1. INTRODUCTION

Food passes from the mouth and pharynx through the esophagus to the stomach, where it mixes with gastric secretions. Digestion mostly occurs in the stomach and duodenum. Peristalsis is a series of ring-like contraction waves. It is responsible for mixing the masticated (chewed) food mass with gastric juices and for emptying the contents of the stomach into the duodenum.

Absorption of chemical compounds occurs principally in the small intestine, a coiled 5- to 6-m-long tube (shorter in life, when tonus is present, than in the cadaver) consisting of the duodenum, jejunum, and ileum. Peristalsis also occurs in the jejunum and ileum; however, it is not forceful unless an obstruction is present. The stomach is continuous with the duodenum, which receives the openings of the ducts from the pancreas and liver, the major glands of the digestive tract.

The large intestine consists of the cecum (which receives the terminal part of the ileum), appendix, colon (ascending, transverse, descending, and sigmoid), rectum, and anal canal. Most reabsorption of water occurs in the ascending colon. Feces form in the descending and sigmoid colon and accumulate in the rectum before defecation.

2. ORAL REGION

The oral region includes the oral cavity (mouth), teeth, gingivae (gums), tongue, palate, and the region of the palatine tonsils. The digestion starts here in the oral cavity. It is the place where the food is ingested and prepared for digestion in the stomach and small intestine. Food is chewed by the teeth, and saliva from the salivary glands facilitates the formation of a manageable food bolus (L. lump). Swallowing is voluntarily initiated in the oral cavity. The voluntary phase of the process pushes the bolus from the oral cavity into the pharynx, the expanded part of the alimentary (digestive) system, where the involuntary (automatic) phase of swallowing occurs.

Oral Cavity

The oral cavity (mouth) is inferior to the nasal cavities and extends from the lips to the pharynx. It has a roof and floor, and lateral walls, opens onto the face through the oral fissure, and is continuous with the cavity of the pharynx at the oropharyngeal isthmus. The oral cavity consists of two parts: the oral vestibule and the oral cavity proper.

The oral vestibule is the slit-like space between the teeth and gingivae (gums) internally and the lips and cheeks externally. The duct of the parotid salivary gland (Stensen’s duct) opens on a small papilla into the vestibule opposite the upper second molar tooth.

The oral cavity proper (mouth proper) is the space between the upper and the lower dental arches or arcades (maxillary and mandibular alveolar arches and the teeth they bear).

The oral cavity has multiple functions:

- It is the inlet for the digestive system involved with the initial processing of food, which is aided by secretions from salivary glands. It is in the oral cavity that food and drinks are tasted and where mastication and lingual manipulation of food occur.
- It manipulates sounds produced by the larynx and one outcome of this is speech.
- It can be used for breathing because it opens into the pharynx, which is a common pathway for food and air. For this reason, the oral cavity can be used by physicians to access the lower airway.

The lips are mobile, musculofibrous folds surrounding the mouth and are covered externally by skin and internally by mucous membrane. The lips function as the valves of the oral fissure, containing the sphincter (orbicularis oris) that controls entry and exit from the mouth and upper alimentary and respiratory tracts.

The cheeks (L. buccae) form the movable walls of the oral cavity. The chief functions of the teeth are to:

- Incise, reduce, and mix food material with saliva during mastication (chewing).
- Help sustain themselves in the tooth sockets by assisting the development and protection of the tissues that support them.
- Participate in articulation (distinct connected speech).
The teeth are set in the tooth sockets. There are 20 deciduous teeth and 32 permanent teeth: four incisors, two canines, four premolars, and six molars in each jaw. They begin to erupt at 6 years of age. The last tooth to erupt is the third molar, which may happen between the ages of 17 and 30. The gingivae (gums) are composed of fibrous tissue covered with mucous membrane. The gingiva proper (attached gingiva) is firmly attached to the alveolar processes of the mandible and maxilla and the necks of the teeth.

**Tongue**

The tongue is a mass of striated muscle covered with mucous membrane. It forms part of the floor of the oral cavity and part of the anterior wall of the oropharynx. Its anterior part is in the oral cavity and is somewhat triangular in shape with a blunt apex of tongue which is directed anteriorly. The root of tongue is attached to the mandible and the hyoid bone. The muscles attach the tongue to the styloid process and the soft palate above and to the mandible and the hyoid bone below.

