

HUMAN ANATOMY & PHYSIOLOGY-II- BP201T

UNIT: 2 (DIGESTIVE SYSTEM)

CLASS: 01

TOPIC: STRUCTURE OF THE ALIMENTARY CANAL

- The layers of the walls of the alimentary canal follow a consistent pattern from the Oesophagus onwards.
- In the organs from the Oesophagus onwards, structural modifications are associated with specific functions.
- The walls of the alimentary tract are formed by four layers of tissue:
Adventitia or Serosa – Outer Covering
Muscle layer
Submucosa
Mucosa – mucosal lining

Adventitia or Serosa: This is the Outermost layer. In the thorax it consists of loose fibrous tissue, and in the abdomen the organs are covered by a serous membrane (Serosa) called Peritoneum.

Peritoneum:

- It is largest serous membrane of the body. It is a single membrane, forming a closed sac and containing a small amount of serous fluid, within the abdominal cavity.
- It is richly supplied with blood and lymph vessels, and contain many lymph nodes.
- It provides a physical barrier to local spread infection and can isolate an infective focus such as appendicitis, preventing involvement of other abdominal structures.
- It has two layers: Parietal Peritoneum, which lines the abdominal wall and the visceral peritoneum, which covers the organs (Viscera) within the abdominal and pelvic cavities.
- The parietal peritoneum lines the anterior abdominal wall. The two layers of Peritoneum are in close contact, and friction between them is prevented by the presence of peritoneal fluid.
- The abdominal organs are covered to varying degrees by the loops and folds of the visceral peritoneum, which attaches them firmly to the abdominal wall.
- If the organ is almost completely covered by the visceral peritoneum, it is said to be intraperitoneal.

- If the organ is covered on its anterior side only, it is said to be retroperitoneal (meaning behind the Peritoneum). This means that:
- Pelvic organs are covered only on their superior surface.
- The stomach and intestines are almost completely surrounded by Peritoneum and have a double fold (the mesentery) that attaches them to the posterior abdominal wall.
- The fold of peritoneum enclosing the stomach extends beyond the greater curvature of the stomach, and hangs down in front of the abdominal organs like an apron.
- This is the greater Omentum, which stores fat that provides both insulation and a long-term energy store.
- The anterior surfaces of the pancreas, spleen. Kidneys and adrenal glands is covered, so these organs are retroperitoneal (lie behind the Peritoneum).
- The liver is almost completely covered by peritoneum, which attaches it to the inferior surface of the diaphragm.
- The main blood vessels and nerves pass close to the posterior abdominal wall and send branches to the organs between folds of peritoneum.

Muscle layer:

- This consists of two layers of smooth (involuntary) muscle. The muscle fibres of the outer layer are arranged longitudinally, and those of the inner layer are circular.
- Between these two muscle layers are blood vessels. Lymph vessels and plexus (network) of sympathetic and Parasympathetic nerves, called the myenteric plexus. These nerves supply the adjacent smooth muscle and blood vessels.
- Contraction and relaxation of these muscle layers occur in waves, which push the contents of the tract onwards.
- This type of rhythmical contraction of smooth muscle is called peristalsis and is under the influence of sympathetic and parasympathetic nerves. Muscle contraction also mixes food with the digestive juices.
- Onward movement of the contents of the tract is controlled at various points by sphincters, which are thickened rings of circular muscle. They also act as valves, preventing backflow into the tract. This control allows time for digestion and absorption to take place.

Submucosa:

- This layer consists of loose areolar connective tissue containing Collagen and some elastic fibres, which binds the muscle layer to the mucosa.
- Within it are blood vessels, nerves, lymph vessels and varying amounts of lymphoid tissue. The blood vessels are arterioles, venules and capillaries. The nerve plexus is the submucosal plexus, which contains sympathetic and parasympathetic nerves that supply the mucosal lining.

Mucosa:

- The mucosa is the lining of the tract. Its most superficial layer is the mucous membrane, which is made from columnar epithelium and has three main functions: protection, secretion and absorption.
- Below this lies a thin layer of loose connective tissue that supports the blood vessels and the protective and lymphatic tissue.
- The deepest layer is a thin layer of smooth muscle that provides features of the tract wall, e.g. Gastric glands and Villi.

