wets the food and mucous acts as a lubricant. The main functions of saliva are - to start digestion of the starch present in the food within the mouth itself, to make the food lubricious and soluble, and to clean the teeth, mouth and tongue. Salivary gland is of three types (Figure 2.3).

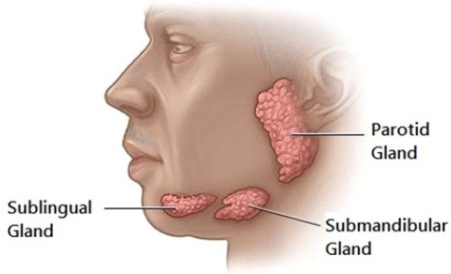


Figure 2.3 Salivary glands of Human

(A) Parotid gland - It secrets a serum like fluid and is found in the cheeks.

(B) Submandibular salivary gland - It is a mixed gland through which fluid and mucus are secreted.

(C) Sublingual gland - This is found beneath the tongue and secrets the mucus like liquids.

2.1.2.2 Pancreas

It is a compound gland which secretes endocrine hormones- Insulin and Glucagon and exocrine Pancreatic juices.This gland is surrounded by liver, pharynx and spleen. It is 6 to 8 inches long U shaped structure (Figure 2.4).The enzyme released by this gland (Table 2.1) helps in the digestion of proteins, fats and carbohydrate in the intestine. Insulin and glucagon hormones together control the level of blood glucose in the body

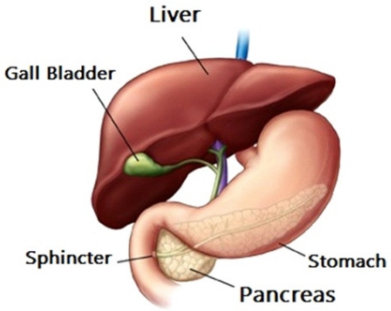


Figure 2.4 Human Pancreas and Liver

2.1.2.3 Liver

This is the largest and one of the most vital digestive gland of the human body. It is a triangular organ located beneath the diaphragm (Figure 2.4). Its maximum weight is inclined towards the right side.

From the front, liver appears to be divided into two parts - right and left lobes. On looking from the front surface to the bottom, two extra lobes are also visible. The liver is made up of about 100,000 small hexagonal structural and functional units called **Liver Lobules**. This gland produces bile. The bile secreted from the liver flows to the Gall Bladder through the Hepatic duct system and bile duct. The gallbladder is located on the concave lower side of the liver. The bile produced by the liver is stored in the Gall Bladder. From here the bile moves through common bile duct into the duodenum.

2.1.3 Digestion of the Food

The digestion of food is mainly carried out by many mechanical and biochemical processes. Within the alimentary canal the enzymes released by various

Table 2.1 Digestive Juices secreted by various digestive organs and their work

S.No.	Organ/Glands secreting the digestive juices	Secreted Enzyme	Work (Complex to simpler form)	Place of Work
1.	Salivary Gland	Ptylin or Amylase	Polysaccharides (like starch, Glycogen) → Smaller polysaccharides, Maltose	Buccal Cavity
2.	Stomach (Gastric Juices)	1. Pepsin 2. Renin	1. Protein → Peptide 2. Casein → Paracasein	Stomach
3.	Pancreas	1. Amylase 2. Trypsin 3. Chymotrypsin 4. Carboxypeptidase 5. Lipase 6. Nuclease	1. Starch → Maltose 2. Protein → Peptide 3. Protein → Peptide 4. Protein, Peptide, Amino acids 5. Fats → Mono-glyceride, fatty acids 6. DNA and RNA → Nucleotides	Small Intestine
4.	Intestinal Juices	1. Maltase 2. Lactase 3. Sucrase 4. Lipase 5. Nuclease 6. Dipeptidase 7. Phosphatase	1. Maltose → Glucose 2. Lactose → Glucose 3. Sucrose → Glucose 4. Fats → Fatty acids, Glycerol 5. Nucleic Acid and Nucleotide → Nucleosides and Sugars 6. Dipeptide → Amino acid 7. Nucleotide → Nitrogenous base, Ribose	Small Intestine
5.	Liver	Bile salts	Fat → Fatty acid/ Fat Globule	Small Intestine

organs and glands simplify the food nutrients by hydrolysis. These enzymes generally belong to the hydrolases group. The key enzymes working in digestion are as follows-

(i) Carbohydrate digesting - Amylase, Maltase, Sucrase.

(ii) Protein digesting - Trypsin, Chymotrypsin, Pepsin etc.

(iii) Fat digesting - Lipase

(iv) Nucleases - Nucleotidase, Nucleases

The task of chewing and mixing food with saliva is transacted in the mouth cavity. The mucus of the saliva helps the food particles to aggregate with each other and form **bolus**. Food in the form of bolus now moves by means of peristaltic movement and through the pharynx and esophagus reaches to the stomach. The entry of food in the stomach is controlled by the cardic/lower esophageal sphincter. Enzyme ptyalin or amylase present in the saliva begins the hydrolytic decomposition of carbohydrate within the buccal cavity. Here about 30 percent of the starch is simplified to maltose. Three types of secretions - gastric mucus, proenzyme pepsinogen and hydrochloric acid are found in the stomach. Mucus is secreted by Foveolar cells or surface mucous cells. Proenzyme pepsinogen is converted into active enzyme pepsin in the acidic atmosphere created by the hydrochloric acid and then it starts the breakdown of proteins present in the food. The gastric juice of new born infants also contains another enzyme called Renin along with pepsin. This helps in the digestion of milk proteins (Table 2.1).

Oxyntic cells present in the stomach secrets hydrochloric acid. The food stays in the stomach for few hours only and through muscular contraction mixes with gastric juices and creates chime.

The partially digested food from the stomach moves to the small intestine. Maximum digestion process occurs in Duodenum. Through different ducts various digestive juices like pancreatic juice, bile salts and intestinal juices are discharged in the small intestine. These juices contain many enzymes which cause the digestion of the various nutrients present in the food (Table 2.1).

The bile salt emulsifies the fat. This is important for the fat digestion. Bile also activates lipase enzyme.

The food that is simplified/ digested in the Duodenum is then absorbed by the Jejunum and Ileum. With the help of blood, the absorbed food nutrients are then transported to various cells. The undigested and unabsorbed material from the ileum moves to the large intestine. The large intestine mainly functions to absorb water and salts and excretes the undigested food. The undigested part of the food concentrates and becomes compact and hard. It temporarily remains stored in the rectum. Through a neural reflex the faces propagates outside.

2.2 Respiration and respiratory system

2.2.1 Respiration

To perform their various functions, cells require energy. To acquire this energy, cells use O_2 to oxidize the nutrients.This process results in the production of ATP and release of harmful CO_2 gas. For the process of obtaining energy, the entry of atmospheric O_2 in the body and expulsion of CO_2 is absolutely essential. This exchange of gases occurs through the blood. The blood dissolves the O_2 gas in itself and transports it to various organs and tissues of the body. The CO_2 generated by various body parts is dissolved in the blood which ultimately directs it into the atmosphere. This exchange of gases (O_2 and CO_2) in between the environment, the blood and the cells is called **Respiration**. During the respiratory process, oxygen rich air is transported through the nose, throat and respiratory ducts (bronchial tubes) to the air chamber / follicles called **Alveoli** found in the lungs. The membrane of the alveolus is very fine and contains a meshwork of capillary vessels. The oxygen brought by the inhaled air is received by the blood contained in the capillary

vessels of the alveoli membrane and the carbon dioxide brought by the blood is released into the air alveoli. By the process of breathing, lungs release this impure air into the atmosphere.

2.2.2 Human Respiratory System

The human respiratory system is mainly classified into three parts- the upper respiratory system, the lower respiratory system and the respiratory muscles (Figure 2.5).

2.2.2.1 Upper Respiratory System

The upper respiratory system mainly comprises of the nose, mouth, pharynx and larynx (Figure 2.5).