The superior surface of the oral or anterior two-thirds of the tongue is oriented in the horizontal plane. The pharyngeal surface or posterior one-third of the tongue curves inferiorly and becomes oriented more in the vertical plane.

The superior surface of the oral part of the tongue is covered by hundreds of papillae. There are four types of papillae in the tongue. The papillae in general increase the area of contact between the surface of the tongue and the contents of the oral cavity.

The mucosa covering the pharyngeal surface of the tongue (posterior one-third of the tongue) is irregular in contour because of the many small nodules of lymphoid tissue in the submucosa. There are no papillae on the pharyngeal surface.

The muscles of the tongue are divided into two types: intrinsic and extrinsic. Intrinsic muscles are confined to the tongue and are not attached to bone and alter the shape of the tongue. The extrinsic muscles are attached to bones and the soft palate.

Innervation of the tongue is complex and involves a number of nerves (trigeminal nerve; sensation from anterior 2/3, glossopharyngeal nerve from posterior 1/3, taste from oral part is carried by the facial nerve; taste from the pharyngeal part of the tongue by the glossopharyngeal nerve). Protrusion, retraction, depression, shape changes are the main movements of the tongue.

**Palate**

The palate forms the arched roof of the mouth and the floor of the nasal cavities. It separates the oral cavity from the nasal cavities and the nasopharynx, the part of the pharynx superior to the soft palate. The palate consists of two regions: the hard palate anteriorly and the soft palate posteriorly. Posteroinferiorly, the soft palate has a curved free margin from which hangs a conical process, the **uvula**.

**Fauces (Thorat)**

The fauces (L. the throat) is the space between the cavity of the mouth and the pharynx. The fauces is bounded superiorly by the soft palate, inferiorly by the root of the tongue. The oropharyngeal isthmus (isthmus of the fauces) is the short constricted space that establishes the connection between the oral cavity proper and the oropharynx. By closing the oropharyngeal isthmus, food or liquid can be held in the oral cavity while breathing. The **palatine tonsils**, often referred to as “the tonsils,” are masses of lymphoid tissue, one on each side of the oropharynx.

**Salivary Glands**

**Parotid gland** is the largest salivary gland. It lies in a deep hollow behind the ramus of the mandible, and in front of the sternocleidomastoid muscle. Parasympathetic secretomotor supply arises from the glossopharyngeal nerve. Parasympathetic stimulation of the parotid gland produces thin watery saliva.

**Submandibular gland** lies beneath the lower border of the body of the mandible. Parasympathetic secretomotor supply is from the facial nerve.

**Sublingual gland** lies beneath the floor of the mouth. The sublingual ducts (8 to 20 in number) open into the mouth. Nerve supply is the same as the submandibular gland.
3. PHARYNX

The pharynx is a musculofascial half-cylinder that links the oral and nasal cavities in the head to the larynx and esophagus in the neck. It is the superior expanded part of the alimentary system posterior to the nasal and oral cavities, extending inferiorly past the larynx. The pharyngeal cavity is a common pathway for air and food. The pharynx extends from the cranial base to and is continuous with the top of the esophagus. The walls of the pharynx are attached anteriorly to the margins of the nasal cavities, oral cavity, and larynx. Based on these anterior relationships the pharynx is subdivided into three regions, the nasopharynx, oropharynx, and laryngopharynx:

• posterior apertures (choanae) of the nasal cavities open into the nasopharynx;
• posterior opening of the oral cavity (oropharyngeal isthmus) opens into the oropharynx;
• superior aperture of the larynx (laryngeal inlet) opens into the laryngopharynx.

The oral part of the pharynx (oropharynx) is posterior to the oral cavity, inferior to the level of the soft palate, and superior to the upper margin of the epiglottis. It opens anteriorly into the mouth. The oropharynx has a digestive function.

The nasal part of the pharynx (nasopharynx) has a respiratory function; it is the posterior extension of the nasal cavities. The Eustachian tube (auditory tube or pharyngotympanic tube) is a tube that links the nasopharynx to the middle ear.

The laryngopharynx lies posterior to the larynx and anterior to the vertebral column. The laryngeal inlet opens into the anterior wall of the laryngopharynx. Inferior to the laryngeal inlet, the anterior wall consists of the posterior aspect of the larynx.