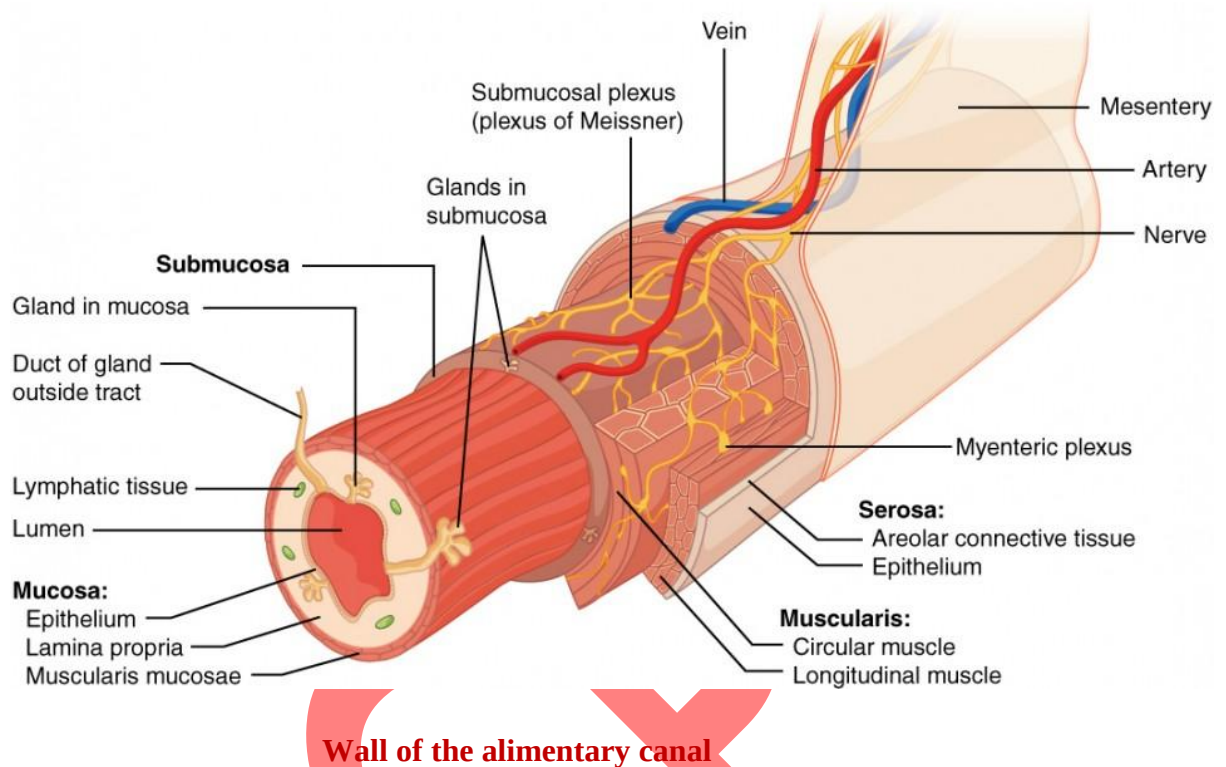
Mucous membrane: In parts of the tract that are subject to great wear and tear or mechanical injury, this innermost layer consists of stratified squamous epithelium with mucus-secreting glands just below the surface.

In areas where food is already soft and moist, and where secretion of digestive juices and absorption occur, the mucous membrane consists of columnar epithelial cells interspersed with mucus-secreting goblet cells.

Mucus lubricates the walls of the tract and provides a physical barrier that protects them from the damaging effects of digestive enzymes. At several points along the tract, specialised sub epithelial glands release secretions into the lumen, including:

- Saliva from the Salivary glands
- Gastric juice from the gastric glands
- Intestinal juice from the intestinal glands
- Pancreatic juice from the pancreas
- Bile from the liver

These are digestive juices and most contain enzymes that chemically breakdown food. Under the epithelial lining are varying amounts of lymphoid tissue that protect against ingested microbes.