(A) Nose: This is the first respiratory organ which starts with a pair of externally visible nostrils. It is a big cavity like structure which is divided into two parts by a slender bone and a thin membrane. The posterior part of the nasal cavity opens in Nasopharynx. The fine hairs found in the nasal cavity, the blood flowing in the thin membrane, the cilia and the mucous, together through mutual cooperation purifies the inhaled air by removing the dust particles, pollen grains, fungi etc. present in the air. Only after this purification, the inhaled air enters in the lungs.

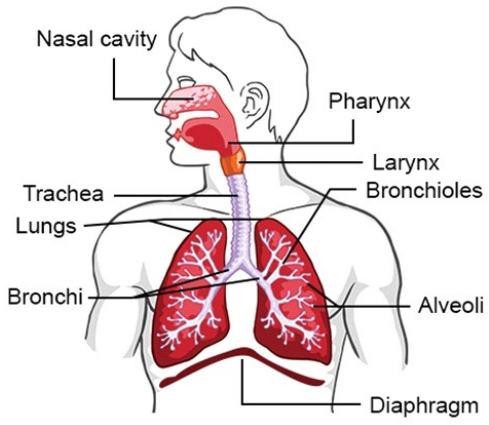


Figure 2.5 Human Respiratory System

(B) Mouth: Mouth works as a secondary organ in the respiratory system. Nostrils play main role in breathing. However, at the time of need mouth can also be used for breathing.

It is worth noting here that the breath taken from the mouth is not pure like a breath taken from the nostrils.

(C) Pharynx: Pharynx is a muscular funnel type structure which extends from the posterior part of the nasal cavity to the upper portion of the esophagus.The pharynx is divided into three parts viz- Nasopharynx, Oropharynx, and Laryngopharynx. The nasopharynx is the first portion of the pharynx which is found in the posterior part of the nasal cavity. Air after passing through the nasal cavity moves into the nasopharynx and reaches to the oropharynx. The breath taken from the mouth directly enters the oropharynx. From oropharynx air passes through the laryngopharynx and with the help of epiglottis enters into the Larynx. **Epiglottis** is a flap like elastic cartilage structure which acts as a switch between the esophagus and wind pipe/ trachea. As we know pharynx also helps to engulf the food, in this situation epiglottis acts as a lid which ensures that the air enters only in trachea and food in food pipe.

(D) Larynx: It is a small structure which connects the laryngopharynx and the trachea (Figure 2.5 and 2.6). It is made up of nine types of cartilages. During food engulfing, epiglottis acts as a covering of the larynx and prevents the food to enter in the larynx. Special structures called vocal cords/ vocal folds are found in the larynx. Vocal cords are mucus membranes which vibrate with the movement of air and produce various sounds.

2.2.2.2 Lower Respiratory System

The lower respiratory system mainly comprises of trachea, bronchi and bronchiole, alveoli and lungs.

(A) Trachea: This is about 5 inch long tubular structure which is made up of C- shaped rings of hyaline cartilage covered by Pseudo stratified ciliated columnar epithelium. Cartilage rings prevents the tracheal to stick with each other and keep the tracheal open all times. Trachea joins the larynx to bronchi and

transports the breath from neck to the chest region. After reaching in the thoracic cavity, the trachea divides into two branches-the left and the right bronchi which then enter into the lungs of the respective side (Figure 2.6). These branches are called **primary bronchi**. The epithelium present in the trachea synthesizes mucus which purifies the inhaled air and forwards it towards the lungs.

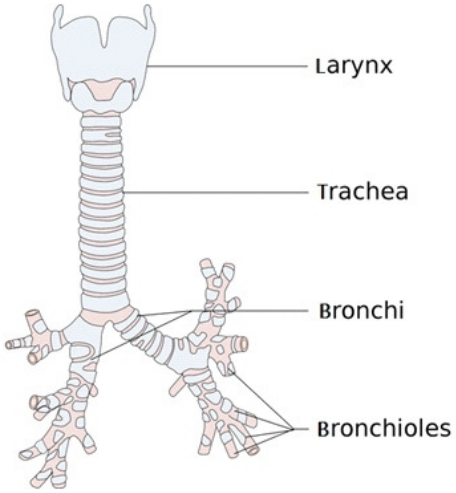


Figure 2.6 Trachea in Human Respiratory System

(B) Bronchi and Bronchiole: The trachea divides into the left and right bronchi. After reaching inside the lungs, the primary bronchi divides into smaller branches called **secondary bronchi**. In every segment of the lung, secondary bronchi further divides into **tertiary bronchi** (Figure 2.5 and 2.6). Each tertiary bronchus divides into smaller **bronchioles**. The bronchioles are distributed all over the lungs. Further every bronchiole divides into smaller terminal bronchiole. Bronchi and bronchiole together forms a tree like structure which remains divided into a number of branches. Special structures called **Alveoli** are found at the terminal end of these branches. The gaseous exchange occurs through these alveoli.

(C) Lungs: Lungs are flexible, soft and light pink coloured organs. A pair of lungs is found just over the diaphragm on left and right sides of the chest. Lungs are made up of numerous bronchi, alveoli, blood vessels, lymphatic vessels, flexible fibers, membranes and several cells (Figure 2.6).

The right lung is slightly smaller in length than the left lung, however it is slightly broader. Men's lungs are slightly heavier than women's lungs. The left lung is divided into two lobes while right one is divided into three. Each lobe is further divided into many subdivisions. Each subdivision splits into several small blocks in which branches of the bronchi, the arteries and the veins divide and forms an independent unit (Figure 2.5).

Each lung is made up of spongy tissue, in which many capillaries and about 30 million alveoli are found. The alveoli are cup like structures which are found at the end of the terminal bronchioles. It is surrounded by several capillaries. Rows of Squamous Epithelium are found in the alveoli which helps in the exchange of the gases from the blood flowing in the capillaries.

2.2.2.3 Lower Respiratory System

Some muscles are needed for gaseous exchange through the lungs. These muscles help in inhalation and exhalation of gases. Diaphragm is primarily responsible for respiration. The diaphragm is a thin sheet like structure which is made up of skeletal muscles found on the surface of the thoraces. On contraction of the diaphragm, the air passes through the nostrils and enters into the lungs. The relaxation of diaphragm causes the exit of air from the lungs. Additionally, special types of muscles called Inter coastal muscles are found in the ribs which helps in the contraction and relaxation of diaphragm.

2.2.2.4 Physiology of Respiration

The pulmonary movement of air is such a rhythmic process of inhalation and exhalation of air in the lungs which facilitates the gaseous exchange. For this aero-navigation, the respiratory system uses - (1) the negative pressure gradient between the atmosphere and the alveoli and (2) the contraction-relaxation of the

diaphragm. Because of these reasons the high pressure air from the atmosphere enters inside the lungs.

The respiration process is carried out at two levels:

(A) External Respiration: In this respiration the gaseous exchange between the air filled alveoli and blood flowing in the capillaries occurs due to difference between the partial pressure of the gases between them.

(B) Internal Respiration: In this respiration the exchange of gases between the blood flowing in the capillaries and the tissues occurs through diffusion.

2.3 Blood and Circulatory System

2.3.1 Blood

Blood is a type of liquid connective tissue present in human and other animals that transports essential nutrients and oxygen to cells and metabolic waste products and carbon dioxide from the cells. It is a slightly alkaline fluid whose pH is 7.4. Blood formation occurs in red bone marrow. The formation of blood in the embryo and newborns occurs in the spleen.A normal person has approximately five liters of blood. Blood consists of two parts - the fluid part called **plasma** and a solid portion which is made up of cells. Plasma makes up 55 percent of blood and contains approximately 92 percent water and 8 percent organic and inorganic substances.

The blood cells are of three types -

(A) Red Blood Cells (RBC) - They comprises 99 percent of total blood cells. These cells contain a protein called haemoglobin. It is the presence of haemoglobin which imparts red colour to the blood. These cells lack nucleus and their average age is 120 days. They are also called as Erythrocytes and all produces in Red bone marrow.

