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DIGESTIVE SYSTEM- A REVIEW ARTICLE

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Abstract:
The digestive system is well adapted for ingesting food breaking it down both mechanically and enzymatic and the absorbing the breakdown products and transporting them to the liver form .separate processes are involved in digesting carbohydrate ,proteins, lipids. The digestive system is well adapted for ingesting food, breaking it down, both mechanically and enzyme and then absorbing the breakdown products and transporting them to the liver. Separate processes are involved in digesting carbohydrates, proteins, and lipids. Many aspects of the digestive process are regulated by neural (autonomic) and local hormonal influences. The structure of the gastric mucosa is well designed to both produce and protect itself from the low pH generated by the secreted hydrochloric acid. The exocrine pancreas produces digestive enzymes in an inactive form. Activation usually occurs within the lumen of the small intestine. The liver receives the bulk of the absorbed nutrients via the portal vein and then uses them for the synthesis of many larger molecules. It includes many more cells than the number present in the human body. These microbes have evolved symbiotically along with the digestive system.

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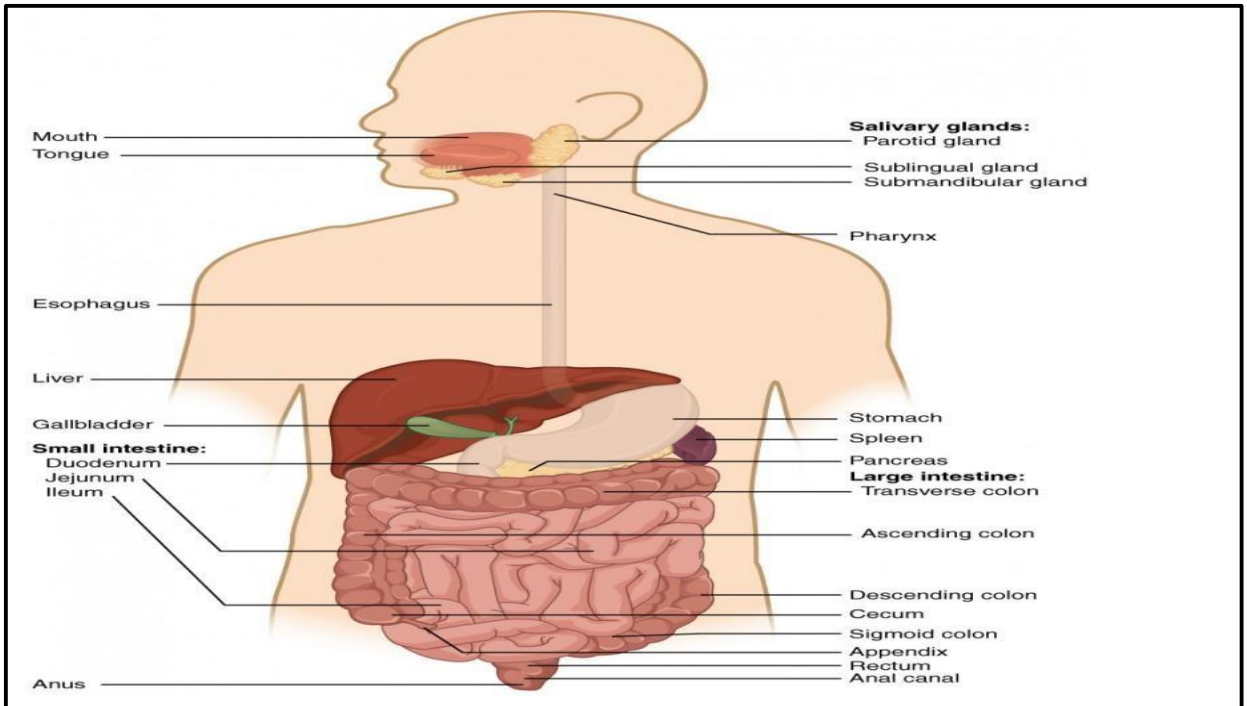
INTRODUCTION:

The digestive system is composed of the gastrointestinal (GI) tract or the alimentary canal, salivary glands, the liver, and the exocrine pancreas. The principal functions of the gastrointestinal track are to digest and absorb ingested nutrients and to excrete waste products of digestion. Most nutrients are ingested in a form that is either too complex for absorption or insoluble and therefore indigestible or incapable of being digested. Within the GI tract, much of these substances are solubility and further degraded enzyme to simple molecules, sufficiently small in size and in a form that permits absorption across the mucosal epithelium. This chapter describes the normal biochemical process of intestinal secretion digestion, and absorption. Once these issues have been put in perspective, the chapter in the of digestive explores the pathogenesis of the important gastrointestinal diseases of domestic animals.

The digestive system includes the digestive tract and its accessory organs, which process food into molecules that can be absorbed and utilized by the cells into body .food is broken down, bit by bit, until the molecule are small enough to be absorbed and waste products are eliminated. The digestive tracks also called the alimentary cannel consist of a long continuous tube that extends from mouth intestine. The tongue and teeth are accessory structure located in the mouth. Salivary gland, liver, bladder and pancreas are major accessory organ that have a role in digestion. The major organs of digestive system are mouth, pharynx, stomach, small intestine, large is the case with all body systems, the digestive system does not work in isolation; it functions cooperatively with the other systems of the body. Consider for example, the interrelationship between the digestive and cardiovascular systems. Arteries supply the digestive organs with oxygen and processed nutrients, and veins drain the digestive tract. These intestinal veins, constituting the hepatic portal system, are unique; they do not return blood directly to the heart. Rather, intestine. AT the same time, the digestive system provides nutrients to the heart muscle and vascular tissue to support their functioning.

The interrelationship of the digestive and endocrine systems is also critical. Hormones secreted by several endocrine glands, as well as endocrine cells of the pancreas, the stomach, and the small intestine, contribute to the control of digestion and nutrient metabolism. In turn, the digestive system provides the nutrients to fuel endocrine function.



DIFFERENT SYSTEM USED OUR BODY THOUGH DIGESTIVE SYSTEM

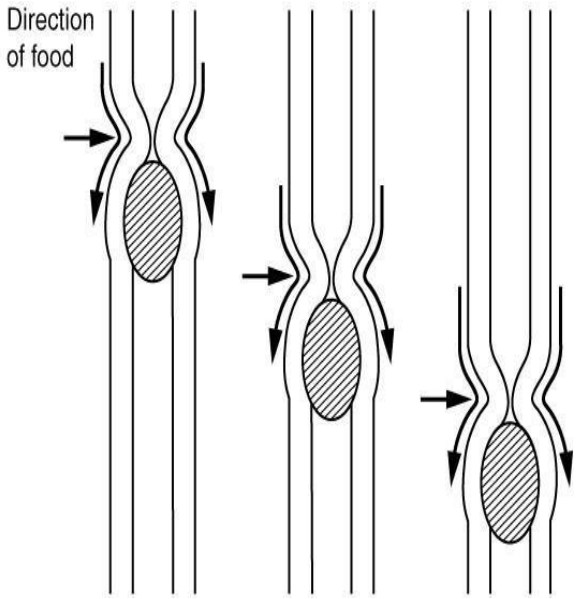
FUNCTION OF DIGESTIVE SYSTEM:

1. Ingestion; taking of food into alimentary tract, eating and drinking.
2. Propulsion; mixes and moves the contents along the alimentary tact.
3. Digestion; mechanical breakdown of food mastication.
4. Absorption; taking in nutrients by cells.

