

NTSE STG1 RAJASTHAN

HUMAN SYSTEM (LIFE PROCESSES & HUMAN REPRODUCTION)

CONTROL & COORDINATION HAS BEEN REMOVED AS PER 2020-21 DUE TO COVID PANDEMIC.

- The human body is a complex and highly efficient organization of organs and organ systems.
- A cell is the smallest structural and functional unit of life.
- Many cells come together in a group to make tissue. A particular tissue is responsible for a particular task.
- Different types of tissues group together to make organs.

Many organs come together to make an organ system. There are several organ systems in the human body which are as follows:

- Respiratory System
- Nervous System
- Reproductive System
- Musculoskeletal System
- Digestive System
- Circulatory System
- Excretory System
- Endocrine System

The nutrients which we take through food are in the form of complex substances and cannot be utilized by the body in complex form.

The system of organs and many glands which convert these complex substances into simple substances is called digestive system.

The process which converts complex nutrients into simple and absorbable substances is called digestion. Many enzymes play important role in digestion.

The digestive system is composed of an alimentary canal, some accessory glands and organs. The alimentary canal begins from mouth and ends up in anus. The alimentary canal is 8 – 10 m in length and is also called the digestive canal.

Parts of Human Digestive System	
Organs	Glands
Mouth, pharynx, oesophagus, stomach, small intestine, large intestine, rectum	Salivary glands, liver, pancreas

Main functions of alimentary canal:

- To simplify the constituents of food.
- Absorption of simplified constituents of food.
- Removal of undigested food and waste from body.

Mouth:

- The opening of the alimentary canal leads to buccal cavity or mouth which is a bowl-shaped structure. Buccal cavity is lined by soft palate at bottom and hard palate at top.
- There is a muscular tongue which is highly flexible and can move in almost all directions. The tongue is attached to the lingual frenulum at the back of the buccal cavity's floor.
- The mouth is surrounded by a pair of muscular lips. The lips facilitate opening and closing of mouth and help in catching the food.

Arrangement of Teeth:

- There are 16 teeth in each jaw, viz. upper and lower jaws. The teeth are tightly fit in the sockets in gums. This type of arrangement of teeth is called the codont.
- Human beings get two sets of teeth in their lifetime. This phenomenon is called diphyodont. The first set of teeth is called milk teeth or temporary teeth. A child gets milk teeth at about six months' of age. These are replaced by permanent teeth between 6 to 12 years of age.

Types of Teeth: There are four types of teeth in human beings.

- Incisors: These are at the front of jaw with four teeth in each jaw. They are also called cutting teeth used for cutting of food. These teeth come up when a child is about six months' old.
- Canine: These teeth come after incisors in sequence. Each jaw has two canine teeth. These teeth come up at the age of 16 to 20 months. Canine teeth are meant for tearing the flesh and cracking the bones or hard nuts.
- Premolar: These teeth help in coarse grinding of food. These teeth fully develop at the age of 10 – 11 years. There are 4 premolar teeth in each jaw.
- Molar: These teeth facilitate fine grinding of food. These teeth come up at 12 – 15 months' of age. There are 6 molar teeth in each jaw.

Pharynx:

The buccal cavity opens in a funnel-shaped cavity called pharynx. Through the pharynx, the food goes to oesophagus and air goes to the windpipe. Both the pipes open near the lower surface of pharynx. The pharynx can be divided into three parts:

- Nasopharynx
- Oropharynx
- Laryngopharynx or Hypopharynx

Oesophagus:

This is a 25 cm long, narrow tube which goes from pharynx to stomach. Its main function is to carry food from mouth to stomach.

- There is a cartilaginous flap called epiglottis which ensures that the food goes only to the food pipe and does not go to the windpipe.
- Secretions of mucus glands in oesophagus make the food slippery. Different parts of oesophagus alternately contract and relax. This movement is called peristalsis and is responsible for forward movement of food.

Stomach:

This is a J-shaped structure which lies between oesophagus and duodenum. The stomach lies towards left in the abdominal cavity and just behind the diaphragm. This is a flexible organ which can accommodate up to three litre of food. Stomach can be divided into three parts which are as follows:

- Cardia: This part is at the left and is connected to the oesophagus.
- Fundus: This part lies between cardia and pylorus.
- Pylorus: This part opens into small intestine.