(B) White Blood Cells (WBC)-These cells impart immunity and are formed in red bone marrow. They are also called Leucocytes. Hemoglobin is not found in these cells, due to which they are colorless and hence are called white blood cells. These cells are of two types - granulocytes and agranulocytes. Examples of granulocytes are neutrophils, eosinophil's and basophils. The most common white blood corpuscles in the blood are neutrophils. In terms of numbers, the neutrophils are the predominant white blood cell found in the blood. Lymphocytes and Monocytes are predominant agranulocytes. Lymphocytes are of three different types - B lymphocytes, T lymphocytes and Natural Killer cells. Lymphocytes are the cells which provide immunity. Monocytes on maturation differentiate into macrophages. Monocytes, macrophages and neutrophils are the major phagocytic cells of the body which phagocytose the external antigens.

(C) Platelets - These are also called as Thrombocytes. Their number in the blood is about 3 million per cubic millimeter. The average life of platelets is only 10 days. These cells primarily help in blood clotting and are devoid of nucleus.

2.3.1.1 Functions of the Blood

Blood is a vital tissue in the body of the organisms which perform many types of functions. The main functions of blood are:

1. Exchange of O_2 and CO_2 between the environment and the tissues.
2. Transport of nutrients to different body parts.
3. Controlling the body's pH.
4. Controlling the temperature of the body.
5. Execution of the immunity related works.
6. Transportation of hormones and other necessary signaling molecules as per the need.
7. Excretion of the waste products out of the body.

2.3.2 Types of Blood

On the basis of the presence and absence of special type of antigen A and B that are found on the surface of red blood cells, human blood has been divided into four groups - A, B, AB and O. A person with A blood group has A antigen, person with B blood

group has B antigen and person with AB blood group has both A and B antigen on the surface of their red blood cells.The red blood cells of the person having O blood group has no antigen on their surface. These groups of blood are called **ABO blood groups**.

In addition to the A and B antigen, another antigen called **Rh** is also found on the surface of the red blood cells. The blood of persons having Rh factor is called Rh Positive (Rh +ve) while the blood of the persons devoid of the Rh antigen is called Rh negative (Rh -ve). About 80 percent of people in the world have Rh positive blood.

2.3.3 Blood Circulation

The circulatory system is a combination of various organs that transport gases, digested food nutrients, hormones, excretory products etc. among various body cells. In humans, closed circulatory system is found which is comprised of blood, heart and blood vessels (Figure 2.7). Apart from blood, another fluid called **lymph** also forms a part of this transport. The lymph moves through a special mechanism called **lymphatic system**. This is an open type circulatory mechanism.

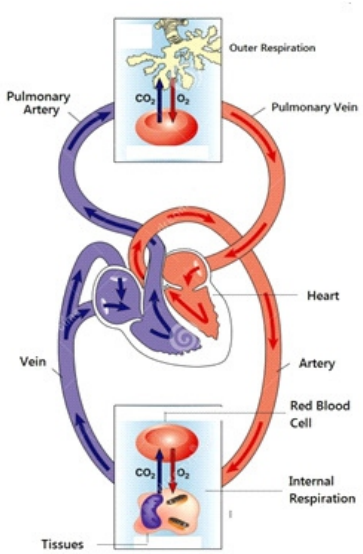


Figure 2.7 Blood Circulation

In the circulatory system, blood acts as a liquid medium, that plays key role in movement of transportable substances. The heart is the center of this system that continuously pumps blood in the blood vessels.

2.3.3.1 Heart

A human heart is a red coloured, closed fist shaped hollow organ which is made up of muscular tissues. It remains surrounded by a double walled membrane cover. This cover is called **pericardium**. Pericardium contains a fluid called pericardial fluid. This fluid protects the heart against the external shocks. Four chambers are found in the heart - the upper two are relatively small and called **Atrium**; the lower two parts are relatively larger and are called **Ventricles**. So, on dividing the heart vertically in the left and right parts, we find each part of the heart contains an Atria and one Ventricle. The atria and ventricles of the left side are connected with each other through a **bicuspid valve**, which is called a **mitralvalve** or left **Atrioventricular valve (AV valve)**. The atrium and ventricles of the right side are connected with each other through a **tricuspid valve** which is also known as right **Atrioventricular valve (AV valve)**. These valves prevent the blood to move in reverse direction. The opening and closing of the heart valves generates a typical sound of **Lub-Dub**. This sound is the sound which we feel during the heart beat. The right and left

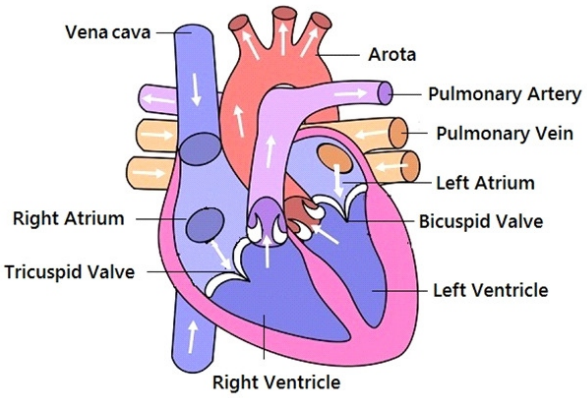


Figure 2.8 Human Heart

atria and ventricles remain separated from each through muscular membranes (Figure 2.8).

The Auricles and ventricles are engaged in continuous rhythmic contraction and relaxation. Through this action the heart pumps blood into different parts of the body. The impure waste from the body is brought to the right atrium by **Vena cave**. After collecting in the right atrium, the right AV valve opens and the blood from the atrium enters inside the ventricle.On contraction of the right ventricle, the pulmonary artery transports the impure blood to the lungs.Within the lungs, through the respiration process, this impure blood is oxidized and made clean.

The pulmonary vein brings the pure blood from the lungs into the left atrium. From left atrium through the left AV valve blood enter in the left ventricle. Due to contraction of the left ventricle, the Arota (the largest artery of the body) transports the oxygenated purified blood to different parts of the body. This cycle runs continuously and is called **heart cycle**. The contraction of heart is called **Systole** and the relaxation is called **Diastole**.

In the circulation process, the blood passes twice through the heart - firstly the impure blood from the body and then pure blood from the lungs enters in the heart (Figure 2.7). The pure blood is then sent back from the left ventricle to the body through Aorta (the largest astery). This type of circulation is called double circulation - one is Systemic circulation and the second is Pulmonary circulation. Some cardiovascular muscles are self-stimulating and control's the pace of the heart's activities. These are called **pace maker**.

2.3.3.2 Blood

Details of the blood have been discussed previously (2.3.1 and 2.3.2) in this chapter.

2.3.3.3 Blood Vessels

Circulation of blood in the body is done by the blood vessels. Blood vessels forms a network within which blood flows and reaches to the cells. They are of two types-

(A) Artery - The blood vessels in which the oxygenated pure blood flows are called arteries. They transport the blood ahead of the heart.

(B) Veins - The blood vessels in which the deoxygenated impure blood containing the body wastes flows are called veins. They transports blood towards the heart.

Blood vessels after reaching the tissues and organs form an extensive cluster of capillaries.

2.4 Excretory System

The excretory system is a mechanism to expel out the waste material from the body. Therefore, excretion is a body system in which the waste products generated by the body cells are disposed out of the body.

All organisms through metabolic processes, keep accumulating waste products such as ammonia, urea, uric acid, carbon dioxide etc. The removal of waste products from living organisms is an essential process, otherwise such wastes (especially nitrogenous wastes) may function like toxin. The carbon dioxide is expelled out through lungs. For the emission of accumulated nitrogenous waste, a special mechanism called the **excretory system** works. The kidneys play a key role in this mechanism.

Nitrogenous wastes are of three different types -

(A) Ammonia: - Animals which excrete ammonia are called Aminotelic. Many bony fishes, amphibians and aquatic insects excretes ammonia by this process. Excessive water is required for the excretion of ammonia.

(B) Urea: - Urea emission is primarily done by mammals, sea fishes and others. These organisms are called Ureotelic. Liver converts the ammonia produced by the cells into urea. Urea is then filtered and excreted by the kidneys.

(C) Uric acid: - Birds, reptiles, insects etc. excretes uric acid. Such organisms are called Uricotelic. These

organisms convert ammonia into the Uric acid. Uric acid is excreted in the form of globules or paste along with very little water.

2.4.1 The human Excretory System

The human excretory system collects and expel out the liquid waste of the body. This system consists of two Kidneys, one Urinary bladder, two Ureters and one Urethra (Figure 2.9).