DIGESTIVE PROCESS:

The processes of digestion include six activities: ingestion, propulsion, mechanical or physical digestion, chemical digestion, absorption, and defecation.

The first of these processes, **ingestion**, refers to the entry of food into the alimentary canal through the mouth. There, the food is chewed and mixed with saliva, which contains enzymes that begin breaking down the carbohydrates in the food plus some lipid digestion via lingual lipase. Chewing increases the surface area of the food and allows an appropriately sized bolus to be produced.



Peristalsis moves food through the digestive tract with alternating waves of muscle Food leaves the mouth when the tongue and pharyngeal muscles propel it into the oesophagus. This act of swallowing, the last voluntary act until defecation, is an example of **propulsion**, which refers to the movement of food through the digestive tract. It includes both the voluntary process of swallowing and the involuntary process of peristalsis. **Peristalsis** consists of sequential, alternating waves of 1). These waves also play a role in mixing food with digestive juices. Peristalsis is so powerful that foods and liquids you swallow enter your stomach even if you are standing on your head.

In **chemical digestion**, starting in the mouth, digestive secretions break down complex food molecules into their chemical building blocks (for example, proteins into separate amino acids). These secretions vary in composition, but typically contain water, various enzymes, acids, and salts. The process is completed in the small intestine.

Food that has been broken down is of no value to the body unless it enters the bloodstream and its nutrients are put to work. This occurs through the process of **absorption**, which takes place primarily within the small intestine. There, most nutrients are absorbed from the lumen of the alimentary canal into the bloodstream through the epithelial cells that make up the mucosa.

Lipids are absorbed into lacteals and are transported via the lymphatic vessels to the bloodstream (the veins near the heart). The details of these processes will be discussed later.

DIGESTIVE SYSTEM PROCESS:

The easiest way to understand the digestive system is to divide its organs into two main categories. The first group is the organs that make up the alimentary canal. Accessory digestive organs comprise the second group and are critical for orchestrating the breakdown of food and the assimilation of its nutrients into the body. Accessory digestive organs, despite their name, are critical to the function of the digestive system.

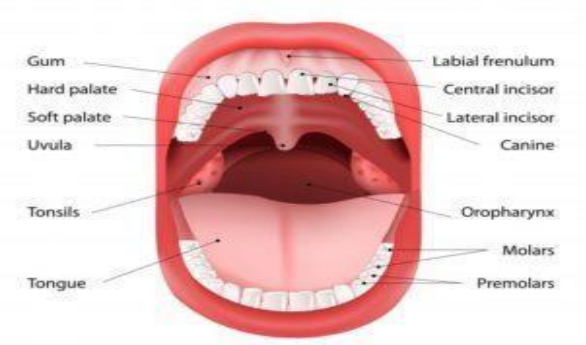
ALIMENTARY CANAL ORGAN:

Also called the gastrointestinal (GI) tract or gut, the **alimentary canal** (aliment- = “to nourish”) is a one-way tube about 7.62 meters (25 feet) in length during life and closer to 10.67 meters (35 feet) in length when measured after death, once smooth muscle tone is lost. The main function of the organs of the alimentary canal is to nourish the body. This tube begins at the mouth and terminates at the anus. Between those two points, the canal is modified as the pharynx, oesophagus, stomach, and small and large intestines to fit the functional needs of the body. Both the mouth and anus are open to the external environment; thus, food and wastes within the alimentary canal are technically considered to be outside the body. Only through the process of absorption do the nutrients in food enter into and nourish the body’s “inner space.

ANATOMY OF DIGESTIVE SYSTEM:

MOUTH:

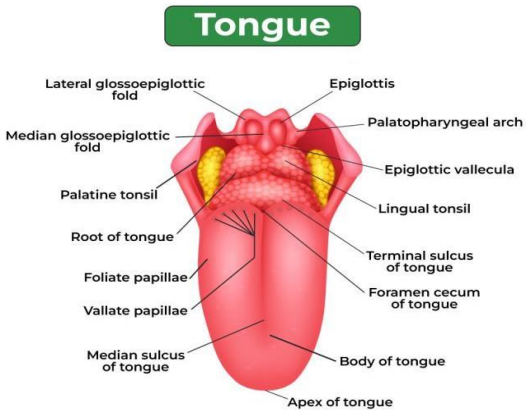
The mouth is the first portion of alimentary canal that receives food and produce saliva. The oral mucosa is the mucous membrane epithelium lining the inside of the mouth. Anterior portion are lips, posterior portion are continue with the pharynx, laterally muscles of cheeks, superiorly to bony hard palate, inferiorly muscular tongue & the soft tissue of the floor of the mouth. The palate forms the roof of the mouth & is divided into the anterior hard palate and posterior soft palate. At the entrance to the mouth are the lips, or **labia** (singular = labium). Their outer covering is skin, which transitions to a mucous membrane in the mouth proper. Lips are very vascular with a thin layer of keratin; hence, the reason they are "red." They have a huge representation on the cerebral cortex, which probably explains the human fascination with kissing! The lips cover the orbicular is ores muscle, which regulates what comes in and goes out of the mouth. The **labial frenulum** is a midline fold of mucous membrane that attaches the inner surface of each lip to the gum. The cheeks make up the oral cavity's sidewalls.



TONGUE:

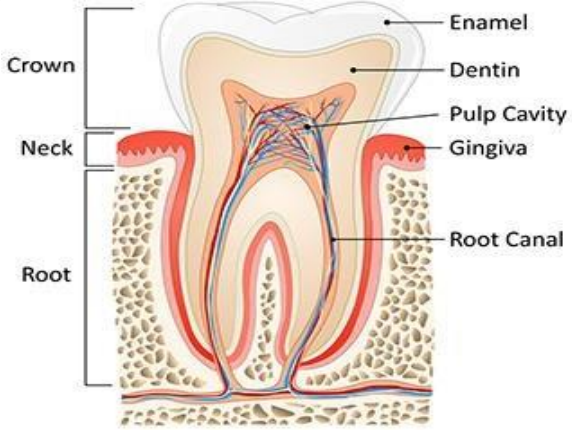
The tongue is a muscular organ in the mouth that manipulates food for mastication, and used in the act of swallowing. It is of importance in the digestive system and is the primary organ of taste in the gustatory system. The upper surface is covered by taste buds housed in numerous lingual papillae. The human tongue is divided into two parts, an oral part at the front and pharyngeal part at back. Taste and sensation are pharyngeal nerve. The tongue is attached to the mandible, the steroid processes of the temporal bones, and the hyoid bone. The hyoid is unique in that it only distantly/indirectly articulates with other bones. The tongue is positioned over the floor of the oral cavity. A medial septum extends the entire length of the tongue, dividing it into symmetrical halves.

Beneath its mucous membrane covering, each half of the tongue is composed of the same number and type of intrinsic and extrinsic skeletal muscles. The intrinsic muscles (those within the tongue) are the longitudinally inferior, longitudinal is superior, transverses lingual, and verticals lingual muscles. These allow you to change the size and shape of your tongue, as well as to stick it out, if you wish. Having such a flexible tongue facilitates both swallowing and speech.