The stomach has two sphincters to control the movement of food. They are as follows:

- Cardiac or lower oesophageal sphincter: This sphincter separates the oesophagus from stomach and prevents acidic food from going back into the oesophagus.
- Pyloric Sphincter: This sphincter separates stomach from small intestine and controls the movement of food to small intestine.

Small Intestine:

This is a highly coiled tube-like structure which begins from pylorus and ends in large intestine. Small intestine is about 7 m long. Major portion of digestion takes place in small intestine. It can be divided into three portions:

- Duodenum: This is the anterior-most portion of small intestine and is connected to pylorus. All the digestive juices come into duodenum and digestion of food takes place here.

- Jejunum: This is the middle portion of small intestine. Absorption of most of the digested food takes place in jejunum. Absorption is carried by specialized cells which are called enterocytes.
- Ileum: This is the last portion of small intestine and is connected to large intestine. Some of the substances which are not absorbed by jejunum are absorbed in this portion, e.g. bile salts and vitamins.

Large Intestine:

This is much shorter than small intestine and has a larger diameter. Some microbes live in large intestine. These microbes digest the remaining food by fermentation. Moreover, excess water and salt are absorbed by the walls of large intestine. Large intestine can be divided into following parts:

Cecum:

This is connected to ileum. Absorption of materials takes place in this part and remaining portion of food is sent to colon. At the junction of ileum and cecum, a tubular structure can be seen. This is called vermiform appendix. Vermiform appendix is a vestigial organ and serves no purpose in human body.

Colon:

The next portion of large intestine is called colon. This appears like inverted 'U' and is about 1.3 m long. The colon can be divided into four parts, which are as follows:

- Ascending Colon: This part is about 15 cm long and goes upwards from near appendix.
- Transverse Colon: This part is about 50 cm long and is almost horizontal.
- Descending Colon: This part is about 25 cm long and goes downwards.
- Sigmoid Colon: This part is about 40 cm long and is somewhat S-shaped.
- Rectum: This is the last portion of large intestine. It is 20 cm long. The last portion is called anus and is about 3 cm long. There are two sphincters in the anal canal, viz. external and internal sphincters. Undigested food and waste products are expelled out of the body through anus.

Salivary Gland:

It is situated in buccal cavity. It secretes mucus and a slimy liquid. The liquid keeps the food hydrated and mucus lubricates the food so that swallowing becomes easier. Saliva contains the enzyme salivary amylase or ptyalin which digests starch. There are three types of salivary glands:

- Parotid gland: Secretes liquid only
- Sub-mandibular gland: Secretes liquid and mucus both.
- Sublingual gland: Secretes liquid and mucus both.
- Pancreas: Pancreas is situated below stomach. It is a U-shaped gland and is a mix of endocrine and exocrine glands. Pancreas secretes many digestive enzymes which are sent to the small intestine. Pancreas also secretes insulin and glucagon hormones which play important role in glucose metabolism.
- Liver: Liver is the largest gland in the human body. It is situated below the diaphragm and its major portion is towards right side. Liver is composed of about 100,000 hexagonal functional units which are called liver lobules. Liver produces bile which goes to the gall bladder through hepatic duct system. From gall bladder, bile goes to the small intestine through hepato-pancreatic duct.

Digestive Juices secreted by different organs or glands and their Functions			
Organ or Gland	Enzyme	Function (Complex → Simple)	Site of function
Salivary gland	Ptyalin or amylase	Starch → maltose	Mouth
Gastric juice	Pepsin	Protein → peptide	Stomach
	Rennin	Casein → paracasein	

Pancreas	Amylase Trypsin Chymotrypsin Carboxypeptidase Lipase Nuclease	Starch → Maltose Protein → peptide Protein → peptide Protein → peptide + amino acid Fat → monoglyceride + fatty acid DNA or RNA → Nucleotide	Small intestine
Succus entericus (enteric juice)	Maltase Lactase Sucrase Lipase Nucleases Dipeptidase Phosphatase	Maltose → Glucose Lactose → Glucose Sucrose → Glucose Fat → Fatty acid + glycerol Nucleic acid or nucleotide → Nucleoside or glucose Dipeptide → Amino acid Nucleotide → nitrogenous base, ribose	Small intestine
Liver	Bile	Fat → Amino acid/Fat globules	Small intestine

Digestion in Mouth:

Mastication breaks the food into smaller particles and mix the saliva to the food. The mucus in saliva helps in food particles coalescing together. The food mixture in mouth is called bolus. It passes through pharynx and oesophagus to reach stomach.