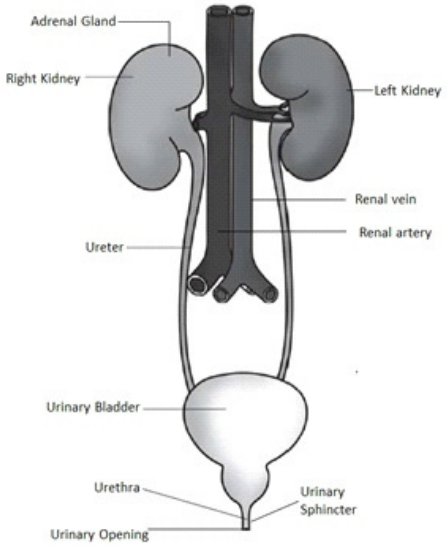


Figure 2.9 The Human Excretory System

(A) Kidney: It is the main excretory organ of the human body (Figure 2.9 and 2.10). It excretes about 75-80 percentage of the liquid waste out of the body. It also controls all the juices released in the body. It is a dark brown coloured bean shaped structure. A pair of kidneys is located on the posterior side of the abdominal cavity and below the stomach on right and left side of the spinal cord. The left kidney is slightly more superior to the right kidney. A groove/ indentation is found on the central surface of the kidney, which is called **Renal Hilum**. The urinary ducts/ ureter, nerves and blood vessels enter the kidney through the hilum. In the inner part of the hilum, a funnel shaped Renal Pelvis is found. Each kidney consists of two parts, the outer Cortex and the inner Medulla. Each kidney is made up of several million functional units called **Nephrons** (Figure 2.10 and 2.11). Each nephron has two parts -

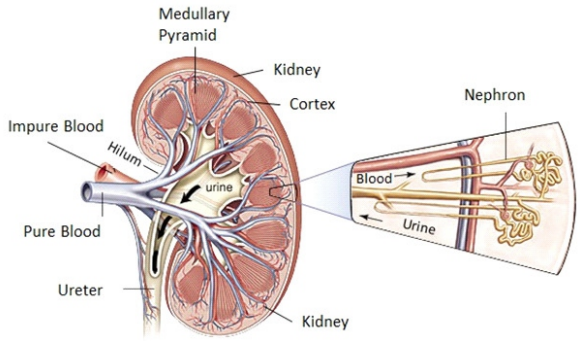


Figure 2.10 Structure of Human Kidney

(a) Bowman 's capsule -

It is a cup-shaped bag found in the upper portion of the Nephron. A meshwork of capillaries of branch afferent arteriole is found in the Bowman's capsule. These bunches are called **Glomerulus**. One end of glomerulus is joined to the Renal Artery which brings oxygenated blood containing the metabolic wastes in the Bowman's capsule while the other end which transports the filtered blood out of kidney is joined with the Renal vein.

(b) Renal Tubule -

This is the duct that starts from the bottom of the Bowman's capsule and its second part remains connected to the urine collecting duct (Figure 2.11). The first section of this duct is called **proximal convoluted tubule (PCT)**. In the central part, this tube forms a hair pin loop like structure called **Henle-Loop**. The terminal portion of this tube is called **distal convoluted tubule (DCT)**. DTC remains connected with the collecting duct of the nephron.

(B) Urinary Bladder : It is a muscular sac like organ which stores urine coming from the kidney. It is present in the pelvic region just above and behind the pubic bone. It shapes like a pear. It helps in urination and can store 400 ml to 600 ml of urine. The urine descends down from the kidneys into the bladder through ureters.

(C) Ureters: They are a pair of tubes that carry urine from both the kidneys to the urinary bladder. These

tubes are made up of smooth muscles and have a size of 25-30 cms (in adults).

(D) Urethra : It is a tube like structure which carry the urine from the bladder to the exterior of the body. In males it is connected to the penis and in females it ends just above the vaginal opening. In males it also carries semen which it receives from the ejaculatory ducts. Length of the male urethra is larger as compared to females.

2.4.2 Urine formation

The formation of urine is carried out in three stages - The glomerular filtration, re-absorption and secretion. All these functions are carried out in different parts of the kidney. The blood keeps flowing continuously in the kidney. This blood is brought by the renal artery and contains metabolic waste products. Both kidneys filter about 1000-1200 ml blood every minute. The branch afferent arteriole in Bowman's capsule converts into large number of capillaries. These capillaries forms a bunch.

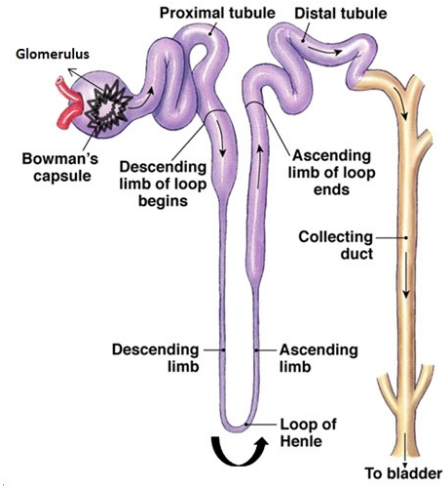


Figure 2.11 Structure of the Human Nephron

The filtration of the blood is carried out in the nephron. Here glucose, salts, amino acids, urea etc. are filtered from the blood and are collected in the Bowman's capsule. This filtrate then passes through the renal tubule. The walls of the renal tubule are made up of simple cuboidal epithelia. These cells almost completely re-absorb the glucose, amino acids and other useful substances from the filtrate. These reabsorbed substances are then replenished in the blood stream. About 99% filtrate is re-absorbed in the renal tubules. Importantly the waste products like urea are not reabsorbed. The renal vein carries the clean blood from the kidney. After re-absorption of the nutrients by nephrons, the clean blood is passed to the efferent arteriole. The unabsorbed filtrate containing the waste substances remain within the renal tubules. Such waste containing liquid forms urine. The urine from the nephron is transported to the collection tube from where urine enters in the urinary tract/ ureter. From each of the kidney one ureter opens in the urinary bladder. The bladder is the organ where urine is stored. With the collection of the urine, the bladder enlarges. When enough urine gets accumulated, the central nervous system sends a signal to the bladder. This signal cause the contraction of the bladder muscles and relaxation in the bladder/urethral sphincter muscles. As a result excretion of the urine takes place.

2.4.3 Other organs employed in excretion

In addition to the kidneys our lungs, skin, liver etc also helps in the excretion of the body wastes. Lungs help in the expulsion of the CO_2, while liver helps to excrete bilirubin, biliverdin, vitamins, steroid hormones etc along with the feaces. Skin through sweat expels out salts, urea and lactic acid while sterols, hydrocarbons etc are secreted along with the sebum.

2.5 Reproductive System

Reproduction is one of the most important body system found in the living beings in which one organism gives birth to the offspring's.Sexual reproduction is found in humans. It is a bisexual reproductive process in which male's synthesis sperms (male gametes) while female produces egg (female gametes). The fertilization of the egg with the sperm produces zygote which further gives rise to a new organism.

The reproductive cells which are responsible for the sexual reproduction develops in specific period of life called puberty. At this stage signs of sexual

development start to become visible and leads to sexual maturity. In boys the features of puberty are voice heaviness, development of mustache and beard, growth of pubic hairs near the genital organs and underarms, oiliness of the skin etc. In females, the development of the breast and increase in its size, oiliness of the skin, growth of pubic hairs near the genital organs, start of the menstrual cycle etc marks the start of the puberty. Puberty in females is marked at the age of 12-14 years while in males this age is 13-15 years. Generally the sexual maturity is achieved at the age of 18-19 years.

During this period a human being undergoes transformation in his sensations and his intellectual and mental levels. The root cause of various changes seen in between the age of puberty and the age of sexual maturity is the secretion of various hormones.The main sexual hormone in human males is **Testosterone** while in females **Estrogen** and **Progesterone** are the major sexual hormones.

2.5.1 Male Reproductive System

The male reproductive organs can be classified as primary and secondary sexual organs (Figure 2.12).