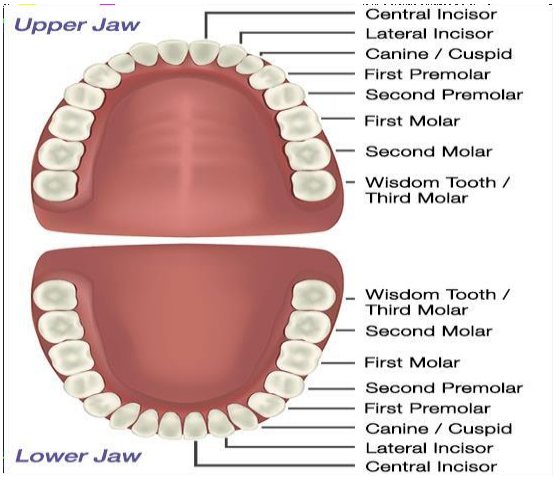
TEETH:

The human teeth function to mechanically break down items of food by cutting and crushing them in preparation for swallowing and digesting. Humans have four types of teeth are incisors, canines, premolar, and molar each with specific function. Primary teeth ten are found in maxilla (upper jaw) and ten in mandible (lower jaw).all primary teeth are normally later replaced with their permanent counter parts. Permanent teeth are two incisor, one canine.



FUNCTION OF TEETH:

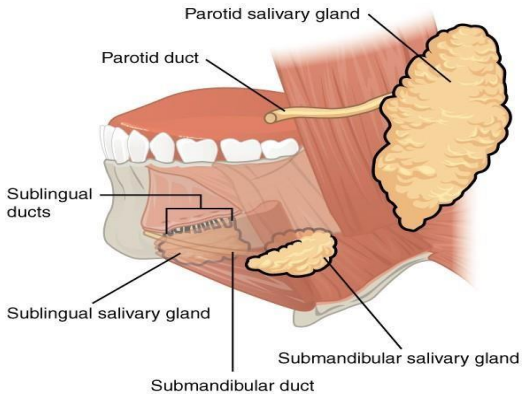
Tooth eruption in humans is a process in tooth development in which the teeth enter The mouth and become visible. Primary teeth erupt into the mouth from around six months until two years of age.

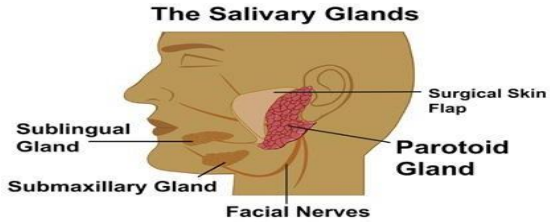


SALIVARY GLANDS:

Human have 3 paired major salivary gland parotid, sub mandibular and sublingual. Parotid glands are major salivary gland wrapped around in humans. its secrete saliva to facilitate mastication and swallowing. it enter the oral cavity. The secretion produced is a mixture of both serous fluid and mucus. Many small **salivary glands** are housed within the mucous membranes of the mouth and tongue. These minor exocrine glands are constantly secreting saliva, either directly into the oral cavity or indirectly through ducts, even while you sleep. In fact, an average of 1 to 1.5 liters of saliva is secreted each day. Usually just enough saliva is present to moisten the mouth and teeth. Secretion increases when you eat, because saliva is essential to moisten food and initiate the chemical breakdown of carbohydrates. Small amounts of saliva are also secreted by the labial glands in the lips. In addition, the bucket glands in the cheeks, palatal glands in the palate, and lingual glands in the tongue help ensure that all areas of the mouth are supplied with adequate saliva.

SALIVA:





Saliva

is essentially (95.5 percent) water. The remaining 4.5 percent is a complex mixture of ions, glycoproteins, enzymes, growth factors, and waste products. Perhaps the most important ingredient in salvia from the perspective of digestion is the enzyme **salivary amylase**, which initiates the breakdown of carbohydrates. Food does not spend enough time in the mouth to allow all the carbohydrates to break down, but salivary amylase continues acting until it is inactivated by stomach acids. Bicarbonate and phosphate ions function as chemical buffers, maintaining saliva at a pH between 6.35 and 6.85. Salivary mucus helps lubricate food, facilitating movement in the mouth, bolus formation, and swallowing. Saliva contains immunoglobulin A, which prevents microbes from penetrating the epithelium, and lysozyme, which makes saliva antimicrobial. Saliva also contains epidermal growth factor, which might have given rise to the adage “a mother’s kiss can heal a wound.”

Each of the major salivary glands secretes a unique formulation of saliva according to its cellular makeup. For example, the parotid glands secrete a watery solution that contains salivary amylase. The submandibular glands have cells similar to those of the parotid glands, as well as mucus-secreting cells.

FUNCTION OF SALIVA:

1. Saliva contributes to the digestion of food and to maintenance of oral hygiene.
2. In people with little saliva soreness of mouth is very common sticks to inside of mouth.
3. this lubricates function of saliva allows the food bolus to be passed easily from mouth into esophagus. its is also very imp in sense organ.

MAJOR SALIVARY GLANDS:

Majority of saliva into ducts that open into the mouth:

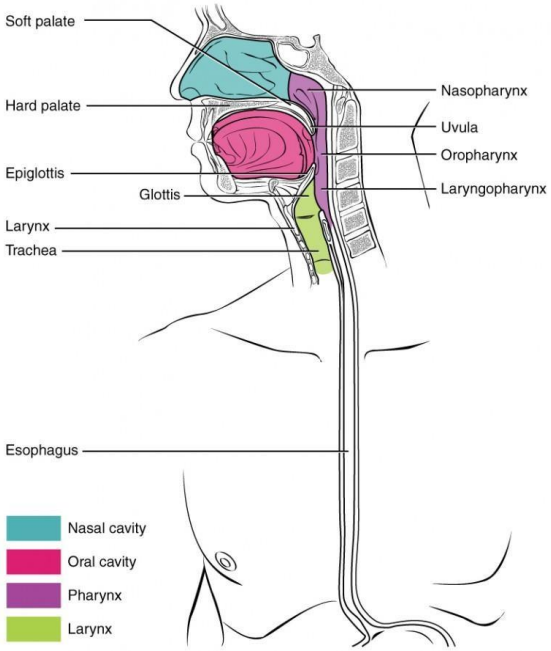
- The **submandibular glands**, which are in the floor of the mouth, secrete saliva into the mouth through the submandibular ducts.
- The **sublingual glands**, which lie below the tongue, use the lesser sublingual ducts to secrete

saliva into the oral cavity.

- The **parotid glands** lie between the skin and the massagers muscle, near the ears. They secrete saliva into the mouth through the parotid duct, which is located near the second upper molar tooth.

PHARYNX:

The **pharynx** (throat) is involved in both digestion and respiration. It receives food and air from the mouth, and air from the nasal cavities. When food



enters the pharynx, involuntary muscle contractions close off the air passageways.

Figure. The pharynx runs from the nostrils to the oesophagus and the larynx.

A short tube of skeletal muscle lined with a mucous membrane, the pharynx runs from the

in the superior medium, extending to diaphragm. As the oesophagus is followed distally, it passes behind the aortic arch at the level of the T4 through T5 inter vertebral discs and enters the posterior medium, The final segment, the abdominal segment, runs from the diaphragm of the stomach. This segment descends and passes through the right side of the diaphragm at the level of the tenth thoracic vertebra and into the cardiac of the stomach at the eleventh thoracic vertebra level.

STOMACH:

The stomach is a muscular organ located on the left side of the upper abdomen. The stomach receives food from the oesophagus. As food reaches end of oesophagus, it enters the stomach through the stomach is an important organ and the most dilated portion of the digestive system. The oesophagus precedes it, and the small intestine follows. It is a large, muscular, and hollow organ allowing for a capacity to hold food. It is comprised of 4 main regions, the body and pylorus. The cardiac is connected to the oesophagus and is where the food first enters the stomach. The digestion follows the cardiac and is a bulbous, dome-shaped, superior portion of the stomach. Following the body is the pylorus, which conically funnels food into the duodenum, or upper portion of the small intestine. The stomach is located in the human body left of the midline and centrally in the upper area of the abdominal the next stage of digestion begins in the stomach.Muscular valve called the lower esophageal sphincter.