Digestion in Stomach:

Stomach secretes three digestive juices, viz. mucus, proenzyme pepsinogen and hydrochloric acid. Mucus is secreted by mucus membrane and hydrochloric acid is secreted by oxyntic cells. Hydrochloric acid kills any germs in food and makes the medium in stomach acidic required for working of gastric enzyme. Pepsinogen changes to pepsin which digests protein into peptide. Rennin is secreted in small children and helps in digestion of milk protein. The food mixture in stomach is called chyme.

Digestion in Small Intestine:

Major portion of digestion happens in the duodenum of small intestine. Digestive juices from liver and pancreas come into duodenum through hepato-pancreatic duct. The bile makes the medium in small intestine alkaline which is necessary for digestive enzymes to function. Bile also carries out emulsification of fat so that digestion of fat can be carried out.

Absorption of Food:

Once food components are converted into simple substances, they are absorbed by cells of internal wall of jejunum. The inner wall is projected into numerous finger-like structures called villi. Numerous folds in the form of villi, increase surface area of lumen and thus provide more absorbent surface. The absorbed food is sent to different organs via blood.

Egestion of Food:

Food from small intestine goes to large intestine. Water and salt are absorbed by the walls of large intestine. After that, undigested food and waste material are expelled from time to time.

Respiration:

The body needs energy for various activities. This energy comes after oxidation of food in cells. The oxidation of food to release energy in cells is called respiration. Energy produced after respiration is stored in the form of ATP (Adenosine tri-phosphate) and is utilized by cell as and when required.

The whole process of respiration is composed of two processes, i.e. cellular respiration and exchange of gases. The oxidation of food takes place inside cells and this step is called cellular respiration. Each cell needs timely supply of oxygen to carry out respiration. The carbon dioxide gas, formed after respiration needs to be removed from the cell. All of this is achieved by a mechanism of breathing and blood circulation.

Human Respiratory System:

The respiratory system in humans can be divided into three major parts, viz. upper respiratory system, lower respiratory system and respiratory muscles.

Upper Respiratory System:

The upper respiratory system is composed of nose, mouth, pharynx and larynx.

- **Nose:** The nose opens outside through two nasal openings. The nasal chamber is divided into two by a bone in between and it opens in nasopharynx. The thin lining, along with hairs and mucus in nasal chamber work like air-filter, s-
- **Mouth:** Mouth plays a secondary role in breathing. In case of any obstruction in nose, we can easily breathe

through mouth. However, air which enters through mouth is not as clean as that entering through nose.

- Pharynx: Pharynx can be divided into three parts, viz. nasopharynx, oropharynx and laryngopharynx. Air from nasal chamber goes to oropharynx via nasopharynx.
- Larynx: Larynx is also called voice box which connects pharynx with trachea. Larynx is composed of nine cartilaginous structures. There are two vocal cords stretched across larynx. When air passes through larynx, it creates vibrations in vocal cords and sound is produced.

Lower Respiratory System:

The lower respiratory system is composed of trachea, bronchioles, lungs and alveoli.