2.5.1.1 Primary Reproductive Organs

They are the organs which produces the sex cells or gametes. They also secrete some hormones. These organs are called **gonads**. The male gonads are called Testis. A pair of testis is present in humans and these are responsible for the synthesis of male reproductive cells called **sperms**.Testis are present outside the abdominal cavity in a pouch like structure called **Scrotum**.Testis consists of two parts - one which produces sperms and second which acts as an endocrine gland and secrets testosterone hormone.

2.5.1.2 Secondary Reproductive Organs

All the organs other than Primary Reproductive Organs which are involved in the reproductive system are called Secondary Reproductive Organs (Figure 2.12).

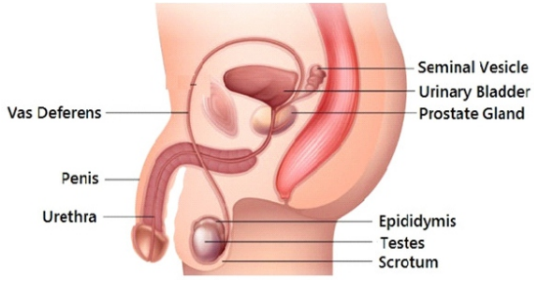


Figure 2.12 Male reproductive System

(A) Scrotum:

Scrotum is important to keep the testis stable. The sperm production requires a temperature lower than the temperature of the body. The scrotum functions as a device which regulates the temperature of the testis. Temperature of the scrotum is lower than the other organs of the body.

(B) Vas Deferens:

The sperms take the help of Vas Deferens to reach the seminal vesicles. Vas Deferens is a duct like structure which together with ureter forms a common vessel and hence sperms and urine both flow through a common route. A pair of these ducts is found in the body. One duct carry sperm from each of the testis and along with the seminal vesicle joins with the left and right ejaculatory duct.

(C) Seminal Vesicle:

The Vas Deferens opens up in a pouch like structure called Seminal Vesicle. This pouch is used for the storage of sperms before ejaculation. The seminal vesicle produces a fluid which helps in the formation of semen. This fluid also provides swimming movement and nourishment to the sperms.

(D) Prostate Gland:

It is a walnut like structure which acts as an exocrine gland. It produces and secretes a fluid which forms a part of semen. This fluid helps in providing motion to the sperms.

(E) Urethra:

It is a muscular duct which begins from the urinary bladder and joins with the ejaculatory vessels to form Urinogenital canal. Through this duct urine, sperms, secretions of glands like prostate etc comes out. This duct passes through the penis and opens outside through Urinogenital canal.

(F) Penis:

It is a cylindrical organ located in the pubic region, it hangs from the middle of the scrotum. It is an erectile copulatory organ. In the normal conditions it remains small and flaccid and is used for urination. During the sexual intercourse, this organ becomes erectile and is used to deliver semen (with sperms) into the female genital organs.

2.5.2 Female Reproductive System

The female reproductive system has also been divided into primary and secondary sexual organs

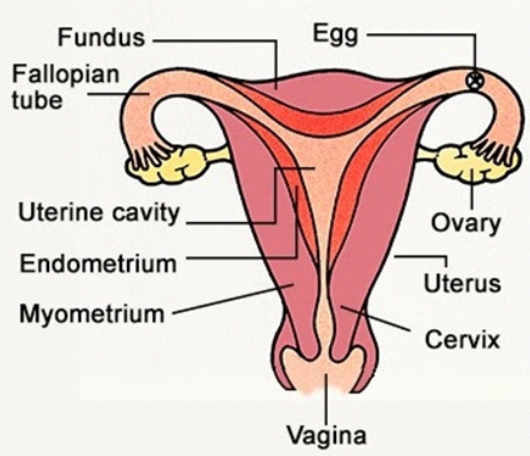


Figure 2.13 Female Reproductive System

2.5.2.1 Primary Reproductive Organs

In females a pair of **ovaries** works as primary sexual organs (Fig. 2.13). The ovaries have two major functions - first, it produces female germ cells (ovum). Second, it acts as an endocrine gland and secretes two hormones - Estrogen and Progesterone. Both the ovaries are found in the pelvic region of abdominal cavity beneath the kidneys on both sides of the uterus. Numerous distinct structures called ovarian follicles are found in each ovary. These follicles produce ovum/ egg. After maturation, the egg is released from the ovary and through fallopian tubes it reaches to the uterus. Hormones released from the ovaries helps in - female sexual transformation, egg formation etc.

2.5.2.2 Secondary Reproductive Organs

Like in males, the organs other than the Primary Sexual Organs which are involved in the reproductive system are called **Secondary Reproductive Organs** (Figure 2.13).

(A) Fallopian Tubes

It is a long coiled tubular organ which is located on both sides of the uterus. These ducts transport the eggs from the ovaries into the uterus. It is 10-12 cm long and extends beyond the abdomen. It helps in creating conducive conditions for fertilization.

(B) Uterus

The uterus is a pear shaped hollow muscular genital organ found in the lower abdomen in between the urinary bladder and rectum (posterosuperior to the bladder and anterior to the rectum) where both the fallopian tubes join and form a pouch like structure. Its wider side (fundus) faces upwards and the narrow part (cervix) faces downwards. Through cervix, the uterus opens in the vagina. Uterus is the place where the egg fertilized by the sperm gets implanted and develops into the embryo. Placenta which acts as a link between the mother and the embryo also develops here.

(C) Vagina

It is approximately 8-10 cm long muscular and tubular structure found in the middle of the bladder and rectum and functions as female copulatory chamber. This organ also works as a canal for the flow of menstruation discharge and delivery pathway (birth canal). Lactic acid producing bacteria i.e. *Lactobacillus* are found in the vagina. The presence

of lactic acid and carbonic acid keeps the vaginal atmosphere acidic.

2.5.3 Phases of Reproduction

The flowing stages of reproduction are found in the human beings-

(A) Gametogenesis: The process of production of the haploid gametes in the testis and ovaries is called gametogenesis. This process in male testis produces sperms and the process is called as **spermatogenesis**. The process of gamete formation in the female ovaries which leads to the production of eggs is called **Oogenesis**.

(B) Fertilization: The eggs present in the female uterus come in contact with the sperms liberated by the male during the intercourse. They conjugate with each other and forms **Zygote**. This process is known as fertilization.

(C) Cleavage and embryo implantation: The zygote undergoes a series of mitotic divisions and forms a structure called **Blastula**. The blastula gets implanted in the endometrium wall of the uterus. This process is called Embryo implantation.

(D) Accouchement/ Delivery: Embryo, after its implantation passes through many stages of development and leads to the development of foetus in the uterus. After the full development of the baby in the uterus, child birth takes place. The process of giving birth is called accouchement/ delivery.

2.6 Nervous and endocrine system

In humans, different organs work in harmony and coordination. This harmony and co-ordination is very important for the smooth functioning of various organs and organ systems. Independently, no organ system can function appropriately. For establishing the mutual coordination among various body organs and body systems, a special system called **Nervous system** functions in the body.

To make coordination among the various body systems even better, another system called the **Endocrinal system** also works in the human body. The nervous system cannot control work of all the cells. In such a condition, the control is established by the endocrinal system. In this system many ductless glands secretes hormones. These hormones work as messenger and control the functioning of different organs. Both the above systems functions to - deliver the information and sensations perceived from the environment to different organs, allows the organs to react appropriately and to establish coordination among different organs.

2.6.1 Human nervous system

The human nervous system is a system which establishes the coordination between different organs and environment and among various organs. Moreover, it controls the functioning of body organs.

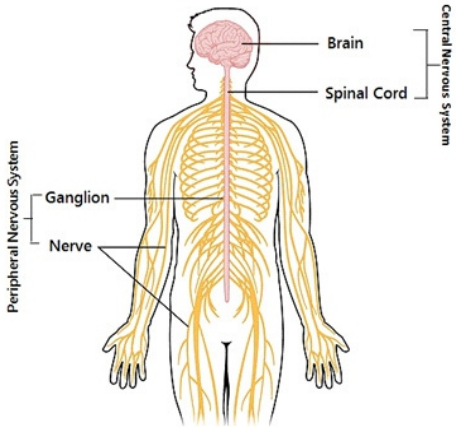


Figure 2.14 Human Nervous System

The nervous system can be classified into two parts - (A) The Central Nervous System and (B) The Peripheral Nervous System. The central nervous system mainly consists of Brain, Spinal Cord and the nerves coming out of them. The peripheral nervous system is made up of two different types of nerves - **(A) The Sensory nerves:** nerves which transfer the stimulus from the tissues and organs to the central nervous system. **(B) Motor nerves:** nerves which transfer the regulatory stimulus from the central nervous system to the corresponding organs. Functionally the

peripheral nervous system has been classified into two parts: (A) Somatic nervous system and (B) Autonomous nervous system.