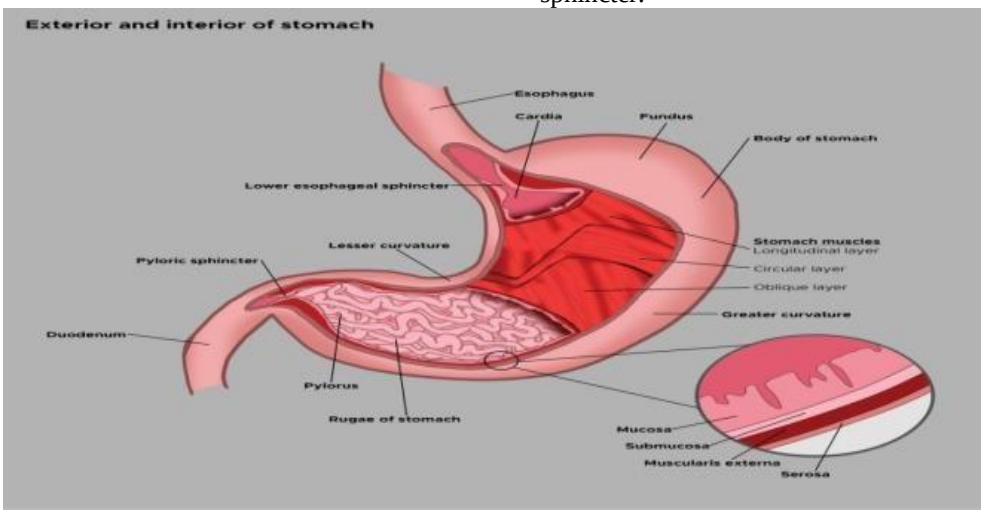


Table 1. Hormones Secreted by the Stomach

Hormone	Production site	Production stimulus	Target organ
Gastric	Stomach mucosa, mainly G cells of the pyloric tantrum	Presence of peptides and amino acids in stomach	Stomach
Gherkin	Stomach mucosa, mainly fundus	Fasting state (levels increase just prior to meals)	Hypothalamus
Histamine	Stomach mucosa	Presence of food in the stomach	Stomach
Serotonin	Stomach mucosa	Presence of food in the stomach	Stomach
Somatisation	Mucosa of stomach, especially pyloric atrium; also duodenum	Presence of food in the stomach; sympathetic axon stimulation	Stomach

ACID PRODUCTION IN THE STOMACH:
HYDROCHLORIC ACID PRODUCTION:
it is produced by the **parietal cells** of the stomach. To begin with, water (H_2O) and carbon dioxide (CO_2) combine within the parietal cell cytoplasm to produce carbonic acid (H_2CO_3), which is catalysed by **carbonic anhydrite.** Carbonic acid then spontaneously dissociates into a hydrogen are highly acidic environment in the stomach lumen degrades proteins (e.g., food). Peptide bond which comprise proteins. The gastric cells of the stomach secrete enzymes for protein breakdown.

GASTRIC ACID SECERTION:
Acid is secreted by parietal cells in the proximal two thirds (body) of the stomach. Gastric acid aids digestion by creating the optimal pH for pepsin and gastric lipase and by stimulating pancreatic bicarbonate secretion. Acid secretion is initiated by food: the thought, smell, or taste of food effects of stimulation of the gastro-secreting G cells located in the distal one third of the stomach. The arrival of protein to the stomach further stimulates gastro output. Circulating gastro triggers the release of histamine from like cells in the body of the stomach. Histamine stimulates the parietal cells via their H2 receptors. The parietal cells secrete acid, and the resulting drop in pH causes the D cell.

PRODUCTION BY PARASYMPATHEIC NERVOUS SYSTEM:
The parasympathetic nervous system regulates bodily functions when a person exists at rest. Some of its activities include promoting digestion, activating metabolism, and assisting the body relax.
The parasympathetic nervous system exists as part of the body's autonomic nervous system. Its partner exists the sympathetic nervous system, which control's the body's fight or flight response. The parasympathetic nervous system regulates the body's ability to relax. It's sometimes named the "rest and digest" state.

Secretion of gastric acid exists regulated positively by the parasympathetic nervous system, by the hormone, and by the histamine. The final for each of these elements is the proton pump located in the parietal cell.

The parasympathetic nervous system regulates processes in the body such as digestion, repair, and relaxation. When the parasympathetic nervous system stands dominant in the body it conserves energy, slows heart rate, increases digestion, and relaxes sphincter muscles in the digestive tract.

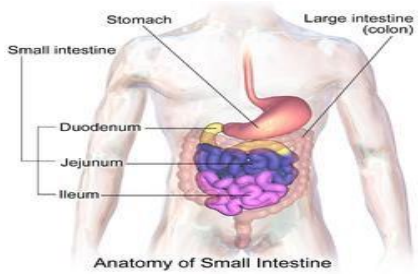
PEPSIN ROLE IN PROTEIN DIGESTION:
Pepsin is an end peptidase that breaks down dietary proteins reaching the stomach into amino acids. It functions by digesting peptide bonds, the predominant chemical bonds found in proteins. In response to various stimuli, small basophilic cells in the deeper layers of gastric glands, known as Chief cells, produce pepsin. Acetylcholine, gastro, and low pH directly stimulate chief cells to secrete pepsin. Acetylcholine is a neurotransmitter released from various parasympathetic nerve terminals in the "cephalic phase" of food digestion. Besides

enhancing chief cell activity, it also stimulates parietal cells to produce hydrochloric acid via their proton pumps. The low pH imposed by to breaks down pepsin into its active form, pepsin. Gastro is another gastrointestinal hormone released by G cells in the stomach anus and the duodenum. G cells secrete gastro in response to many stimuli, including stomach distension, amino acids and peptides, high pH, and stimulation. Similar to acetylcholine, gastro also activates parietal cells to secrete hydrochloric acid (HCL) on top of its chief cell stimulatory effects. It does so both directly, and indirectly, through the action of histamine released by cells. Histamine is, in fact, the most potent activator of parietal cells. On the other hand, is an inhibitory gastrointestinal hormone released by D cells in the duodenum and stomach anus? It inhibits pepsin release from chief cells, thereby opposing the effects of gastro and acetylcholine.

SMALL INTESTINE:

The small intestine (also referred to as the small bowel) is the specialized tubular structure between the stomach and the large intestine (also called the colon or large bowel) that absorbs the nutrition from your food. It is approximately 20-25 feet in length and is about as big around as your middle finger. It is divided into three parts: the duodenum, jejunum and ileum.

The beginning portion of the small intestine (the duodenum) begins at the exit of the stomach (pylorus) and curves around the pancreas to end in the region of the left upper part of the abdominal cavity where it joins the jejunum. The duodenum has an important anatomical feature which is the cells. This is the site at which the bile duct and pancreatic duct empty their contents into the small intestine which helps with digestion. The jejunum is the upper part of the small intestine and the ileum the lower part, though there is no clear delineation between the jejunum and ileum.