Pharyngeal Muscles

The wall of the pharynx is exceptional for the alimentary tract, having a muscular layer composed entirely of voluntary muscle, arranged with longitudinal muscles internal to a circular layer of muscles. Most of the alimentary tract is composed of smooth muscle, with a layer of longitudinal muscle external to a circular layer. The external circular layer of pharyngeal muscles consists of three pharyngeal constrictors: superior, middle, and inferior. There are also internal longitudinal muscles. These muscles elevate the larynx and shorten the pharynx during swallowing and speaking.

4. WALDEYER’S RING OF LYMPHOID TISSUE

The abundant lymphoid tissue in the pharynx forms an incomplete tonsillar ring (Waldeyer’s Ring of Lymphoid Tissue) around the superior part of the pharynx. Collections of lymphoid tissue in the mucosa of the pharynx surrounding the openings of the nasal and oral cavities are part of the body's defense system. The largest of these collections form distinct masses (tonsils). Tonsils occur mainly in three areas:

• pharyngeal tonsil, known as adenoids when enlarged, is in the midline on the roof of the nasopharynx;
• palatine tonsils are on each side of the oropharynx just posterior to the oropharyngeal isthmus; (The palatine tonsils are visible through the open mouth of a patient when the tongue is depressed.)
• lingual tonsil refers collectively to numerous lymphoid nodules on the posterior one-third of the tongue.
• tubal tonsil is the collection of lymphoid tissue in the submucosa of the pharynx near the pharyngeal opening or orifice of the pharyngotympanic tube.

5. OESOPHAGUS

The esophagus is a muscular tube about 10 in. (25 cm) long, extending from the pharynx to the stomach. It begins in the neck where it is continuous with the laryngopharynx at the pharyngo-esophageal junction. The esophagus consists of striated (voluntary) muscle in its upper third, smooth (involuntary) muscle in its lower third, and a mixture of striated and smooth muscle in between.
6. STOMACH

The stomach is the expanded part of the digestive tract between the esophagus and small intestine. It is specialized for the accumulation of ingested food, which it chemically and mechanically prepares for digestion and passage into the duodenum. The stomach acts as a food blender and reservoir; its chief function is enzymatic digestion. The gastric juice gradually converts a mass of food into a semiliquid mixture, chyme (G. juice), which passes fairly quickly into the duodenum. An empty stomach is only of slightly larger caliber than the large intestine; however, it is capable of considerable expansion and can hold 2-3 L of food.

The size, shape, and position of the stomach can vary markedly in persons of different body types (bodily habitus) and may change even in the same individual as a result of diaphragmatic movements during respiration, the stomach's contents (empty vs. after a heavy meal), and the position of the person. The stomach has four parts:

Cardia: part surrounding the cardial orifice (opening), the superior opening or inlet of the stomach.
Fundus: dilated superior part that is related to the left dome of the diaphragm and is limited inferiorly by the horizontal plane of the cardial orifice.
Body: major part of the stomach between the fundus and pyloric part.
Pyloric part: funnel-shaped outflow region of the stomach.

7. SMALL INTESTINE

The small intestine, consisting of the duodenum, jejunum, and ileum, is the primary site for absorption of nutrients from ingested materials. It extends from the pylorus to the ileocecal junction where the ileum joins the cecum (the first part of the large intestine). The pyloric part of the stomach empties into the duodenum, duodenal admission being regulated by the pylorus.

The duodenum (L. breadth of 12 fingers), the first and shortest (25 cm) part of the small intestine, is also the widest and most fixed part. The duodenum pursues a C-shaped course around the head of the pancreas.

The second part of the small intestine, the jejunum, begins at the duodenojejunal flexure. The third part of the small intestine, the ileum, ends at the ileocecal junction, the union of the terminal ileum and the cecum. Together, the jejunum and ileum are 6-7 m long, the jejunum constituting approximately two fifths and the ileum approximately three fifths of the intraperitoneal section of the small intestine. Most of the jejunum lies in the left upper quadrant (LUQ), whereas most of the ileum lies in the right lower quadrant (RLQ). The terminal ileum usually lies in the pelvis from which it ascends, ending in the medial aspect of the cecum. Although no clear line of demarcation between the jejunum and ileum exists, they have distinctive characteristics that are surgically important.

The structure of the small intestine is similar to other regions of the digestive tube, but the small intestine incorporates three features which account for its huge absorptive surface area:

Mucosal folds: the inner surface of the small intestine is not flat, but thrown into circular folds, which not only increase surface area, but aid in mixing the ingesta by acting as baffles.
Villi: the mucosa forms multitudes of projections which protrude into the lumen and are covered with epithelial cells.
Microvilli: the luminal plasma membrane of absorptive epithelial cells is studded with densely-packed microvilli.