2.6.1.1 Central Nervous System

Brain, spinal cord and the nerves coming out of them together comprise the central nervous system (Figure 2.14).

(A) Brain

Human brain is one of the central organs of the body which works for the exchange of the information , provide commands and control various body systems.Various activities of the body like temperature control, human behavior, blood circulation, respiration, looking, listening, speaking, gland secretions and others are monitored by brain. It is most complex organ of the body with a weight of about 1.5 kg and is protected by the skull.The brain envelop contains a groove shaped fluid called **Cerebrospinal Fluid** (CSF acts as a cushion to provide protection to the brain). Brain is divided into three parts (Figure 2.15) - fore brain, mid brain and hind brain.

(1) Fore Brain

The cerebrum, thalamus and hypo-thalamus together forms the fore brain. Cerebrum constitutes 80-85% portion of the human brain. It is that part of the brain where knowledge, consciousness and thinking related works are executed. An elongated deep fissure divides the cerebrum into the right and left cerebral hemispheres.

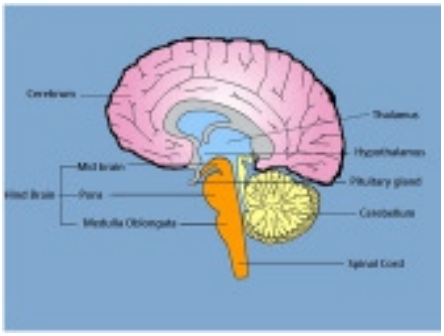
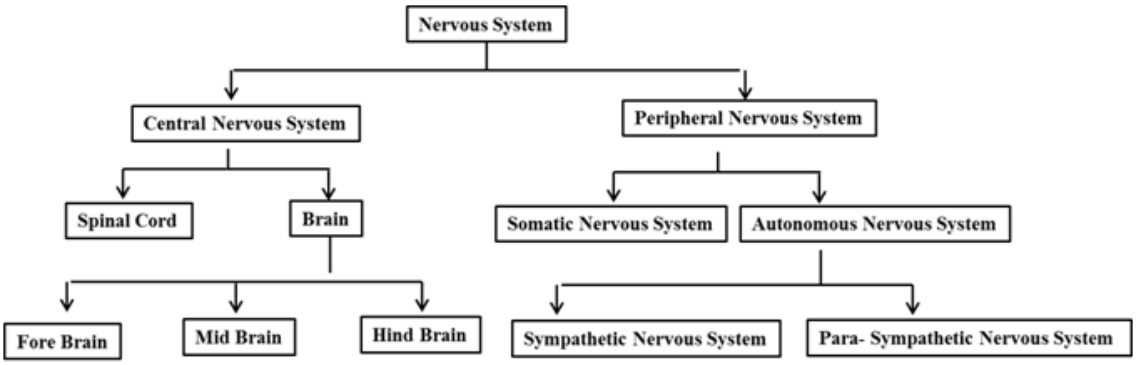


Figure 2.15 Human Brain

Each hemisphere in the outer area contains a **Grey matter** which is called as **Cortex**. On the inner side is found **white matter** which is called as **Medulla**. Many nerves are found in the grey matter. Because of the presence of excessively large number of nerves this matter looks grey. Both these hemispheres are joined with each other through a strip of **Corpus Callosum**. The cerebrum is surrounded from every side by thalamus. Thalamus is the center of the sensory and motor signals. Another portion called Hypothalamus is located on the **Diencephalon** part (which is present on the basal part of the thalamus) of the fore brain.This section makes sense of hunger, thirst, sleep, temperature, fatigue, expression of feelings etc.

(2) Mid Brain

Mid brain is divided into four lobes and is present in between the hypothalamus and the hind brain. Each lobe is called the **Corpora quadrigemina**. The upper two are responsible for the sight and the lower two



are responsible for the hearing.

(3) Hind Brain

This part comprises of the Cerebellum, Pons and Medulla Oblongata. Cerebellum is the second largest part of the brain that regulates the voluntary muscles (such as muscles of hands and feet). It is a somewhat an unusual surface that provides extra space to Neurons. Pons connects the different parts of the brain. Medulla oblongata controls the involuntary actions like heartbeat, blood pressure, secretion of digestive juices etc. Medulla is the last part of the brain that remains connected to the spinal cord.

(B) Spinal Cord

The length of spinal cord is about 45 cm. It is an important organ of the central nervous system. Through medulla oblongata, the hind brain remains joined with the spinal cord. Spinal cord is a neural canal which, for its safety, remain housed in between the vertebra column. A narrow central tube is found in the central part the spinal cord which remains surrounded by a two-layer thick wall - the inner layer is called **Grey Matter** and the outer layer is called **White Matter**. The Grey matter is located in the form of a long column-from the start to the terminal region of the spinal cord. Just like the grey matter, many small columns of the white matter are also found in the spinal cord. The spinal cord mainly works to conduct and regulate the involuntary actions. Additionally, it provides a passage for the impulses coming from and going to the brain.

2.6.1.2 Peripheral Nervous System

This is a group of nerves which originates from the brain and spinal cord and conveys the impulses coming from and going to the central nervous system. This system works extrinsic to the central nervous system and hence it is known as Peripheral Nervous System. It is of two types:

(A) Somatic Nervous System

This system works for the execution of functions which are performed as per our wish. With the help of this system, the central nervous system responds to the external stimuli and transects the functions of muscles etc.

(B) Autonomous Nervous System

This system is responsible the functioning of those organs that do not work by one's desire, rather works automatically such as heart, lungs, endocrine glands etc. This system is comprised of a series of groups of nerves with which the nerve fibers of the various internal body organs remains connected.

The autonomic nerve system has been classified into two parts-

(1) Sympathetic Nervous System

This system controls the alertness and excitement in a person. In the case of emergency situations, this system provides extra energy to the person's body. The enhanced heart rates, the increase in breathing speed etc. which are seen in the emergency situations are transacted by the sympathetic system.

(2) Para - Sympathetic Nervous System

This system is responsible for the conservation of the energy in the body. This system becomes functional during the resting hours and starts the conservation of the energy. This system slows down the heart rate, shrinks the pupil of the eye and enhances the secretion of the saliva and digestive juices.

2.6.1.3 Neuron

Neuron is the structural and functional unit of the nervous system through which this system sends signals from one part of the body to other. Neurons keep most of the cells/tissues of the body in touch with the central nervous system.

The neurons receive both the external and internal stimuli. Through electro- chemical impulses these stimuli moves from one neuron to another and reach the central nervous system. The reactionary stimulus from the central system is also send through the neurons.

Every neuron is made up of three units (Figure 2.16) -

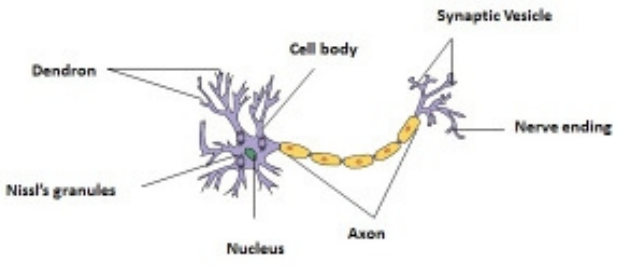


Figure 2.16 Structure of Neuron

(A) Cell Body

This part is also called as Cytone. The cell body contains a nucleus and other typical cell organelles. Within the cytoplasm characteristic highly stained Nissl's granules are found.

(B) Dendron

They are small fine filaments which are found as branches of cell body. The Dendron's send the stimuli towards the cell body.