Anatomy of Small Intestine

The **small intestine** or **small bowel** is an organ in the gastrointestinal tract where most of the absorption of nutrients from food takes place. It lies between the stomach and large intestine, and receives bile and pancreatic juice through the pancreatic duct to aid in digestion. The small intestine is about 5.5 metres (18 feet) long and folds many times to fit in the abdomen. Although it is longer than the large intestine, it is called the small intestine because it is narrower in diameter.The length of the small intestine can vary greatly, from as short as 3 metres (10 feet) to as long as 10.5 m (34+1⁄2 ft), also depending on the measuring technique used. The typical length in a living person is 3–5 m (10–16+1⁄2 ft). The length depends both on how tall the person is and how the length is measured. Taller people generally have a longer small intestine and measurements are generally longer after death and when the bowel is empty.

Small bowel dilation on CT scan in adults[]

<2.5 cm	Non-dilated
2.5-2.9 cm	Mildly dilated
3–4 cm	Moderately dilated
>4 cm	Severely dilated

It is approximately 1.5 centimetres (5⁄8 inch) in diameter in newborn after 35 weeks of gestational age, and 2.5–3 cm (1–1+1⁄8 in) in diameter in adults. On abdominal X-rays, the small intestine is considered to be abnormally dilated when the diameter exceeds 3 m on CT scans, a diameter of over 2.5 cm is considered abnormally dilated.The surface area of the human small intestinal mucosa, due to enlargement caused by folds, vile and microvillus, averages 30 square metres (320 sq ft).

LARGE INSTESTINE:

The **large intestine**, also known as the **large bowel**, is the last part of the gastrointestinal tract and of the digestive system in tetrapods. Water is absorbed here and the remaining waste material is stored in the rectum as fees before being removed by defecation. The colon is the longest portion of the large instestine.

In humans, the large intestine begins in the right iliac region of the pelvis, just at or below the waist, where it is joined to the end of the small intestine at the scum, via the ileocecal valve.

It then continues as the colon ascending the abdomen, across the width of the aominal cavity as the transverse colon, and then descending to the rectum and its endpoint at the anal canal .Overall, in humans, the large intestine is about 1.5 metres (5 ft) long, which is about one- fifth of the whole length of the human gastrointestinal tract.
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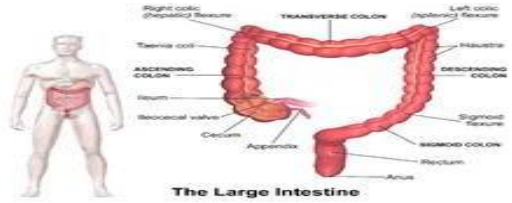
One of the main functions of the colon is to remove the water and other key nutrients from waste material and recycle it. As the waste material exits the small intestine through the ileocecal valve, it will move into the scum and then to the ascending colon where this process of extraction starts. The waste material is pumped upwards toward the transverse colon by peristalsis.The ascending colon is sometimes attached to the appendix via Grenache's valve. In ruminants, the ascending colon is known as the **spiral colon**. Taking into account all ages and sexes, colon cancer occurs here most often (41%).

TRANSVERSE COLON:

The transverse colon is the part of the colon from the hepatic flexure, also known as the right colic, (the turn of the colon by the liver) to the spleen also known as the left colic, (the turn of the colon by e spleen). The transverse colon hangs off the stomach, attached to it by a large fold of peritoneum called the greater omentum. On the posterior side, the transverse colon is connected to the posterior abdominal wall by a mesentery known as the transverse mesocolon.
The transverse colon is encased in peritoneum, and is therefore mobile (unlike the parts of the colon immediately before and after it).
The proximal two-thirds of the transverse colon is perfumed by the middle colic artery, a branch of the superior mesenteric artery (SMA), while the latter third is supplied by branches of the inferior mesenteric artery (IMA). The "watershed" area between these two blood supplies, which represents the embryologic division between the midgut and hindgu, is an area sensitive to ischemia.

DESCENDING COLON

The descending colon is the part of the colon from the splenic flexure to the beginning of the sigmoid colon. One function of the descending colon in the digestive system is to stored.

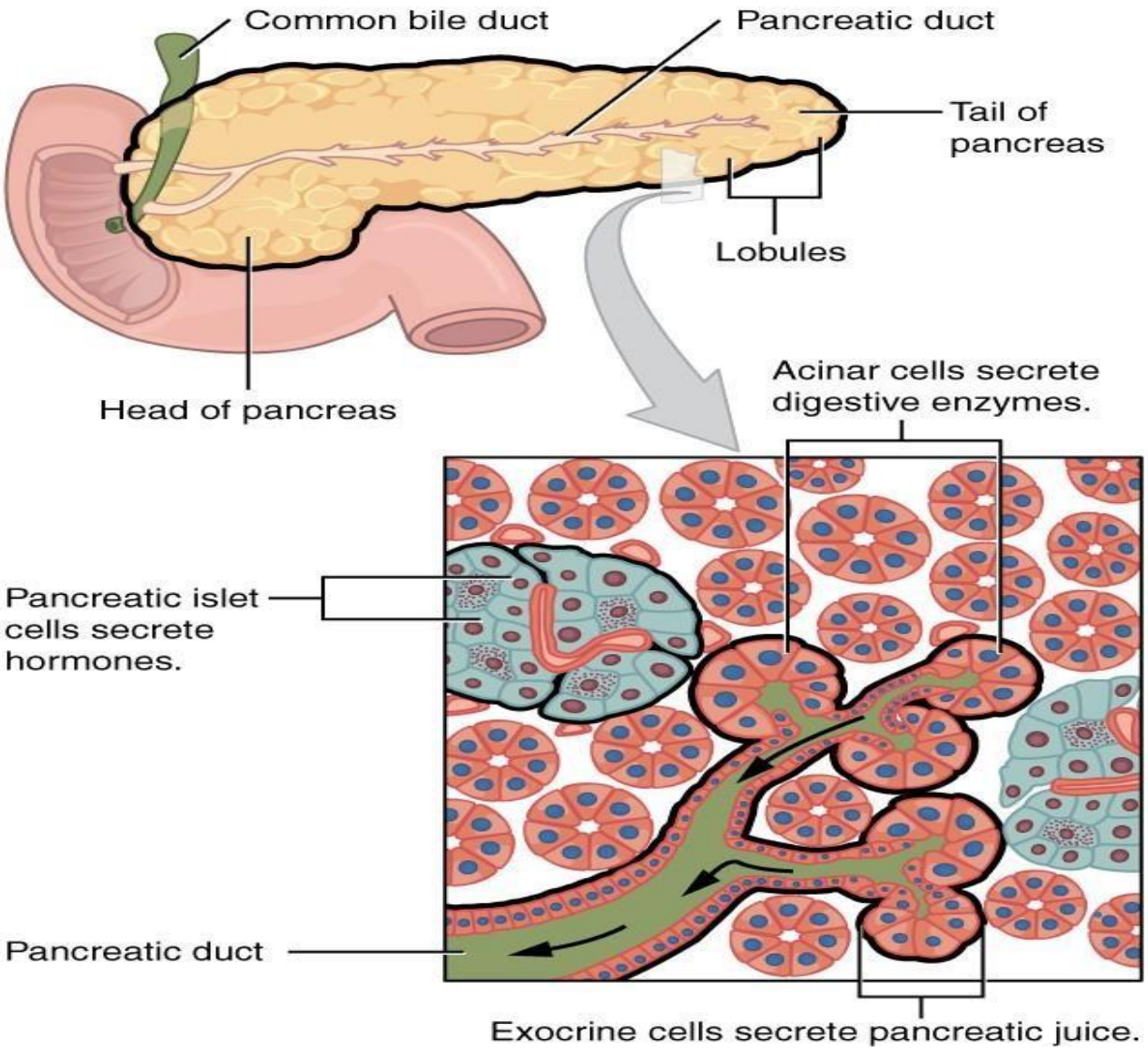


The Large Intestine

It will be emptied into the rectum. It is retro potential in two-thirds of humans. In the other third, it has a (usually short) mesentery. The arterial supply comes via the left colic artery. The descending colon is also called the *distal gut*, as it is further along the gastrointestinal tract than the proximal gut. Gut flora are very dense in this region.

