12. THE DIGESTIVE SYSTEM

The digestive tract or the alimentary canal consists of a long tube that runs through the body. It is made up of the pharynx (the back part of the mouth), the esophagus (a tube connecting the mouth with the stomach), the stomach, the large and the small intestines, the rectum and the anus.. The stomach, the large and the small intestines form the gastrointestinal tract.

The Process of Digestion : The food that is chewed is mixed with saliva. Saliva contains ptyalin which acts upon the starches in food. The ptyalin breaks down complex starch molecules into simpler ones. The muscles in the back of the mouth first relax to receive the bolus, (the ball of food). Then the constrictor muscles of the pharynx contract and the food is forced into the upper opening of the esopohagus. The esophagus is a thick-walled tube Whose inner surface is lined with mucous membrane. The food is earned through the esophagus into the stomach's opening,

Form and Structure of the Stomach: Some amount of digestion takes place in the stomach. The stomach is located in the upper left part of the abdominal cavity. The average capacity of an adult's empty stomach is one litre. The inner surface of stomach is lined with a mucous coat. This contains a surface lining called the epithelium and various glands which secrete mucous and other substances. This is followed inwards by three layers of smooth muscle. The outer coat of the stomach is made up of a smooth membrane called the peritoneum. The fundus or the upper part of the stomach is always filled with some gas that has been trapped. Part of this gas consists of air swallowed with food and the rest is a product of digestion.

Stomach Secretions : Upon receiving food, the stomach secretes various substances like mucous, hydrochloric acid and certain enzymes like pepsin and renin. Mucous, hydrochloric acid and pepsin are contained in the gastric juice, which is a ciear. waterv fluid. Protein rich foods such as meat, lead to. greater secretion of gastric juice, while carbohydrates and fats lead to least secretion of gastrjc juice. Through the action of gastric juice, the proteins are broken down into smaller units in the stomach. However, these are not completely digested till they are acted upon by various juices in the intestine. Some minerals such as calcium salts may be dissolved in the stomach. Fats and carbohydrates undergo only little changes in the stomach. The stomach performs a mechanical action i.e., it mixes food' and gastric juice by means of churning movements. As a result, the food is reduced to a semi-fluid mass called chyme.

The Processes in the Intestine : The semi-liquid chyme is carried from the pylorus to the first' part of the-small intestine i.e., the duodenum. Most food leaves the stomach three to four hours after eating. The digestion of the food is completed in the small interline. The wastes then enter the large intestine. The small intestine is divided into duodenum, the jejunum and the ileum. The duodenum is a little different from the rest of the small intestine. Its wall is thicker and more richly supplied with glands. It receives secretions not oniy from these giands but also from the liver and the pancreas. Digestion and absorption simultaneously occur in the upper part of the small intestine. Wave motion of the small intestine carries the liquid content into the large intestine. The liver provides bile to the small intestine. The bile is emptied into the duodenum. The pancreas .also empties pancreatic juice into the duodenum. If any one of these, are lacking, the digestive processes are seriously affected. The secretions i.e., bile and pancreatic juice are alkaline. Bile is. stored in the gall bladcfer, which is under the liver. Bile's most important function is to emulsify fats in the intestinal tract. Bile salts, break up globules of fats into very fine particles. They also help in the solution of fatty acids.

Chyme causes the secretion of the hormones secretin and pancreozymin from the intestinal wall. These hormones cause the secretion of pancreatic juice from the pancreas. Pancreatic juice contains sodium carbonate and other substances which aid in the solution of carbohydrates, fats and proteins. The enzyme amylase in the pancreatic juice changes starch into maltose. Trypsin and chymotrypsin are enzymes that act on proteins and break them down. Lipase is another pancreatic enzyme which acts an fats i.e., it breaks them down into fatty acids and glycerin. Intestinal juice, secreted by the upper part of the intestine, contains sodium chloride, sodium carbonate and other enzymes. After starches and complex sugars are broken down to simple sugars, fats to fatty acids and glycerin and proteins to amino acids, they are absorbed by the walls of the intestine.

The Large Intestine: The small intestine opens into the large intestine via the colic valve, the junction between both. The colic valve permits chyme to enter the large intestine but prevents it from re-entering the small intestine. The normal time of the small intestine to empty into the 'large intestine is 5-8 hours. When the chyme enters the large intestine, it is made up of indigestible residue, fats, cellular debris, bacteria and minerals. A great deal of water is absorbed as they pass through the large intestine to form the feces. The large intestine is made up of the caecum, the colon and the rectum. The caecum

occurs below the junction of the small and the large intestine. A small tube like projection called the vermiform appendix extends from the lower part of the caecum. The vermiform appendix serves, no special purpose in man and is hence a vestigal organ. The colon is the part of the large intestine extending from the caecum to the rectum. The rectum is the last section of the large intestine. It is divided into the rectum and the and anal cuaial. The anal canal leads to an aperture called the anus. After the contents of the ileum pass through the colic value, they collect in the caecum. Then they pass into the colon. The. fecal masses are finally pushed by colon movements into the rectum. The rectum expands to produce a definite stimulus indicating the need to pass the feces.