(C) Axon

It is a long cylindrical projection that starts from the cell body and forms thread like branches.The axons conduct the electric impulse away from the neurons. Every branch of the axon forms a bulge like structure called **synaptic knob**. Every synaptic knob contains synaptic vesicles which contains chemicals called **Neurotransmitters**. These neurotransmitters play an important role in transmission of the neural stimuli. The point of joining of the dendrite of one neuron with the Axon of other is called **Synapse**. At this point the neurotransmitters are found.

2.6.1.4 Physiology of Nervous System

Many neurons join with each other and form a chain like structure. They join various body parts with the brain and the spinal cord. Sensory nerves respond to various stimuli like sound, light, touch etc. and send them to the central nervous system. This work is executed with the help of a series of electrochemical impulses. This is also called as **nervous impulse**. The nervous impulse propagates the stimulus received through the sensory organs (skin, tongue, nose, eyes and ears) to the central nervous system. The nervous impulse weakens as it reaches from the Dendron to the Axon. The neurotransmitters present at the synapse make these impulses strong and sends them ahead. In turn the responding signals (impulse) from the central nervous system are broadcasted by the motor nerves which in-turn activates the muscles and the glands.

2.6.2 Endocrine System

The endocrinal system is such a system which along with the nervous system establishes co-ordination between various cellular activities of the body. The nervous system cannot keep long time control over all the cellular activities. Therefore for continued long term regulation, hormones secreted by the endocrine system are required in the body. The endocrinal system works through the endocrinal glands. Such glands are ductless and directly secrets their secretion (hormones) into the blood stream.

Some glands in our body can function both as endocrine and exocrine. For example pancreas as an endocrinal gland secrets insulin and glucagon hormone while as an exocrine gland it secrets digestive enzymes. The testis and ovary also function similarly.

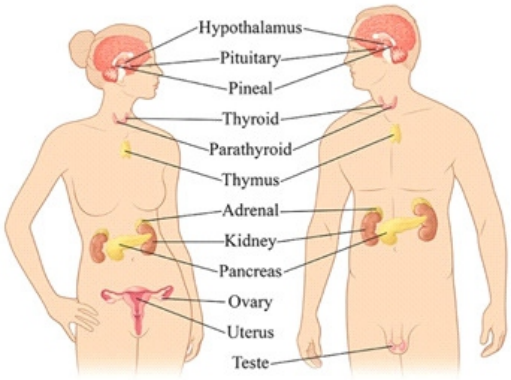


Figure 2.17 Human endocrinal System

The endocrinal glands, in addition to hormone secretion also work to store and release the hormones. Various endocrine glands present in the human body are - Hypothalamus, Pituitary gland, Pineal gland, Thyroid gland, Parathyroid gland, Adrenal gland, Pancreas, Thymus, Testis, Ovaries etc (Figure 2.17). In addition to these, some other organs like Liver, Kidneys, Heart etc also release hormones.

Hypothalamus plays the most important role in establishing the control by the endocrinal system. Hypothalamus collects different information's from various parts of the brain. Through various secretions and nerves the collected information is send to the pituitary gland. On the basis of the information received, the pituitary gland through its own secretions, directly or indirectly, control the activities of other endocrinal glands.

As per the instructions received through secretions of the pituitary gland, other glands release various hormones. In the human body these secreted hormones transacts and controls various works like growth, metabolic activities etc. The hormones put their effect by linking with the specific proteins present on the target cells/tissues.

2.6.2.1 Important human Endocrine Glands

(A) Hypothalamus:

The Hypothalamus is the basal part of the Diencephalon (Forebrain). It mainly regulates the hormone production and secretion by Pituitary gland. Hypothalamus contains many hormone secreting cells. Two types of hormones are secreted by the hypothalamus:

(1) Releasing hormones - which induces the pituitary gland to release its hormones.

(2) Inhibitory hormones - which inhibits the hormone production by the pituitary gland.

(B) Pituitary gland:

This gland is found in the lower portion of the brain near the hypothalamus. This gland can be divided into two parts - **Adenohypophysis** and **Neurohypophysis**. The Adenohypophysis is also called as anterior pituitary gland and the Neurohypophysis is also called as posterior pituitary gland. This is the **master gland** of the body which synthesize and secret many hormones like Somatotropin (growth hormone), Prolactin, Thyroid stimulating hormone, Oxytocin, Vasopressin, Gonadotropin etc.

(C) Pineal Gland:

This gland is found in the upper part of the fore brain and secrets a hormone called **Melatonin**. This hormone is important for the regulation of body's internal clock.

(D) Thyroid Gland:

This gland is situated on both the sides of the trachea. Most importantly this gland secrets **Thyroxin hormone** which regulates the metabolic activities that are based upon this hormone. The thyroxin hormone helps in the synthesis of red blood corpuscles. It also regulates the protein, carbohydrate and fat metabolism. Iodine is required for the synthesis of thyroxin hormone. The lack of iodine results in decreased production of thyroid hormone and may result in a disease called **Goiter**.

(E) Parathyroid Gland:

This gland is found in the posterior part of the thyroid gland and secrets a hormone called **Parathormone**. The main function of parathormone is to control calcium and phosphate levels in blood. Lack of this hormone may cause tetany (parathyroid tetany) disease.

(F) Pancreas:

Pancreas secret two Endocrine hormones - **Insulin** and **Glucagon**. Insulin is secreted by β - cells of islets of Langerhans of this gland while Glucagon is secreted by α- cells of the islets of Langerhans. The main function of insulin is to control the blood glucose level by converting glucose into glycogen. Glucagon

on the other hand stimulates the conversion of glycogen into glucose. Therefore both these hormones collectively control the level of sugar in the blood. If due to some reasons there is a reduction in the level of blood insulin, the level of sugar in blood and urine increases and a disease called **Diabetes Mellitus** is caused.

(G) Adrenal Gland:

A pair of adrenal glands is found on top of the kidneys. They secrete two kind of hormones called **adrenaline** or **epinephrine** and **noradrenaline** or **norepinephrine**. These hormones work to protect the body in emergency conditions. In emergency conditions these hormones are released more rapidly and regulate various functions such as heart beat, heart contraction, respiratory rate, expansion of the pupil of the eyes, etc. These hormones are also called as emergency hormones.

(H) Thymus Gland:

Thymus is situated on the upper side of the heart and the aorta. It releases a peptide hormone called **Thymosine**. This gland is developed maximum in young children and starts to shrink from puberty onwards.

(I) Testes:

This gland is found only in males. This is a sexual gland which secrets male hormone called **Testosterone**. This hormone is responsible for the development of male sexual organs and plays an inductive role in the synthesis of sperms.

(J) Ovary:

This gland is found in the females. It produces and secrets female steroid hormones called **Estrogen** and **Progesterone**. These hormones are helpful in development of female sexual characters, regulation of menstrual cycle, maintenance and up-keeping of the embryo etc.

Important points

1. Cell is the basic structural and functional unit of the body.
2. The co-ordinated collective working of various body organs forms a body system.
3. The process starting from the intake to the excretion of the faeces from digestive system. The major functions of the digestive system are - conversion of complex components of the food into simpler substances and its absorption.
4. At different levels, the sphincter muscle regulates the movement of food, digested food juices and the waste materials.
5. Four types of teeth are found in the jaw *viz* Incisors, Canines, Premolars and Molar. The position of jaw and teeth in humans is called Thecodont. Humans have Diphyodont type of teeth arrangement.
6. Pharynx through its structure prevents the entry of food in the trachea and entry of air in food pipe.
7. Stomach is divided into three portions viz Cardiac, Pyloric and Fundus.
8. The maximum digestion and absorption of the food takes place in the small intestine. The small intestine is divided into three parts - duodenum, jejunum and ileum.
9. The large intestine mainly absorbs the water and minerals and then excretes the unabsorbed food through the anus. The large intestine is also divided into three parts - cecum, colon and rectum.
10. Some glands like - salivary gland, liver and pancreas are also found in the digestive system. These glands through the digestive enzymes help in the digestion of the food. In addition to the glands, the stomach, small intestine and other organs also secrets their enzymes.
11. The exchange of O_2 and CO_2 which takes place between the environment, blood and cells is called respiration. The blood transports O_2 carrying the pure air in the cells and liberates the

CO_2 into the environment through the lungs.