Nerve Supply:

- The alimentary canal and its related accessory organs are supplied by nerves from both divisions of the autonomic nervous system, i.e. both parasympathetic and sympathetic parts.
 - Increased parasympathetic activity to the digestive organs promotes digestive processes, and increased sympathetic activity inhibits them.

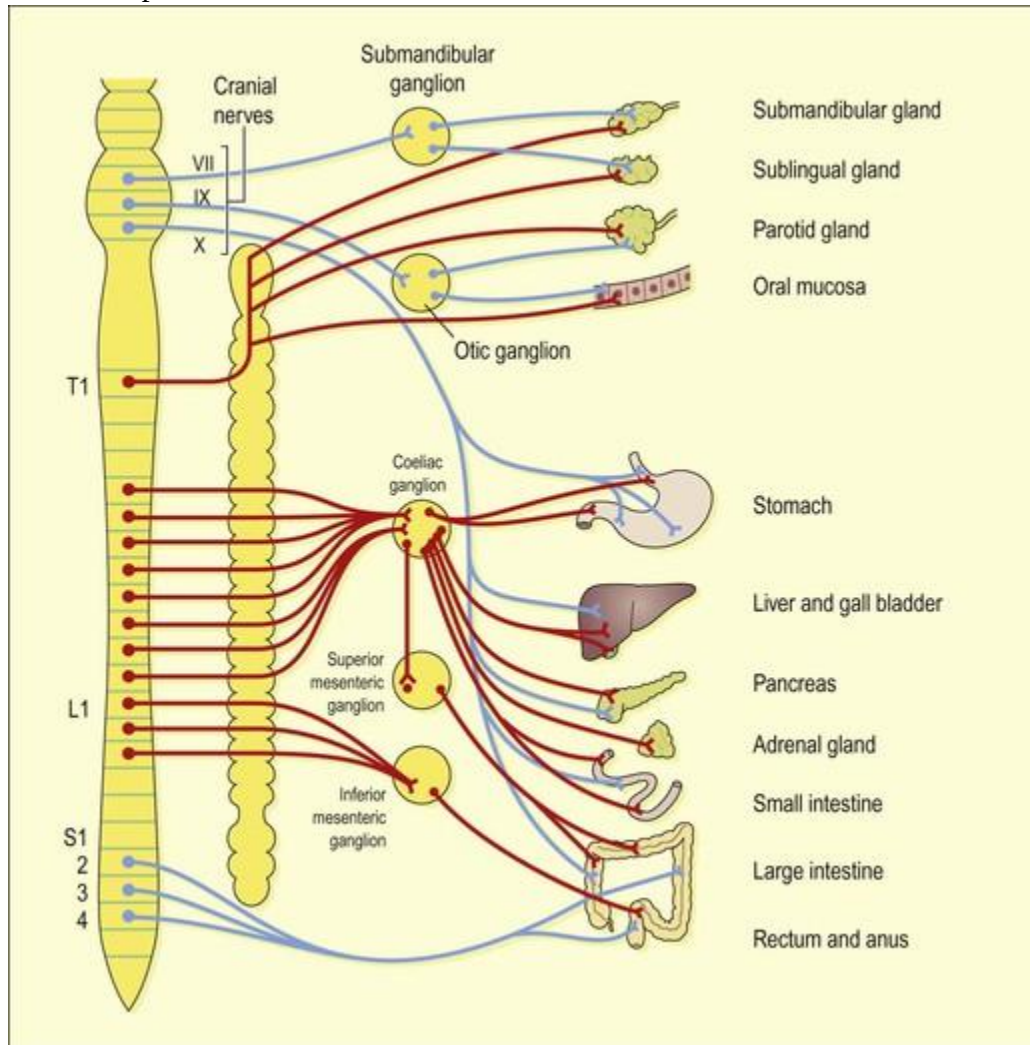
The Parasympathetic supply

- One pair of Cranial nerves, the vagus nerves, supplies most of the alimentary canal and the accessory organs.
- Sacral Nerves supply the most distal part of the GI Tract.
- The effects of parasympathetic stimulation on the digestive system are:
 - Increased Muscular activity, especially Peristalsis, stimulated by increased activity of the Myenteric Plexus
 - Increased glandular Secretion, through increased activity of the Submucosal Plexus

The Sympathetic Supply

- This is provided by numerous nerves that emerge from the spinal cord in the thoracic and lumbar regions.
- These form plexuses (ganglia) in the thorax, abdomen and pelvis from which nerve pass to the organs of the alimentary tract.