Digestive Tract Disorders :

1. **Constipation** : This is a condition of irregular or delayed bowel movements. This could be due to voluntarily delaying defecation for long periods or due to weakness of abdominal muscles. It could also be due to too little bulk or too little fluid in the food.
2. **Diaorrhea** : The bowels move too frequently in this condition and the stools are too soft. This nappens wnen contents of the large intestine pass through the large intestine rapidly and hence enough water is not absorbed by the contests from the bowel wall.
3. **Dysentery** : This of two sorts
   (a) Bacillary dysentery which is caused by shigella bacteria
   (b) Amebic dysentery : This is due to the amoeba entamoeba histolytica. This amoeba is found in the fecal matter of infected persons (infected with amoebic dysentery).
4. **Appendicitis :** When deposits accumulate in the vermiform appendix, its outlet may be obstructed. Bacteria wili invade the Wall of the appendix and inflamme it. Nausea is one of the principal symptoms of appendicitis. The appendix is removed by surgery.
5. **Ulcers :** The pepsin and the hydrochloric acid in the gastric juice destroy the lining of the duodenum or the stomach hence destroying the tissue. If the ulceration is intense, the walls of the duodenum and the stomach may develop pores, causing the contents of these organs to enter the abdominal cavity. The membrane lining the abdominal cavity i.e., the peritoneum may also be infected, a condition called peritonitis.
6. **Gallstones :** These are irregularly shaped bodies found in the gall bladder or the bile duct. They contain cholesterol, bile salts and calcium in varying proportions. Faulty metabolism may be one cause or infection of the gall bladder may be another. Sometimes the gallstones may. pass into the bile duct and obstruct the passage of bile into the intestine. Gallstones cannot be dissolved, surgery is the Only solution. Very frequently, the entire gall bladder is removed.

THE MUSCULAR SYSTEM

The human body has more than 600 different muscles. Latissimus Dorsi. is the broadest muscle of the back. The masses of muscle are bundles of firm threads or fibres. The human body has three types of muscle tissues. These are :

1. **Skeletal Muscles** : These are the most numerous of the three tvpes of muscles. These muscles are also called striated or striped muscles because they are made up of light and dark cross-striped bands. The skeletal muscles are voluntary muscles because they can be controlled by the mind. Each skeletal muscle cell has a large number of nuclei. These nuclei lie in the outer part of the cell. In this respect, skeletal muscle cells differ from most other muscle cells because in other muscle cells, a single nucleus is located in the center of the- cell. The striped portion of the skeletal muscle is made up of two types of proteins i.e., the actin and the myosin. The dark bands in the striped skeletal muscle is made up of rod iike molecules of myosin while the light bands consist of bent or curved molecules of actin. During a muscle contraction of the skeletal muscle, the straight rods slide past one another and the whole fibre is shortened.
2. **Smooth Muscles:** These do not show anv cross stripes. These are involuntary muscles since we do not have any control over their movements. .These are found in the walls of the stomach and intestines, in the blood vessels, in the bladder, around the pupils of the eyes and muscles attached to the roots of ttie hair. The smooth muscles contract more slowly than skeletal muscles.
3. **The Cardiac Muscle** : This is the heart muscle and if resembles the smooth muscle in that it is also an involuntary muscle. It also has a similarity to skeletal muscle since its fibres have a cross striped pattern-

Energy for Muscle Action : Muscular activity requires abundant energy. The most important sources of energy for muscles are the sugars and the starches. During digestion and assimilation, sugar and starch are changed to glycogen. Most glycogen is stored in the liver and is given out when needed. Fat is another source of energy for muscle. The body uses fat when the store of glycogen is greatly reduced. The carbon of food is another source of muscle energy. The human body does not burn glycogen directly but breaks it down into lactic acid. About one — fifth of the lactic acid (i.e., around 25%) is burned when it combines with oxygen, the remaining lactic acid is reconverted into glycogen. Since the breakdown of glycogen and lactic acid is a time

consuming process, the phosphorous compound Adenosintriphosphate or ATP breaks down to provide the energy necessary for muscle contraction. Another compound i.e., phosphocreatine also breaks down and provides the energy to build-up ATP again. Glycogen now decomposes into lactic acid and lactic acid provides the energy for the build-up of phosphocreatine. Any excess lactic acid is carried **by** the lymphatic system to the liver, where it is reconverted into glycogen.