8. LARGE INTESTINE

The large intestine is where water is absorbed from the indigestible residues of the liquid chyme, converting it into semi-solid stool or feces that is stored temporarily and allowed to accumulate until defecation occurs. The large intestine consists of the cecum; appendix; ascending, transverse, descending, and sigmoid colon; rectum; and anal canal. The large intestine can be distinguished from the small intestine by:

- Omental appendices: small, fatty, omentum-like projections.
- Teniae coli: three distinct longitudinal bands.
• **Haustra:** sacculations of the wall of the colon between the teniae
• A much greater caliber (internal diameter).

9. LIVER

The liver is the largest gland in the body and, after the skin, the largest single organ. It weighs approximately 1500 g and accounts for approximately 2.5% of adult body weight. Except for fat, all nutrients absorbed from the digestive tract are initially conveyed to the liver by the portal venous system. In addition to its many metabolic activities, the liver stores glycogen and secretes bile, a yellow-brown or green fluid that aids in the emulsification of fat.

Bile passes from the liver via the biliary ducts—right and left hepatic ducts—that join to form the common hepatic duct, which unites with the cystic duct to form the (common) bile duct. The liver produces bile continuously; however, between meals it accumulates and is stored in the gallbladder, which also concentrates the bile by absorbing water and salts. When food arrives in the duodenum, the gallbladder sends concentrated bile through the biliary ducts to the duodenum.

The liver lies mainly in the right upper quadrant of the abdomen where it is protected by the thoracic cage and diaphragm. The normal liver lies on the right side and crosses the midline toward the left nipple. Consequently, the liver occupies most of the right hypochondrium and upper epigastrium and extends into the left hypochondrium. The liver moves with the excursions of the diaphragm and is located more inferiorly when one is erect because of gravity.

The liver has a convex diaphragmatic surface (anterior, superior, and some posterior) and a relatively flat or even concave visceral surface (posteroinferior), separated anteriorly by its sharp inferior border that follows the right costal margin.

Externally, the liver is divided into two anatomical lobes and two accessory lobes by the reflections of peritoneum from its surface, the fissures formed in relation to those reflections and the vessels serving the liver and the gallbladder.

10. GALL BLADDER & THE BILIARY DUCTS

The gallbladder lies in the fossa for the gallbladder on the visceral surface of the liver. This shallow fossa lies at the junction of the right and left (parts of the) liver. The relationship of the gallbladder to the duodenum is so intimate that the superior part of the duodenum is usually stained with bile in the cadaver. Because the liver and gallbladder must be retracted superiorly to expose the gallbladder during an open anterior surgical approach (and atlases often depict it in this position), it is easy to forget that in its natural position the body of the gallbladder lies anterior to the superior part of the duodenum, and its neck and cystic duct are immediately superior to the duodenum.

The pear-shaped gallbladder can hold up to 50 mL of bile. The biliary ducts convey bile from the liver to the duodenum. Bile is produced continuously by the liver and stored and concentrated in the gallbladder, which releases it intermittently when fat enters the duodenum. Bile emulsifies the fat so that it can be absorbed in the distal intestine.

The bile duct (formerly called the common bile duct) forms by the union of the cystic duct and common hepatic duct. The bile duct descends posterior to the superior part of the duodenum and lies in a groove on the posterior surface of the head of the pancreas.

11. PANCREAS

The pancreas is an elongated, accessory digestive gland that lies retroperitoneally, overlying and transversely on the posterior abdominal wall. It lies posterior to the stomach between the duodenum on the right and the spleen on the left. The pancreas produces:

• An exocrine secretion (pancreatic juice from the acinar cells) that enters the duodenum through the main and accessory pancreatic ducts.
• Endocrine secretions (glucagon and insulin from the pancreatic islets [of Langerhans]) that enter the blood.

For descriptive purposes, the pancreas is divided into four parts: head, neck, body, and tail.
The main pancreatic duct begins in the tail of the pancreas and usually unites with the bile duct to form the short, dilated hepatopancreatic ampulla (of Vater), which opens into the duodenum at the summit of the major duodenal papilla.