ANATOMY OF PANCREAS:

The pancreas is an extended, accessory digestive gland that is found retroperitoneal, crossing into the bodies of the L1 and L2 vertebrae on the posterior abdominal wall. The pancreas lies transversely in the upper abdomen between the duodenum on the right and the spleen on the left. It is divided into the head, neck, body, and tail. The head lies on the inferior vena cava anther renal vein and is surrounded by the C loop of the duodenum. The tail of the pancreas extends up to the splendid helium. The pancreas produces an exocrine secretion.



STRUCTURE AND FUNCTION

the main and accessory pancreatic ducts and endocrine secretions (glucagon and insulin from the pancreatic islets of Langerhans) that enter the blood.

Divisions

The pancreas is divided into 4 parts: head, neck, body, and tail.

The head of the pancreas is the enlarged part of the gland surrounded by the C-shaped curve of the duodenum. On its way to the descending part of the duodenum, the bile duct lies in a groove on the poster superior surface of the head or is embedded in its substance. The body of the pancreas continues from the neck and passes over the aorta and L2 vertebra. The anterior surface of the body of the pancreas is covered with peritoneum. The posterior surface of the body is devoid of peritoneum. It is in contact with the aorta, the superior mesenteric artery (SMA), the left suprarenal gland, the left kidney, and renal vessels.

The neck of the pancreas is short. The tail of the pancreas lies anterior to the left kidney, closely related to the splendid helium and the left colic flexure. The main pancreatic duct carrying the pancreatic secretions joins with the bile duct to form the hepatopancreatic ample, which opens into the descending part of the duodenum. The hepatopancreatic sphincter of Odder around the hepatopancreatic ampoule is a smooth muscle sphincter that controls the flow of bile and pancreatic juice into the ampoule and inhibits reflux of duodenal substances into the ampoule.

Cell Types

The majority of the pancreas (approximately 80%) is made up of exocrine pancreatic tissue. This is made of pancreatic acne (pyramidal acinar cells with the apex directed towards the lumen). These contain dense zymogens granules in the apical region, whereas the basal region contains the nucleus and endoplasmic reticulum (which aids in synthesizing the digestive enzymes). These enzymes are stored in secretor vesicles called the Golgi complex. The basolateral membrane of the acinar cells contains several receptors for neurotransmitters including secret in, cholecystokinin, and acetylcholine, which regulate exocytosis of the digestive enzymes.

The pancreas also contains the islet of Langerhans, which contain the endocrine cells. Unlike the exocrine enzymes, which are secreted by exocytosis, the endocrine enzymes enter the bloodstream via a complex capillary network within the pancreatic blood flow. There are 4 types of endocrine cells (A cells produce glucagon, B cells produce insulin, D cells produce somatostatin, and F cells produce pancreatic polypeptide). cells are a direct formation of epithelial structures within the pancreas. In conditions like chronic pancreatitis, these cells promote inflammation and fibrosis.

Cell Type	% Islet Cell Mass	Major Hormone Secreted	Location Within Islet	Location Within Pancreas	Associated Tumor Syndrome
A (alpha)	10%	Glucagon	Peripheral	Evenly distributed	Glucagonoma: necrolytic migratory erythema, diabetes, hypoaminoacidemia
B (beta)	70%	Insulin	Central	Body/Tail	Insulinoma: hypoglycemia and associated symptoms
D	5%[a]	Somatostatin	Evenly distributed	Body/Tail	Somatostatinoma: diabetes, gallstones, steatorrhea
D_2	5%[a]	Vasoactive intestinal peptide (VIP)	Evenly distributed	Body/Tail	VIPoma: high-volume secretory diarrhea, hypokalemia, metabolic acidosis, hypochlorhydria
F	15%	Pancreatic polypeptide	Peripheral	Head and uncinate process	Treatment directed at presenting symptoms
E C	<1%	Substance P, serotonin	Evenly distributed	Evenly distributed	None
G	Not present in normal physiologic state	Gastrin, ACTH-related peptides	Not applicable	Head, uncinate process, duodenum	Gastrinoma: acid hypersecretion, gastric/duodenal ulcers, diarrhea

[a]Combined D and D_2 mass.

EMBROLOGY

Development

The pancreas develops from the posterior foregut endoderm. At about 4 weeks gestation, this endoderm first gives rise to dorsal and ventral buds, which gradually elongate.] Around week 6, the ventral bud rotates around the then developing duodenum and eventually fuses with the dorsal bud at about the 17th week of gestation to form the pancreas. The dorsal bud thus forms the upper part of the pancreatic head, the body, and the tail, whereas the ventral bud forms the lower part of the pancreas and the incarnate process.

The pancreatic enzymes are drained by 2 pancreatic ducts: the duct of Wising (major pancreatic duct) and the duct of Santorin (minor pancreatic duct). The ventral duct forms the proximal portion of the major pancreatic duct, which opens into the duodenum via the ampoule of Voter. The dorsal duct forms a part of the major ducts as well as the minor duct or the accessory duct of Santorin. The latter usually empties through the ampoule of Vitter but may empty independently in approximately 5% of people.

Blood Supply and Lymphatic:

Arterial Supply

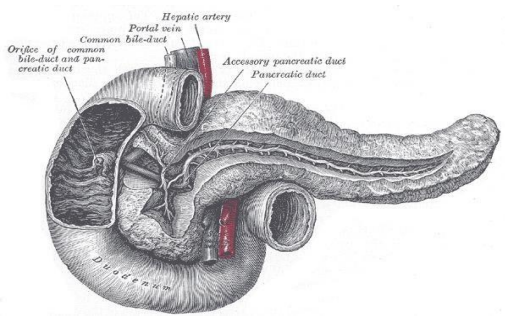
1. Branches of the splendid artery (a branch of the celiac trunk), superior mesenteric artery (SMA), and
2. Pancreatic head: The gastro duodenal artery (a branch of the common hepatic artery) supplies the head and the uncoated process of the pancreas in the form of the pancreatic duodenal artery (PDA). Part of the inferior portion of the head is supplied by the inferior PDA, which arises from the SMA.
3. Body and the tail: The spleen artery and its branches supply these.

Venous Supply

1. Pancreatic head: The head drains into the superior mesenteric vein (SMV).
2. Body and the neck: The splendid vein drains these.

The SMV and splenic vein merge to form the portal vein.

Nerves:



The pancreas has a complex network of parasympathetic, sympathetic, and sensory innervations. It also has an intrinsic nerve plexus. Sympathetic and parasympathetic fibers are dispersed to pancreatic acinar cells. The parasympathetic fibers arise from the posterior vagal trunk and are secretomotor, but the secretions from the pancreas are predominantly mediated by cholecystokinin and secreting, which are hormones produced by the epithelial cells of the duodenum and proximal intestinal mucosa regulated by acidic compounds from the stomach. Sympathetic innervations are via the T6-T10 thoracic splanchnic nerves and the celiac plexus.