- The effects of sympathetic stimulation on the digestive system are to:
 - Decrease muscular activity, especially peristalsis, because there is reduced stimulation of the myenteric plexus.
 - Decrease glandular secretion, as there is less stimulation of the submucosal plexus.

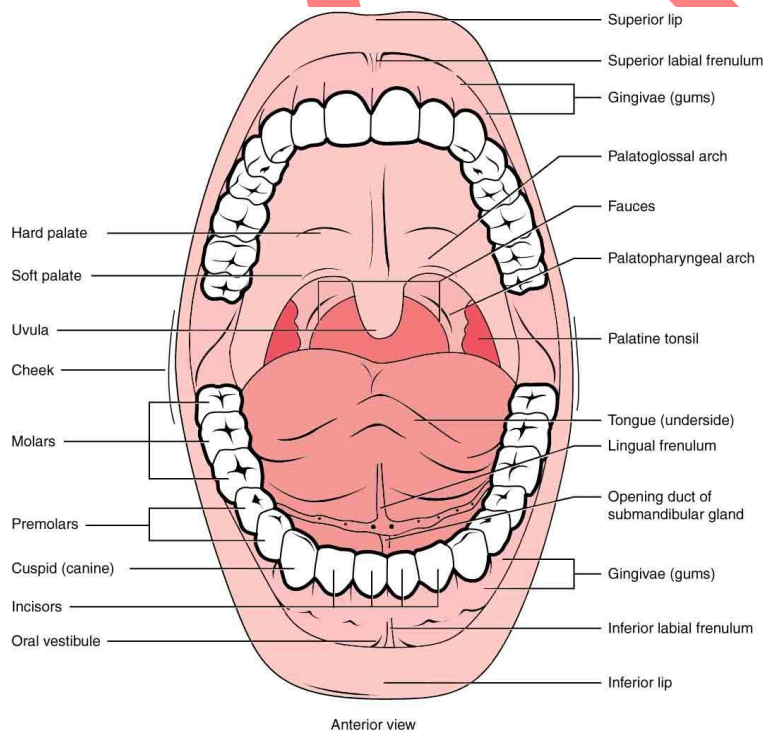


Autonomic Nerve Supply to the Digestive System

STRUCTURE OF THE MOUTH

- The mouth or oral cavity is formed by muscles and bones:
 - Anteriorly – by the lips
 - Posteriorly- it is continuous with the oropharynx
 - Laterally – By the muscles of the Cheeks
 - Superiorly- by the bony hard palate and muscular soft palate
 - Inferiorly- by the muscular tongue & the soft tissues of the floor of mouth

- The oral cavity is lined throughout with mucous membrane, consisting of sturdy, stratified squamous epithelium containing small mucus-secreting glands.
- The part of the mouth between the gums and the cheeks is the **vestibule**, and the remainder of its interior is the oral cavity.
- The mucous membrane lining of the cheeks and the lips is reflected on to the gums or alveolar ridges and is continuous with the skin of the face.
- The palate forms the roof of the mouth and is divided into **anterior hard palate** and the **posterior soft palate**.
- The hard palate is formed by the maxilla and the palatine bones.
- The soft palate which is muscular, curves downward from the posterior end of the hard palate and blends with the walls of the pharynx at the sides.
- The **uvula** is curved fold of muscle covered with mucous membrane, hanging down from the middle of the free border of the soft palate.
- Originating from the upper end of the Uvula are **four folds of mucous membrane**, two passing downwards at each side to form **membranous arches**.
- The **posterior folds**, one on each side, are the **palatopharyngeal arches**, and the two **anterior folds** are the **palatoglossal arches**.
- On each side, between the arches, is a collection of lymphoid tissue called the **Palatine tonsil**.