- Trachea: Trachea is made up of C-shaped cartilaginous rings. The rings are held together by pseudo stratified ciliated columnar epithelium. The cartilaginous rings prevent the trachea from collapsing and keep it open so that air can go through without obstruction. Trachea divides into two branches in thoracic chamber, each branch going to a lung. The epithelium in trachea produces mucus which filters impurities from air.
- Bronchi and bronchioles: Bronchi enter the lungs and divide into secondary bronchi. The secondary branches further divide into tertiary bronchioles. Further division creates bronchioles. These bronchioles finally end up in terminal bronchioles. This system of branches and sub-branches appears like branches of a tree inside lungs. The terminal bronchiole ends in alveoli.
- Lungs: A lung is a balloon-like structure which contains bronchii, bronchioles, alveoli and blood capillaries. The left lung is divided into two lobes and the right lung is divided into three lobes. Each lobe is divided into many sub-lobes. Each sub-lobe is divided into many small segments and each segment has fine branches of bronchii, arteries and veins.
- Alveoli: Each lung is made up of spongy tissues and contains many capillaries and about 30 million alveoli. Alveolus is lined by squamous epithelium and blood capillaries. Exchange of gases takes place in alveoli.

Respiratory Muscles:

Breathing is facilitated by special muscles like diaphragm. Contraction in diaphragm facilitates entry of air in lungs. Relaxation of diaphragm facilitates removal of air from lungs. Intercostalis muscles also play a role in breathing.

Physiology of Respiration:

Exchange of gases takes place at two levels:

- External Respiration: This happens in alveoli. The pressure difference between air in alveoli and gases in capillaries facilitates removal of carbon dioxide from blood and addition of oxygen to blood.
- Internal Respiration: This happens at cellular level. In this case, exchange of gases between blood and cells takes place by diffusion.

Blood:

Blood is a fluid connective tissue. Transport of various substances, gases and waste products happens through blood. The pH of blood is slightly alkaline. Blood is produced in bone marrow in adults. In neonates and at embryonic stage, blood is produced by spleen. There are two parts in blood, viz. plasma and formed elements.

- Plasma: Plasma composes about 55% of total blood. About 92% of plasma is composed of water and rest is composed of organic and inorganic substances.

Formed elements are composed of cells which are as follows:

- Red Blood Cells or Red Blood Corpuscles (RBCs): RBCs comprise 99% of blood cells. RBCs contain a protein called haemoglobin which imparts red colour to them. They lack nucleus, s- White Blood Cells or
- White Blood Corpuscles (WBCs): These are colourless as haemoglobin is absent in them. They provide immunity to the body and fight against diseases. WBCs are produced in bone marrow. There are two types of WBCs, viz. granulocytes and agranulocytes.
- Granulocytes: Neutrophil, eosinophil and basophil are the granulocytes. Neutrophils are largest in number.
- Agranulocytes: Lymphocytes and monocytes are the agranulocytes. Lymphocytes are of three types, viz. B-lymphocytes, T-lymphocytes and

natural killer cells. Lymphocytes provide immunity against diseases. Monocyte becomes macrophage after attaining maturity. Neutrophil, lymphocyte and macrophage are the prime defenders and eat away antigens.

- Platelets: They are also known as thrombocytes. There are about 3 lakh platelets per cubic mm of blood. The lifespan of platelets is of 10 days. Platelets facilitate clotting of

Functions of Blood:

- Transport of nutrients.
- Maintenance of pH in body. Controlling the temperature of body. Removal of metabolic wastes.
- Exchange of oxygen and carbon dioxide.
- Transport of medicines.
- Facilitates immunity.
- Transportation of hormones to target sites.

Types of Blood:

Based on the presence or absence of a special antigen A or B, there are four types of blood, viz. A, B, AB and O. Blood group A has antigen A, blood group B has antigen B, blood group AB has both antigens and blood group O has none. RBCs also contain another antigen which is called Rh factor. Blood with Rh factor is called Rh positive, while one without Rh factor is called Rh negative. About 80% people in the world have Rh positive blood.

Heart:

There are 4 chambers in the human heart. The 2 upper chambers (atria) are thin walled and 2 lower chambers (ventricles) are thick walled.

- Between the atria and ventricles is an aperture which remains closed by valves. Valves prevent the back flow of blood.
- Oxygenated blood is separated from deoxygenated blood to allow an efficient supply of O₂ to the body for high energy needs.
- Amphibians and reptiles have 3 chambered heart – oxygenated and deoxygenated blood are not completely separated because body

temperature varies with environment. Fishes have 2-chambered heart as blood is oxygenated in the gills heart pumps the blood only once.