12. SPLEEN

The spleen is an ovoid, usually purplish, pulpy mass about the size and shape of one’s fist. It is relatively delicate and considered the most vulnerable abdominal organ. The spleen is located in the superolateral part of the left upper quadrant (LUQ) or hypochondrium of the abdomen where it enjoys protection of the inferior thoracic cage.

As the largest of the lymphatic organs, it participates in the body’s defense system as a site of lymphocyte (white blood cell) proliferation and of immune surveillance and response. To accommodate these functions, the spleen is a soft, vascular (sinusoidal) mass with a relatively delicate fibroelastic capsule.

The spleen normally contains a large quantity of blood that is expelled periodically into the circulation by the action of the smooth muscle in its capsule and trabeculae.

13. PERITONEUM

The peritoneum is a continuous, and slippery transparent serous membrane. It lines the abdominopelvic cavity and invests the viscera. The peritoneum consists of two continuous layers: the parietal peritoneum, which lines the internal surface of the abdominopelvic wall, and the visceral peritoneum, which invests viscera such as the stomach and intestines. The peritoneal cavity is a potential space of capillary thinness between the parietal and visceral layers of peritoneum. It is within the abdominal cavity and continues inferiorly into the pelvic cavity. It contains a thin film of peritoneal fluid, which is composed of water, electrolytes, and other substances derived from interstitial fluid in adjacent tissues. Peritoneal fluid lubricates the peritoneal surfaces, enabling the viscera to move over each other without friction, and allowing the movements of digestion.

14. INGUINAL CANAL

The inguinal canal is formed in relation to the relocation of the testis during fetal development. The inguinal canal in adults is an oblique passage approximately 4 cm long directed inferomedially through the inferior part of the anterolateral abdominal wall. It lies parallel and superior to the medial half of the inguinal ligament. The main occupant of the inguinal canal is the spermatic cord in males and the round ligament of the uterus in females. These are functionally and developmentally distinct structures that occur in the same location.

15. PORTAL SYSTEM

The portal vein is the final common pathway for the transport of venous blood from the spleen, pancreas, gallbladder, and the abdominal part of the gastrointestinal tract. It is formed by the union of the splenic vein and the superior mesenteric vein posterior to the neck of the pancreas. Venous drainage of the spleen, pancreas, gallbladder, and the abdominal part of the gastrointestinal tract, except for the inferior part of the rectum, is through the portal system of veins, which deliver blood from these structures to the liver. Once blood enters the hepatic veins, it returns the venous blood to the inferior vena cava just inferior to the diaphragm.

16. VESSELS & NERVES OF THE GASTROINTESTINAL SYSTEM

The gut requires a rich blood supply to support its digestive activities. Arterial blood is supplied mainly by the coeliac artery to the stomach, pancreas, spleen and liver and by the mesenteric arteries to the intestines. Venous blood drains from the stomach, pancreas and spleen via the hepatic portal vein into the liver, where the products of digestion undergo further processing and detoxification. Blood from the oesophagus and rectum does not go through the liver but drains directly into the venous system.

There are two types of nerve supply to the GI tract. The enteric system, found within the walls of the GI tract, is sometimes known as the ‘gut brain’ and controls movement and secretion within the gut. Nerves from the autonomic nervous system also supply the GI tract. The sympathetic nerves generally reduce blood
flow to the gut and decrease secretions, motility and contractions, while stimulation of the parasympathetic nerves leads to an increase in motility and secretion within the tract and relaxation of the gut sphincters. The vagus nerve (Xth cranial) supplies the oesophagus, stomach, pancreas, bile duct, small intestine and upper colon.

17. ABDOMINAL CAVITY

The abdominal cavity:
- forms the superior and major part of the abdominopelvic cavity, the continuous cavity that extends between the thoracic diaphragm and pelvic diaphragm.
- has no floor of its own because it is continuous with the pelvic cavity.
- is the location of most digestive organs, parts of the urogenital system (kidneys and most of the ureters), and the spleen.

9 regions of the abdominal cavity are used to describe the location of abdominal organs, pains, or pathologies. The regions are delineated by four planes: two sagittal (vertical) and two transverse (horizontal) planes. The two sagittal planes are usually the midclavicular planes that pass from the midpoint of the clavicles (approximately 9 cm from the midline) to the midinguinal points, midpoints of the lines joining the anterior superior iliac spine (ASIS) and the superior edge of the pubic symphysis on each side. Most commonly, the transverse planes are the subcostal plane, and the transtubercular plane. Both of these planes have the advantage of intersecting palpable structures.