Muscle Fatigue: If too much lactic acid accumulates within a muscle, it becomes tired and finally stops contracting. If myscles are to act effectively, lactic acid must be broken down into carbon dioxide and water or built up into glycogen. The waste products resulting from the activity of muscle cells also produce fatigue. Muscles must be well supplied with glycogen and oxygen and they must get rid of the waste products of combustion by way of the circulatory system.

Control of Muscle Activity : The fibres contained in the nerves that connect the brain or the spinal cord with the muscles are fundamental in the control of muscle activity. At the place of contact of the nerve fibre with the muscle, each nerve fibre divides into many branches and each goes to a muscle fibre. A message along a nerve fibre may cause as many as 100 muscle fibres to contract.

Muscle Motion: Flexor muscles bring adjacent body parts closer together and extensors move them apart. Abductors are muscles that move a part, such as a limb, away from the rest of the body and adductor muscles move A back. Pronator muscles can turn a part, such as the hand, face up. Suppinator muscles turn it face down. There are also muscles for rotation, as at the shoulder and the hip joints.

The main superficial muscles on the ventral (front) side are :

1. Orbicularis oculi (eye)
2. Pectoralis Major (the Greater Breast Muscle)
3. The Sartcrius - (Thigh)
4. Trapezius - (muscle over the collar bones)

Main superficial muscles on the dorsal side :

1. Grand Latissmus Dorsi.
2. Achille's Tendon - the muscle running from the calf of the leg to the heel bone.
3. Gemellr- the calf muscle.

Tendons : These are bands of connective tissue attaching the ends of muscles to the bones. They are very strong. Ligaments are also made up of connective tissue but they join one bone to another. Tendons serve to transmit the force exerted by muscle fibres. In many muscles, the fibres are set at an angle and their force is carried by a tendon running the length of the muscle. Tendons also help muscles to withstand sidewise pressure and friction. Where muscles rub against each other or against bone, they develop protective tendon patches. The tendons are protected against friction by connective tissue called tendon sheaths. These sheaths contain a fluid that acts as a lubricant as the tendon slides back and forth.

Muscle Tone: Muscles play a chief part in preventing unwanted movement. The ligaments are only a secondary line of defense i.e., they act when the strain on joints is too great or to too quick for the muscles to control. Even when the muscles are relaxed, some of their fibres are contracting. This partial contraction is called muscle tone or tonus. The muscle tone serves to hold the bones in place. Muscle tone helps us to maintain an upright posture.

HUMAN TEETH

Human teeth are stationed at the entrance of the alimentary canal. The teeth are made hard by embedding of calcium, phosphorous, magnesium and other mineral salts in organic matter. The four tissues that make up teeth are :

1. **Enamel:** This covers the crown or the visible part of the teeth and is the hardest substance in the body.
2. **Dentine:** This makes up the main mass of the tooth andjs denser and harder than bone.
3. **Cementum:** This covers the dentine in the teeth root arid is a bone like substance.
4. **The Pulp** : This occupies the center of the tooth and contains nerves, arteries, veins, and lymphatic vessels. The periodontal membrane is a layer of soft tissue between the teeth root and jaw. It holds the tooth in place and.acts as a cushion.

Types of Teeth :

1. **Deciduous Teeth** : In a young child, there are 20 teeth in the first set. These are called the deciduous teeth because they are shed. They are also called the milk teeth. Tooth buds begin to form in the embryo as early as the sixth week of prenatal life.' They begin to harden about the 16th week. Of the deciduous teeth, the first to be shed are the central incisors (which are shed around 7 Vi years) and the last teeth to be shed are the cuspid teeth (which are shed around eieven and half years of age).
2. **Permanent Teeth** : These number 32. The first permanent teeth to develop are the central incisors and the first molars. The eight front teeth are the central «nd lateral incisors, which are cutting instruments. Adjacent to these are the 4 cuspid teeth which have a sharp point for tearing food. These are also called canines. Next to the cuspids are 8 biocuspids or the premolars. (They occur as two on each side of the upper and lower jaw). The biocuspids tear and crush food. In the back of the mouth are the 12 molar teeth in groups of three on each side of the upper-and lower jaws: The third molars, the hindmost teeth of the mouth, are also known as wisdom teeth. The teeth in each jaw form

an arch called the dental arch. The first of the permanent teeth are the first molars.