Partial or dorsal agenesis of the pancreas is often asymptomatic. It is sometimes associated with diabetes, polysplenia, malabsorption syndrome, or recurrent pancreatitis.

1. Ectopic pancreatic tissue is present in the stomach (most common) or small intestine. This is seen in about 3% to 5% of the general population and is usually an incidental finding on upper gastrointestinal endoscopy or a barium contrast study. Their umbilicated appearance typically identifies them, and they are most commonly clinically insignificant. Very rarely, a pancreatic rest in the small intestine may be the lead point of intussusception or may cause bowel obstruction.
2. Pancreas deism is the most common developmental anomaly of the pancreas. It occurs in about 10% to 15% of the general population. It occurs as the result of the failure of the pancreatic buds to fuse. Thus the tail, body, and part of the head of the pancreas drain through the accessory duct of Santorini instead of the major duct. Pancreatic devisor has been historically associated with recurrent pancreatitis, and it is hypothesized that this could be due to steno sis of the sphincter leading to obstruction of the outflow of the ventral pancreas. A divisum is diagnosed by an endoscopic.
3. by magnetic resonance cholangiopancreatography (MRCP). Lately, endoscopic ultrasound is used to diagnose a pancreatic divisum. In case of recurrent pancreatitis, the pancreas divisum is treated by insertion of a stent via ERCP as well as a sphincterotomy.
4. Pancreatic dysgenesis/dysfunction is a component of certain syndromes' associations, including Johanson-Blizzard and Schwachmann-Diamond syndrome

ANATOMY OF LIVER:

The liver is located in the upper right-hand portion of the abdominal cavity, beneath the diaphragm, and on top of the stomach, right kidney, and intestines.Shaped like a cone, the liver is a dark reddish-brown organ that weighs about 3 pounds.

Bilirubin:

The main bile pigment, is a waste product produced when the spleen removes old or damaged red blood cells from the circulation. These breakdown products, including proteins, iron, and toxic bilirubin, are transported to the liver via the spleen vein of the hepatic portal system. In the liver, proteins and iron are recycled, whereas bilirubin is excreted in the bile. It accounts for the green color of bile. Bilirubin is eventually transformed by intestinal bacteria into stercobilin, a brown pigment that gives your stool its characteristic color! In some disease states, bile does not enter the intestine, resulting in white ('alcoholic') stool with a high fat content, since virtually no fats are broken down or absorbed.

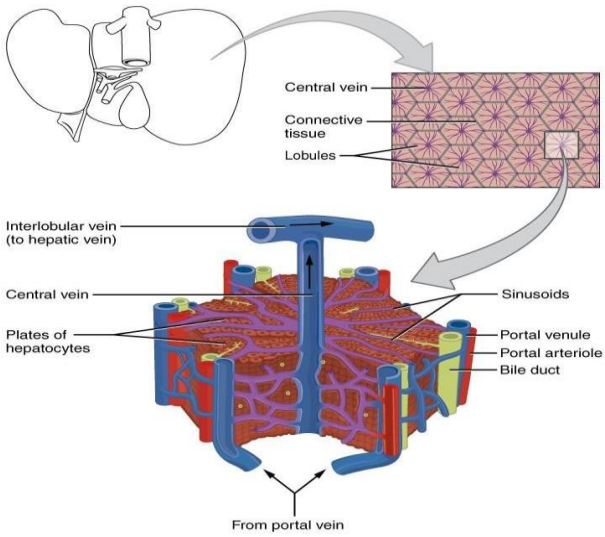
FUNCTION OF LIVER:

The liver regulates most chemical levels in the blood and excretes a product called bile. This helps carry away waste products from the liver. All the blood leaving the stomach and intestines passes through the liver. The liver processes this blood and breaks down, balances, and creates the nutrients and also metabolizes drugs into forms that are easier to use for the rest of the body or that are nontoxic. More than 500 vital functions have been identified with the liver. Some of the more well-known functions include the following:

- Production of bile, which helps carry away waste and break down fats in the small intestine during digestion
- Production of certain proteins for blood plasma
- Production of cholesterol and special proteins to help carry fats through the body
- Conversion of excess glucose into glycogen for storage (glycogen can later be converted back to glucose for energy) and to balance and make glucose as needed
- Regulation of blood levels of amino acids, which form the building blocks of proteins
- Processing of haemoglobin for use of its iron content (the liver stores iron)
- Conversion of poisonous ammonia to urea (urea is an end product of protein metabolism and is excreted in the urine)
- Clearing the blood of drugs and other poisonous substances
- Regulating blood clotting
- Resisting infections by making immune factors and removing bacteria from the bloodstream
- Clearance of bilirubin, also from red blood cells. If there is an accumulation of bilirubin, the skin and eyes turn yellow.

When the liver has broken down harmful substances, its by-products are excreted into the bile or blood. Bile by-products enter the intestine and leave the body in the form of fetes. Blood by- products are filtered out by the kidneys, and leave the body in the form of urine.

- Oxygenated blood flows in from the hepatic artery



Hepatic Duct

The hepatic duct transports bile, produced by the liver cells, to the gallbladder and duodenum (the first part of the small intestine).

The gallbladder, a separate organ that works closely with the liver, is attached to the bile duct. Although it's small, the gallbladder is distensible, which means it's able to stretch out (or distend) if necessary.

The gallbladder stores bile and releases it back into the duct on cues from the stomach.

Portal Vein and Hepatic Artery:

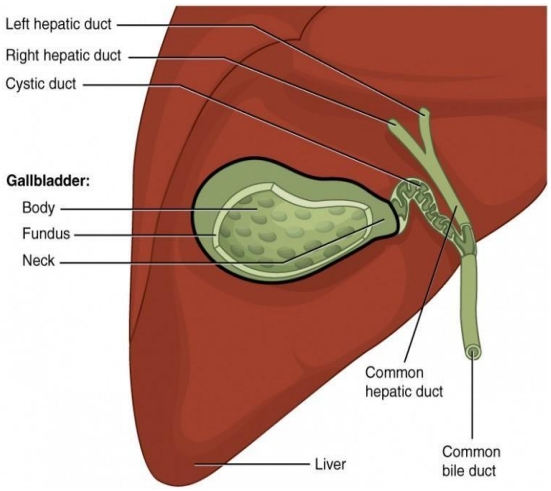
At any given moment, the liver holds about 13 percent of the body's blood supply. Your liver gets blood from two distinct sources: the portal vein and the hepatic artery. **Portal Vein**

- The liver's **primary blood source**
- Carries nutrient-rich blood from the intestines to the liver

Hepatic Artery

- The liver's **secondary blood source**
- Delivers oxygen-rich blood from the heart to the liver

THE GALLBLADDER



The **gallbladder** is 8–10 cm (~3–4 in) long and is nested in a shallow area on the posterior aspect of the right lobe of the liver. This muscular sac stores, concentrates, and, when stimulated, propels the bile into the duodenum via the common bile duct. It is divided into three regions. The fundus is the widest portion and tapers medially into the body, which in turn narrows to become the neck. The neck angles slightly superiorly as it approaches the hepatic duct. The cystic duct is 1–2 cm (less than 1 in) long and turns inferiorly as it bridges the neck and hepatic duct.

The simple columnar epithelium of the gallbladder mucosa is organized in raga, similar to those of the stomach. There is no submucosa in the gallbladder wall. The wall's middle, muscular coat is made of smooth muscle fibers. When these fibers contract, the gallbladder's contents are ejected through the **cystic duct** and into the bile duct. Visceral peritoneum reflected from the liver capsule holds the gallbladder against the liver and forms the outer coat of the gallbladder. The gallbladder's mucosa absorbs water and ions from bile, concentrating it by up to 10-fol.