Tongue

- It is composed of **Voluntary Muscle**. It is attached by its base to the hyoid bone and by a fold of its mucous membrane covering, called the **frenulum**, to the floor of the mouth.
- The superior surface consists of **stratified squamous epithelium, with numerous Papillae** (little projections).
- Many of these contain sensory receptors (specialised nerve endings) for the sense of taste in the taste buds.

Blood supply

- The main arterial blood supply to the tongue is by the lingual branch of the external carotid artery.
- Venous drainage is by the lingual vein, which joins the internal jugular vein.

Nerve Supply

The nerves involved are:

- The hypoglossal nerves (12th Cranial Nerves), which supply the Voluntary muscle.
- The lingual branch of the mandibular nerves, which arise from the 5th Cranial nerves, the nerves of somatic (ordinary) sensation, i.e. pain, temperature and touch.
- The facial and glossopharyngeal nerves (7th and 9th cranial nerves), the nerves of taste.

Functions

The tongue plays an important part in:

- Chewing (mastication)
- Swallowing (deglutition)
- Speech
- Taste

Nerve endings of the sense of taste are present in the papillae and widely distributed in the epithelium of the tongue.

Teeth

- The teeth are embedded in the alveoli, or sockets, of the alveolar ridges of the mandible and the maxilla.
- Babies are born with two sets, or dentitions: temporary or deciduous (baby) teeth and the permanent teeth.
- The teeth of both dentitions are present, in immature form, in the mandible and maxilla at birth.
- There are 20 temporary teeth, 10 in each jaw. They begin to erupt at about 6 months of age, and should all be present by 24 months.

- The permanent teeth begin to replace the deciduous teeth between the ages of 6 and 13 years.
- This dentition consisting of 32 teeth, is usually complete by the age of 20. The third molars (wisdom teeth) are the last to erupt.

Structure:

Although the shapes of the different teeth vary, the structure is the same and consists of:

The **crown**- the part that protrudes from the gum

The **root**- the part embedded in the bone

The **neck**- the slightly narrowed region where the crown merges with the root.

In the centre of the tooth is the **pulp cavity**, containing blood vessels, lymph vessels and nerves, and surrounding this is a **hard, ivory-like** substance called **dentine**.

The dentine of the crown is covered by a thin layer of a very hard substance, **enamel**.

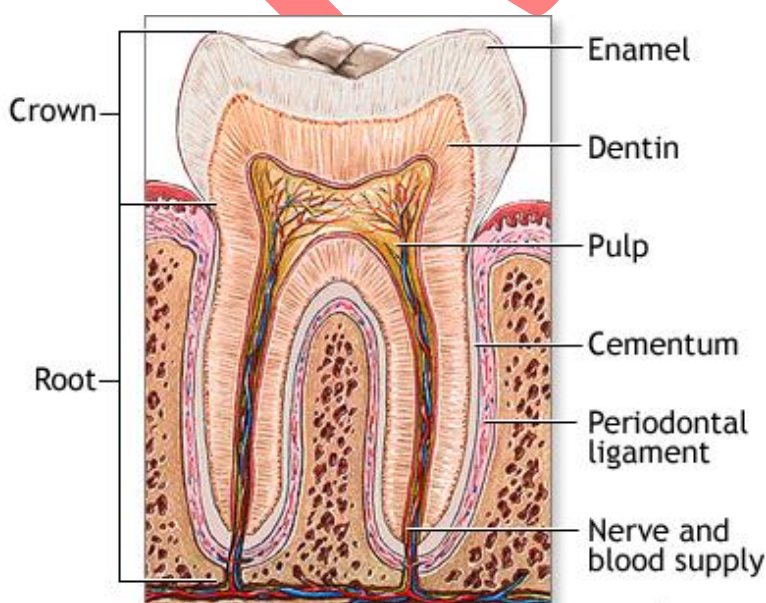
The root of the tooth, on the other hand, is covered with a substance resembling bone, called **cementum**, which secures the tooth in its socket. Blood vessels and nerves pass to the tooth through a small **foramen** (hole) at the apex of each root.