Blood Vessels:

There are three types of blood vessels

- Arteries: Wide and thick vessels, carry blood rich in O₂ from heart to tissues. They do not have valves, blood flows under pressure in them. Arteries are deep seated.
- Veins: Thin walled, with valves, carry deoxygenated blood from tissues to the heart, Blood flows slowly in them. They are superficial (close to the skin).
- Capillaries: Arteries divide repeatedly to form very thin walled vessels called capillaries (one cell thick). Exchange of materials between the blood and cells takes place across this thin wall. Capillaries then join to form veins.

Working of the heart:

The cardiac cycle consists of one heart beat i.e. one cycle of contraction and relaxation of cardiac muscles. The flow of blood through heart is shown as follows:

Systemic circulation → Vena cava → Right auricle → Right ventricle → Pulmonary artery → Lungs → Pulmonary vein → Left auricle → Left ventricle → Aorta → Systemic circulation

Double circulation in man:

Because the blood passes through the heart twice in one complete cycle of the body, so it is called double circulation. This ensures complete segregation of oxygenated and deoxygenated blood.

Excretion is the process of removal of harmful metabolic waste from the body of an organism.

Osmoregulation is the process of controlling the amount of water and ions in the body of an organism.

There are three types of nitrogenous waste in animals, viz. ammonia, urea and uric acid.

- Ammonia: Plenty of water is required to remove ammonia from body. Hence, ammonia is the main excretory product in aquatic animals; like fish and amphibians. Such animals are called ammonotelic animals.
- Urea: Moderate amount of water is required to remove ammonia from body. Urea is the main excretory product in mammals. Such animals are called ureotelic animals.
- Uric Acid: Negligible amount of water is required for removal of uric acid from body. Uric acid is the main excretory product in reptiles and birds. Such animals are called uricotelic animals.

Kidneys:

Excrete urea, uric acid and water. There are 2 kidneys in man, in the abdominal cavity on either side of backbone. Urine collected in the kidneys passes down the ureters to the urinary bladder and passed out through the urethra.

Nephron:

Each kidney consists of about a million long, coiled, fine tubules called nephrons. These are the functional units of kidneys. One end of each nephron has a hollow cup-Bowman's capsule.

The Bowman's capsule has a bundle of blood capillaries called glomerulus. The function of the glomerulus is to filter the blood passing through it. Only small molecules like glucose, amino acids, salts, urea and water passed out in urine. Large molecules, like protein, go back to blood capillaries.

Human Reproductive System:

The human reproductive system becomes functional at a definite age called puberty. Males reach this at the age of 13 – 14 years. While females reach puberty at the age of 10-12 years."

Male Reproductive System: The organs of male reproductive system is divided as Primary and Secondary:

- Primary male reproductive organ is a pair of testis and rest all are secondary. They lie in small pouch like muscular structure outside the abdominal cavity called scrotum or scrotal sac.
- Scrotum provides optimal temperature for formation of sperms. This temperature is
- 1 – 3°C lower than body temperature.
- From each testis arise a long tube called Vas deferens. Along the path of the vas deferens lie the prostate gland and seminal vesicles. They add their secretion which make sperms mobile and provides nutrition to sperms.
- It unites with the duct coming from urinary bladder to form a common tube called urethra. Urethra is enclosed in within a thick muscular organ called penis that opens outside through the genital pore. This opening is common for urine and sperms.
- The sperms are tiny bodies that contain mainly the genetic material and a long tail for motility.

Female Reproductive System:

The organs are also divided as primary and secondary.]

- Paired ovaries are the primary reproductive organs and are located in the abdominal cavity near the kidneys.
- Ovaries produce the female gamete ova and also secrete female hormones estrogen and progesterone
- Each ovary is composed of follicles that mature to produce ova at the puberty.
- Near posterior end of ovary, a funnel like structure leads into a long convoluted tube called fallopian tube or Oviduct.
- Fallopian tube from both the sides open into an elastic bag like structure called uterus. The uterus opens into the vagina through the cervix.
- Vagina is a tubular structure also called “birth canal” as the young one after maturation in the uterus is born through this canal.