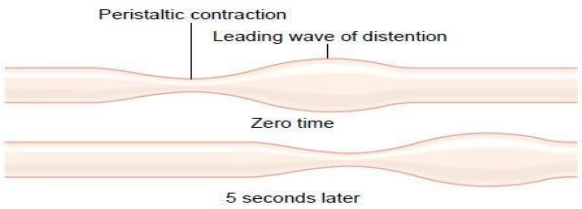


Figure 62–5

Peristalsis.

MOVEMENTS OF GIT:

General Principles of Gastrointestinal Motility

Physiologic Anatomy of the Gastrointestinal Wall

Shows a typical cross section of the intestinal wall, including the fol-lowing layers from outer surface inward: (1) the *servos*, (2) l*ongitudinal muscle layer*, (3) a *circular muscle layer*, (4) the *sub mucosa*, and (5) the *mucosa*. In addition, sparse bundles of smooth muscle fibers, the *mucosal muscle*, lie in the deeper layers of the mucosa. The motor functions of the gut are performed by the different layers of smooth muscle.

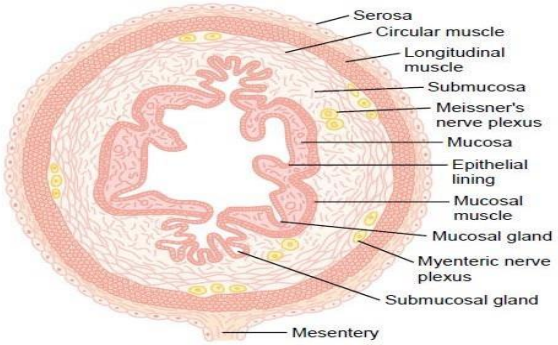


Figure 62–2

Typical cross section of the gut.

Gastrointestinal Smooth Muscle Functions as a Syncytium. The individual smooth muscle fibers in the gastrointestinal tract are 200 to 500 micrometers in length and 2 to 10 micrometers in diameter, and they are arranged in bundles of as many as 1000 parallel fibers. In the *longitudinal muscle layer*, the bundles extend longitudinally down the intestinal tract; in the *circular muscle layer*, they extend around the gut.

Functional Types of Movements in the Gastrointestinal Tract:

Two types of movements occur in the gastrointestinal tract: (1) *propulsive movements*, which cause food to move forward along the tract at an appropriate rate to accommodate digestion and absorption, and (2) *mixing movements*, which keep the intestinal contentsthoroughly mixed at all times.

Propulsive Movements-Peristalsis

The basic propulsive movement of the gastrointestinal tract is *peristalsis*, which is illustrated in Figure 62–5. A contractile ring appears around the gut and then moves forward; this is analogous to putting one's fingers around a thin distended tube, then constricting the fingers and sliding them forward along the tube. Any material in front of the contractile ring is moved forward.

INFERIOR VENA CAVA

The inferior vena cava is a large main vein that carries blood through the liver and back to the heart.

- Blood leaves your liver through a central vein in each lobule, and then through a hepatic vein, one of several short veins originating within the lobes of the liver as small branches.
- These unite in a network of hepatic veins that lead directly to the inferior vena cava.
- The inferior vena cava collects blood from parts of the body below your diaphragm.

- Peristalsis is an inherent property of many syncytial smooth muscle tubes; stimulation at any point in the gut can cause a contractile ring to appear in the circular muscle, and this ring then spreads along the gut tube. (Peristalsis also occurs in the bile ducts, glandular ducts, renters, and many other smooth muscle tubes of the body.)

DIGESTION &ABSORPTION OF NUTRIENTS:

To survive, your body must have a system for transforming food and drink into nutrients that it can absorb and use. Digestion begins when you see, smell, feel, or taste foods. The hormonal and nervous systems signal the gastrointestinal tract that food is on the way. Muscles flex and digestive secretions flow. Cooperating organs including the mouth, oesophagus, stomach, small and large intestines, pancreas, liver, and gall bladder orchestrate digestion. To get the nourishment you need, nutrients must successfully traverse the gastrointestinal tract (GIT). The GIT is a long, muscular tube that extends from the mouth to the anus. Foods contain macronutrients that are broken down during digestion into smaller units that are absorbed by cells lining the small intestine. Ultimately, nutrients traverse absorptive cells and are released into the bloodstream or lymph system and transported throughout the body.
Sometimes problems arise such as regurgitation of stomach contents into the oesophagus, ulcers in the stomach, a blocked bile duct, or insufficient enzymes. Knowing more about the digestive process helps you avoid these problems and stay healthy.

- Describe the role of the mouth, teeth, tongue, epiglottis, and esophagus in chewing, lubricating, and delivering food and drink to the stomach and beyond
- Explain the cause of heartburn or gastro esophageal reflux disease
- Associate the small intestine and vile with their digestive role
- Connect the large intestine to its function
- A System of Muscles, Organs, and Enzymes.

The GIT is a long tube that extends from the mouth to the anus. It consists of longitudinal and circular muscles that contract in waves to propel substances along. Hormones and enzymes assist in the breakdown of food in a process called digestion.
The GIT includes the mouth, oesophagus, stomach, small and large intestines, rectum, and anus. Organs that provide substances needed for digestion include the pancreas, gall bladder, and liver. Together, these organs form a system that efficiently transforms the foods that you eat into the nutrients that you need to maintain your body.The body's hormonal and nervous systems have regulatory control of nutrients. A hormone, such as insulin, is produced by an organ (pancreas) in response to a need. It has a specific site from which it enters the bloodstream, where it begins its
journey to target cells that it influences. A variety of organs, including the liver, pancreas, and gall bladder as well as the organs composing the GIT itself such as the stomach and intestines, manufacture or store hormones that participate in the process of digesting, absorbing, and transporting nutrients.

After a meal high in carbohydrates, the pancreas responds to rising levels of blood glucose by increasing its release of insulin. Insulin is a hormone that stimulates body cells to actively absorb glucose. As a result, glucose quickly moves out of the bloodstream and into cells. Insulin, then, is a hormone that lowers blood glucose levels. An example of a digestive hormone is gastro, which stimulates the stomach to secrete gastric juices.

CONCLUSIONS:

Many IN VITRO simulation tools have been designed to reproduce the complexity of the human digestive system. Many of them are very complex systems with their sometimes in-house computer control and the mechanic or dynamic systems designs. They attempt to reproduce the physiological conditions of the human digestive system as close as possible by the use of observed IN VIVO data obtained from human subjects. They use complex computer control systems to adjust the dynamics of pH, transit time, and digestive secretions. Sophisticated roller or piston systems or application of regulated pressure waves by peristaltic pumps have been used to simulate the fluid dynamics and mechanical forces in the digestive system. Carrier-mediated transport and passive diffusion through the small intestine epithelial cells were simulated as passive diffusion by using a filter medium or by exposing the digested samples to cell lines. The

systems sometimes used a texture analyzer to measure and control the applied forces in the stomach. Even individual organs can be modeled to close perfection in anatomy and physiology. There are examples of early models like a human duodenum model by Wright et al. (2016). Even though it was not possible to perfectly match the complex human digestive system, it was possible to simulate the digestive system's critical mechanical, dynamic, and biochemical processes in a robust, repeatable manner. The models have been improved extensively over the years, and some have been used by the food, nutrition, and medical industry widely.

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