Blood Supply:

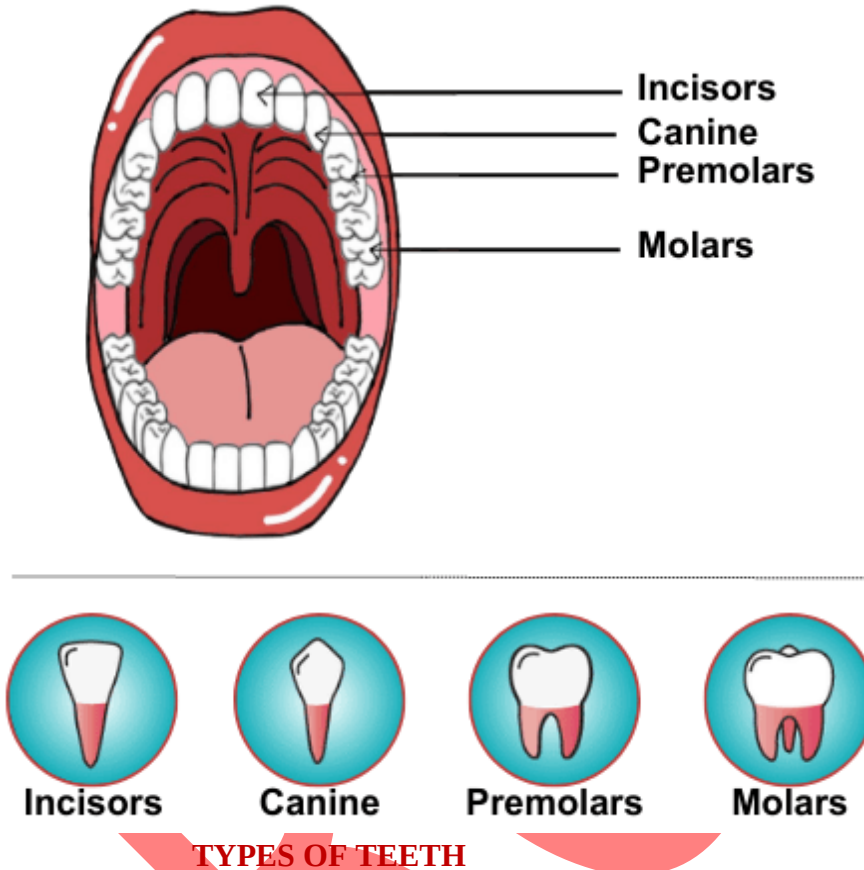
- Most of the arterial blood supply to the teeth is by branches of the maxillary arteries.
- The venous drainage is by a number of veins that empty into the internal jugular veins.

Nerve Supply:

- Nerve supply to the upper teeth is by branches of the maxillary nerves and that to the lower teeth by branches of the mandibular nerves. These are both branches of the trigeminal nerve (5th cranial nerves).



STRUCTURE OF TOOTH



TYPES OF TEETH

PHARYNX

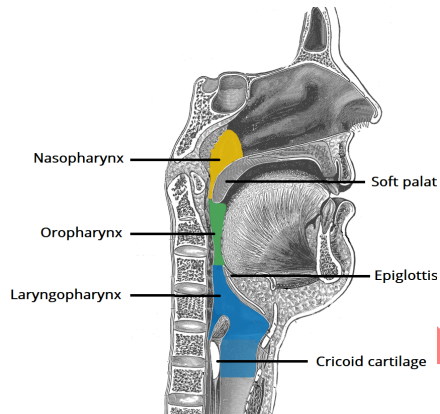
- Pharynx is divided into three parts: nasopharynx, oropharynx, and laryngopharynx.
- The nasopharynx is important in respiration. The oropharynx and laryngopharynx are common passages to both the respiratory and digestive systems.
- Food passes from the oral cavity into the pharynx and then to the oesophagus below, with which it continuous.
- The walls of the pharynx consist of three layers of tissue.
 - The lining membrane (mucosa) is stratified squamous epithelium, continuous with the lining of the mouth at one end and the oesophagus at the other. This provides a thick, sturdy lining well suited to the wear and tear of swallowing ingested food.
 - The middle layer consists of connective tissue, which becomes thinner towards the lower end and contains blood and lymph vessels and nerves.
 - The outer layer consists of involuntary muscles that are involved in swallowing. When food reaches the pharynx, swallowing becomes reflexive, i.e. is no longer under voluntary control.