12. The human respiratory system is divide into three parts - the upper respiratory system, the lower respiratory system and the respiratory muscles.
13. The upper respiratory system mainly comprises of the nostrils, mouth, pharynx, Larynx etc.
14. The lower respiratory system is made up of trachea, lungs, bronchi, bronchiole and alveoli.
15. The diaphragm is the main respiratory muscle. Through its contraction, the air enters inside the lungs while its relaxation results in expulsion of the inhaled air.
16. In the internal respiration the exchange of gases occurs between the blood flowing in the capillary tubes and the tissues. It occues through diffusion.
17. Three types of corpuscles *viz* red blood corpuscles, white blood corpuscles and platelets are found in the blood. Additionally, blood contains a fluid portion called plasma.
18. Blood circulation system mainly comprises of the heart and blood vessels.In addition to the blood, one more fluid called Lymph is also found in the body.
19. On the basis of the presence of antigens on the red blood cells, the blood is divided into four groups viz A, B, AB and O. On the basis of presence and absence of Rh antigen, the blood is of two types - Rh positive and Rh negative.
20. The blood vessels in which the pure oxygenated blood flows are called Arteries and those carrying the impure blood are called Veins.
21. Two atria and two ventricles are present in the heart.
22. Urea is the excretory product in human beings .
23. The human excretory system consists of two kidneys, urinary bladder, ureters and urethra.
24. Nephron is the major structural and functional unit of the excretory system.
25. The production of cells responsible for the sexual reproduction starts from the puberty age.
26. Bisexual reproduction process is found in the humans where male produces sperms and females produces ovum.
27. In human males the testosterone is the main sex hormone while in females it is estrogen and progesterone.
28. The reproductive organs are classified in primary and secondary organs. The primary organs are responsible for gamete production. All the organs, except the primary organs, which function in reproductive system, are called secondary organs.
29. The male sex organs are - scrotum, testis, vas deferens, seminal vesicle,Urethra and penis.
30. The female sex organs include- ovary, fallopian tubes, uterus and vagina.
31. For the coordinated functioning of various organs and organ systems in humans, the nervous system and the endocrinal system functions together.
32. The nervous system can be divided into two parts - the central nervous system and the peripheral nervous system.
33. The brain, spinal cords and different neurons arising from them works for the nervous system.
34. Endocrine glands are ductless gland. The hypothalamus regulates the functioning of pituitary gland.

Practice questions

Objective type questions

1. What controls the movement of food, digested food juice and waste at different levels?
   (a) Sphincter (b) Mucosa
   (c) Mucus epithelium (d) Both (b) and (c)
2. Which of the following teeth are most developed in carnivore animals?
   (a) Incisors (b) Canines
   (c) Premolars (d) Molars

3. The main function of Epiglottis is……
…….
(a) To direct the food into the Trachea
(b) Preventing the food from entering the trachea
(c) To direct the food to the esophagus
(d) None of the above

4. Maximum enzymatic digestion of food takes place in ……
(a) Jejunum (b) Ileum
(c) Duodenum (d) Colon

5. Which of the following is not a salivary gland?
(a) Parotid gland
(b) Submandibular gland
(c) Sublingual gland
(d) Pituitary gland

6. Which of the following enzymes is not secreted by the pancreas?
(a) Amylase (b) Trypsin
(c) Renin (d) Lipase

7. Which of the following is secondary respiratory organ?
(a) Mouth (b) Nose
(c) Nasopharynx (d) Larynx

8. The number of lobes found in the left lungs is?
(a) 3 (b) 4
(c) 2 (d) 1

9. …….is found in Alveoli.
(a) Squamous Epithelium (b) Epithelium
(c) Cartilage rings (d) None of the above

10. What is the liquid portion of blood called as?
(a) Serum (b) Lymph
(c) Plasma (d) None of the above

11. Where the development of red blood cells takes place?
(a) Spleen (b) Red bone marrow
(c) Lymph node (d) None of the above

12. Which of the following cells is not a white blood cell?
(a) B - Lymphocyte (b) Platelet
(c) Basophil (d) Monocyte

13. Red blood cells of which of the following blood groups contains both A and B antigens?
(a) O (b) A
(c) B (d) AB

14. How many times does the blood pass through the heart during circulation?
(a) One (b) Three
(c) Two (d) Four

15. The main excretory product of the human body is…….
(a) Ammonia (b) Uric acid
(c) Urea (d) Both (A) and (C)

16. Where is Glomerulus found?
(a) Bowman's Capsule (b) Renal Duct
(c) Henley-Loop (d) None of the above

17. The main human male hormone is
(a) Estrogen (b) Progesterone
(c) Testosterone (d) Both (B) and (C)

18. The primary Sex organs are
(a) Scrotum (b) Ovaries
(c) Testis (d) Both (B) and (C)

19. The Motor nerves deliver the stimuli
(a) From central nervous system to organs
(b) From organs to Central nervous system
(c) Both (A) and (B) are correct
(d) Both (A) and (B) are wrong

20. The Corpora quadrigemina is found
(a) Fore brain (b) Hind brain
(c) Mid Brain (d) Both (A) and (B)

21. Which of the following hormone is not secreted by Pituitary gland?
(a) Growth Hormone (b) Vasopressin
(c) Melatonin (d) Prolactin

22. Which is responsible for the internal clock of the body

(a) Thyroid gland (b) Pancreas

(c) Adrenal gland (d) Pineal gland

Very short type questions

23. Write the name of the basic structural and functional unit of the body.
24. Define digestive system.
25. What is the work of Sphincter muscles?
26. Write the names of glands involved in the digestive system.
27. What is the function of the Incisor teeth?
28. How many parts of the stomach are there?
29. Where does the maximum absorption of digested food takes place?
30. Write the name of the largest gland found in the body.
31. Which gland secrets the Ptyalin enzyme?
32. How many cartilages are found in the Larynx?
33. The mucous in the trachea is produced by .....
34. How much blood is found in a normal person?
35. What is the life span of the Platelets?
36. Name of the vessel in which impure blood flows?
37. What is Pericardium?
38. What is the work of Aorta?
39. What is the process of excretion of ammonia called?
40. Which is the main excretory organ in human beings?
41. Write the name of the organ that produces ovum.
42. Write the name of the major female sex hormone.
43. Where does the placenta implants in mother?
44. Write the name of the systems responsible for establishing the co-ordination among various organs.
45. Where is the grey matter found?
46. Write name of a neurotransmitter.
47. Name of the hormone released by Thyroid gland.
48. Which gland is responsible for the secretion of the adrenalin hormone?

Short type questions

49. Write the names of the organs involved in the digestive system.
50. Explain the structure and function of the stomach.
51. Where is the salivary gland found? Explain its structure.
52. Discuss the main functions of the nostrils.
53. How is pharynx helpful in respiration?
54. Write the importance of respiratory muscles.
55. Define blood and write its functions.
56. What is the role of blood vessels in the blood circulation.
57. Explain the structure of the kidney.
58. Mention the organs besides the kidney which are involved in the process of excretion.
59. Explain the role of the female primary sex organs.
60. What is the function of VasDeferens in the human reproductive system?
61. What is the significance of spinal cord?
62. What is the work of the forebrain? Explain its structure.
63. What is the role of the hypothalamus in the endocrine system?
64. Explain the exocrine and endocrine functions of the pancreas.

Essay type questions

65. Write a detailed note on the human digestive system. Explain the importance of the enzymes in the digestive system.
66. Explain the significance of bronchioles, lungs and respiratory muscles in human respiratory system,
67. What is blood? Discuss various components of blood and explain its importance.

68. Discuss the process of urine formation in human. Describe the structure of the kidney.

69. Draw a well labeled diagram of male reproductive system. Describe the functioning of the primary genital organs in humans.

70. With the help of an illustrative diagram, explain the structure of a nerve.Discuss the importance of hypothalamus and pituitary gland.

Answer key

1. (a) 2. (b) 3. (b) 4. (c) 5. (d) 6. (c) 7. (a) 8. (c)
9. (a) 10. (c) 11. (a) 12. (b) 13. (d) 14. (c)
15. (c)16. (a) 17. (c) 18. (d) 19. (a) 20. (c)
21. (c) 22. (d)