Diseases of the Teeth :

1. **Dental Caries** : This is tooth decay. The disease destroys the tissues of the tooth and produces cavities that may lead to its death. The disease is caused by an acid that is formed when bacteria act on fermentable carbohydrates (principally sugar) in the -mouth. The acid **is** capable of dissolving the enamel of the tooth.
2. **Periodontal Diseases:** The diseases of the gums and of the bones that support the teeth are called periodontal diseases. They affect the structures surrounding the teeth and hence the teeth may become loosened and fall off. One of the principal periodontal diseases is Gingivitis, an inflammation of the gingivae or gums.
3. **Malocclusions:** Teeth that are irregularly spaced or do not meet properly when the mouth is closed are said to be in malocclusion. The condition may be due to certain hereditary factors like narrow dental arches, the eruption of the teeth before the jaw has grown sufficiently, premature shedding or prolonged retention of deciduous teeth.

THE BONES OF THE BODY

Bones are versatile tissues. Two thirds of the bone is made up of mineral matter, mostly calcuium phosphate, and the rest one-third is made up of collagen, an elastic substance. The outer surface of all bones is made up of compact bone. The compact bone has numerous canals called the Haversian Canals which provide passageway's for nerves and blood cells. Long bones entirely consist of a hollow shaft of compact bone. The cavitv in the centre is tilled with bone marrow. Id some long bones, there is an outer covering of compact bone and an inner covering of spongy bone or cancellous bone. The pore spaces within the cancellous bone are filled with bone marrow. In the ends of long bones and throughout the interior of flat bones and ribs, there are tissues which manufacture RBC. Some materials like benzol and lead are harmful to bone marrow. The human skeleton is made up of 206 bones which fall into two groups i.e.., the axial skeleton and the appendicular skeleton.

The Axial Skeleton and its Bones : The axial skeleton includes those- bones which transmit weight and protect body cavities. These are the skull, the vertebral column, the ribs and the sternum.

1. **The Skull :** There are 22 bones in die human skull. The cranium or the braincase is big in humans and expanded forward hence providing for deep sockets for the eyes. The human cranium is made up of 8 bones. These include the frontal bone which is ronghly over die forehead, the two parietal bones which a*e at the top and the sides of the head, the two temporal and the two sphenoid bones on the lower sides of the head, and the occipital bone which makes up the back of the skull. The foramen magnum is a huge opening at the lowest point in the back of the cranium which provides the passage for the spinal cord. The facial bones are thin and delicate. The facial bones surrounding the nasal cavities contain cavities called sinuses. The sinuses open out into the nose and are lined with the mucous membrane of the nose. The largest sinus extends along the nose, above the upper teeth and below the eyes. There are many sinuses in the bone between the eyes and behind the eyes. Hence infections can spread easily from the sinuses to the eyes. The mandible or the lower jaw is a horse-shoe shaped bone. A pair of vertical platy bones called rami extend the mandible upto the joint. The hyoid bone is a u-shaped facial bone at the junction of the mouth with the neck. The Adam's Apple or thyroid cartilage hangs from the hyoid bone. The Adam's Apple is the chief cartilage of the larynx.

The Vertebral Column : This is the backbone assembly. It is made up of a large number of cylindrical blocks. Each block is joined to the other by a cartilage. The blocks are called vertebrae and the cartilage is called intervertebral disk. The spinal cord is present behind these cylindrical blocks. It passes through, a series of arch-like bones called neural arches. Each neural arch forms part of one of the vertebrae. At the Sides, between adjacent arches, there are large openings called foramina. The spinal nerves make their way to the organs of the human body via the foramina.

The backbone is made up of 33 to 34 vertebrae: These vertebrae fall into 5 main groups i.e. the cervical vertebrae of the neck, the thoracic vertebrae of the chest, the lumbar vertebrae of the lower back, the sacral vertebrae below the lumbar vertebrae and finally the vertebrae making up the terminus of the backbone called coccyx. There are 7 cervical vertebrae, of which the first cervical vertebra which supports the head is called the Atlas and the cervical vertebrae below the Atlas is called the Axis. There are twelve thoracic vertebrae. These are larger than the cervical vertebrae. Each thoracic vertebra cairies a pair of ribs. There are 5 lumbar vertebrae. There are 5 sacrum vertebrae. All 5 are fused to form a single bone called the sacrum. It very large and triangular and attached to the hip bones. The sacroiliac joints occur at the place of attachment of the sacrum with the hip bones. These joints transmit the weight of the body to the legs. The coccyx makes up the lower end of the sacrum and represents the vestige of a tail.

The Sternum : This is the breastbone. The cartilages of the first seven ribs are attached to the sternum. (These

seven ribs are called the true ribs). The two clavicles or collar bones are joined to the sternum.