Blood Supply

Blood supply to the pharynx is by several branches of the facial arteries. Venous drainage is into the facial veins and the internal jugular veins.

Nerve Supply

This is from the Pharyngeal plexus and consists of parasympathetic and sympathetic nerves. Parasympathetic supply is mainly by the glossopharyngeal and vagus nerves, and sympathetic supply is from the cervical ganglia.



Oesophagus

- It is about 25 cm long and about 2 cm in diameter; it lies in the medial plane in the thorax, in front of the vertebral column and behind the trachea and the heart.
- It is continuous with the pharynx above, and just below the diaphragm it joins the stomach. It passes between muscle fibres of the diaphragm behind the central tendon at the level of the 10th thoracic vertebrae.
- Immediately the oesophagus has passed through the diaphragm it curves upwards, before opening into the stomach.
- This sharp angle is believed to be one of the factors that prevents the regurgitation (backflow) of gastric contents into the oesophagus.
- The upper and lower ends of the oesophagus are closed by sphincters. The upper oesophageal sphincter prevents the passage of air into the oesophagus during inspiration, and the aspiration of oesophageal contents.
- The lower oesophageal (cardiac) sphincter and prevents the reflux of acid gastric contents into the oesophagus.
- There is no thickening of the circular muscle in this area and this sphincter is therefore 'Physiological', i.e. this region can act as a sphincter without the presence of the anatomical features.
- When intra-abdominal pressure is raised, e.g. during inspiration and defaecation, the tone of the lower oesophageal sphincter increases. There is an added pinching effect by the contracting muscle fibres of the diaphragm.

STRUCTURE

There are four layers of tissue. As the oesophagus is almost entirely in the thorax, the outer covering the adventitia, consists of elastic fibrous tissue that attaches the oesophagus to the surrounding structures. The proximal third is lined by stratified

squamous epithelium for protection during swallowing, and the distal third by Columnar epithelium. The middle third is lined by a mixture of the two.

Blood Supply

Arterial Supply

The thoracic region is supplied mainly by the paired oesophageal arteries, branches from the thoracic aorta. The abdominal region is supplied by branches from the inferior phrenic arteries and the left gastric branch of the coeliac artery.

Venous drainage

From the thoracic region venous drainage is into the azygous and hemizygous veins. The abdominal part drains into the left gastric vein. There is a venous Plexus at the distal end that links the upward and downward venous drainage, i.e. the general and portal circulations.

Functions of the Mouth, Pharynx and oesophagus

1. Formation of a bolus

When food is taken into the mouth, it is chewed (masticated) by the teeth and moved around the mouth by the tongue and muscles of the cheeks. It is mixed with saliva and formed into a soft mass, or bolus, ready for swallowing. The length of time that food remains in the mouth largely depends on the consistency of the food.

2. Swallowing (deglutition)

Swallowing occurs in three stages after chewing is complete and the bolus had been formed. It is initiated voluntarily but completed by a reflex (involuntary) action.

▪ **Oral Stage**

With the mouth closed, the voluntary muscles of the tongue and cheeks push the bolus backwards into the pharynx.

▪ **Pharyngeal Stage**

The muscles of the Pharynx are stimulated by a reflex action initiated in the walls of the oropharynx and coordinated by the swallowing centre in the medulla. Involuntary Contraction of these muscles propels the bolus down into the oesophagus. All other routes that the bolus could take are closed. The soft palate rises up and closes off the nasopharynx; the tongue and the Pharyngeal folds blocks the way back into the mouth; and the larynx is lifted up and forwards so that its opening is occluded by the overhanging epiglottis, preventing entry into the airway (trachea).

▪ **Oesophageal Stage**

The presence of the bolus in the pharynx stimulates a wave of peristalsis that propels the bolus through the oesophagus to the stomach. Peristaltic wave pass along the oesophagus only after swallowing begins. Otherwise the walls are relaxed. Ahead of Peristaltic wave, the lower oesophageal sphincter guarding the entrance to the stomach relaxes to allow the descending bolus to pass into the stomach. Usually Constriction of the lower oesophageal sphincter prevents reflux of gastric acid into the oesophagus.