The Ribs : These are made up of twelve paired bows of bone. Each pair of ribs is attached to each of the twelve thoracic vertebrae. The first seven pairs of the ribs joined to the breastbone are called the true ribs. The next 5 pairs of ribs are called the false ribs. The last two pairs are called the Floating Ribs which extend only halfway across the body. The ribs play an important part in breathing and protect the heart and lungs.

The Appendicular Skeleton: The appendicular skeleton includes the shoulder girdle and the pelvic girdle. The shoulder girdle includes the collar bones, the shoulder blade and the arm bones. The pelvic girdle includes the bones of the pelvis and the limb bones.

1. **I'he Collarbone (or clavicle):** it is attache d to the breastbone at its inner end and at its outer end, to the shoulder blade. It forces the shoulder joint to keep its distance from the breastbone. When it breaks, the shoulder collapses inward.
2. **The shoulder Blade or Scapula** : It is a thin triangular bone suspended from the outer end of the clavicle. It slides over the upper and back parts of the chest. At the armpit, the outer part of the scapula forms the socket of the ball and socket joint between the shoulder blade and the upper arm. Just besides the shoulder joint another strong bone projects from the scapula called the coracoids. process. The clavicle is.joined to coracoids process by a ligament.

Arm Bones : These include :

(i) **The Humerus** : This is a single bone of the upper arm. Its upper end makes up the ball of the bail and socket joint. At its lower part towards the elbow, the humerus expands to form two joint , surfaces, one of which is called the trochlea. The inner bone of the lower ami i.e., the ulna is joined to the trochlea.

(ii) **The Radius and the Ulna** : The ulna is the inner bone of the forearm and is concerned with bending and straightening of the elbow. The radius is the outer bone of the forearm and carries the hand at the wrist.. When the thumbs point towards the body, the ulna and radius are crossed.

The Hand Bones : These include :

1. **The Carpais** : These are **8** little bones of the wrist. These occur as two rows. The movements of the carpais gives flexibility to the wrist.
2. **Metacarpals** : These are the palm bones. Their square bases lie towards the wrist and are in contact with each other . Their rounded heads form the knuckles. The metacarpal of the thumb moves freely and is opposable to the rest of the fingers.
3. **The Phalanges** : TheSe are the finger bones while the thumb has two phalanges, all other fingers have three.

The Hip Bones : The hip bone is very irregular in shape and is hence called the innominate bone. It has two symmetrical bones attached to the sacrum above and uniting below at the crotch. Three sets of bones make up the hip bone, the Ilia, the Ischia and the Pubes. l~he two ilia are the topmost bones. The ilia protect the lower abdominal organs. The lower end of each ilium ends in a cup like structure called the acetabulam. The acetabulum is joined to the thigh bone or femur - in a ball anu socket joint. This is the most secure ball and socket joint of the human body. The ischia is made up of the Ischium bones which run vertically down from the acetabulum. It is the bone on which were rest . when we sit straight. The Ischium merges with die Pubis. The Ischia, the Ilia and the Pubis and sacrum form the pelvis, which has no bottom. The cavity at the bottom of the pelvis houses the reproductive organs.

The Leg Bones : These include :

1. **The Patella :** This is kneecap and slides down the femur when the leg is bent.
2. **The Femure :** This is th^ thigh hor.c and is the longest bone of the body It fits i^to the acetabulum at its upper end. Its lower end at the knee develops a pair of prominences called the condyles.
3. **The Tibia :** The inner bone of the lower leg is the tibia. It alone receives and transmits weight. It supports the condyles of the femur.
4. **The Fibula :** This is the outer bone of the leg and is very thin and delicate. The tibia and fibula develop projections near theankle joint called flanges. These flanges hold the topmost bone of the foot i.e., talus. The fibula does not take any part in-the knee joint.

The Foot Bones : These are :

The'Talus : This is the uppermost bone of the foot and rests on the heel bone or calcaneus. The talus, the calcaneus and the 5 small bones in front of them are called the tarsals or the ankle bones. In front, theankle bones are joined to metatarsals an phalanges similar to those of the hand.

Disorders of Bones : The bones of the young are flexible and soft. Hence when they fracture, ᶜthey splinter instead of breaking completely. When the bones are very fragile, the ailment is called Fragilitas Ossium. Rickets is a bone disease of children. It is due to deficiency of calcium, phosphorous and vitamin D. Hence the bones do not solidify properly and the bones are deformed out of shape. When the bones are infected by certain bacteria, the marrow is inflamed by pus. This condition is called Osteomyelitis.