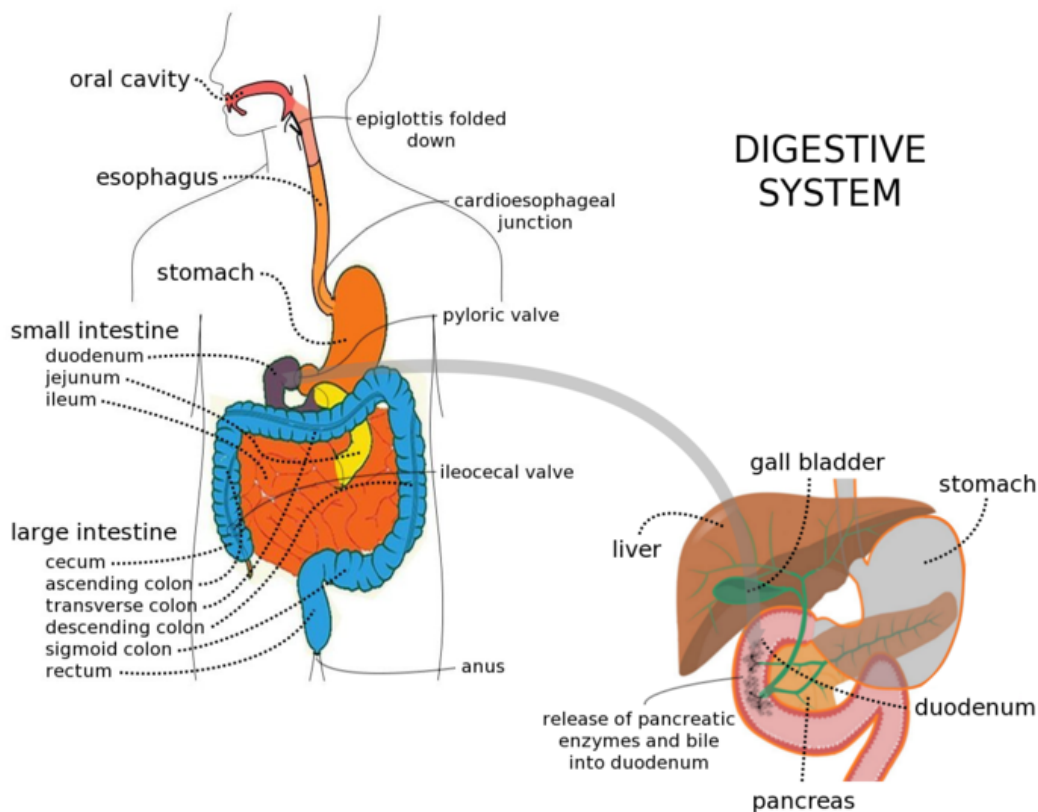


Anatomy of the Oral Cavity and Gastrointestinal Tract

[See online here](#)

Digestion is the mastication and breakdown of nutrients and their subsequent incorporation into an organism. Thereafter, the bloodstream carries all the nutrients to the cells of the body. This article is a compact overview of the anatomy of the oral cavity as well as the specific features of the gastrointestinal (GI) tract and the liver.



Structure and Secretion of the Salivary Gland

The swallowing process is the movement of food from the mouth to the stomach. Before this happens, saliva is secreted by the salivary glands into the oral cavity.

Saliva consists of 99.5% water and 0.5% dissolved substances such as sodium, potassium, and bicarbonate. The main function of the secretion of saliva is to lubricate the food as well as to start the chemical digestion of carbohydrates and lipids.

The autonomic nervous system controls the secretion of saliva in the oral cavity, throat,

and esophagus. The salivary glands secrete 1,000–1,500 mL of saliva every day.

There are numerous salivary glands in and around the oral cavity.

They are classified as follows:

Minor salivary glands

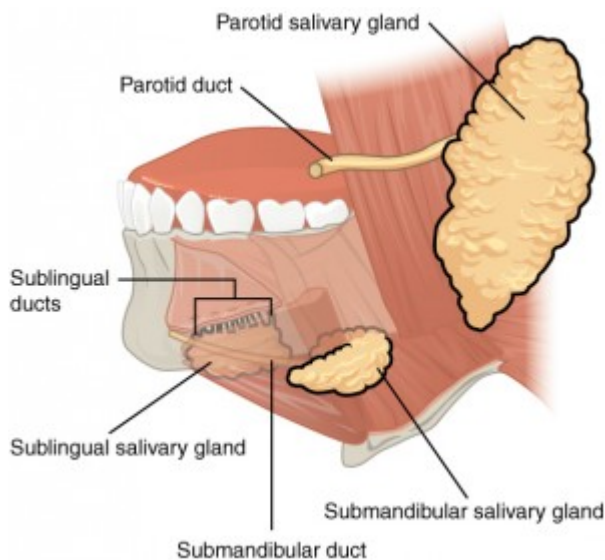
- *Glandulae labiales* in the mucosa of the lips
- *Glandulae buccales* in the mucosa of the cheeks
- *Glandulae palatinae* in the pharyngeal mucosa
- *Glandulae linguales* in the anterior part of the floor of the mouth, lateral to the tongue and medial to the mandible

Major salivary glands

- *Glandula parotideae* (parotid gland; below and in front of each ear)
- *Glandula submandibularis* (submandibular gland; lower jaw)
- *Glandula sublingualis* (sublingual gland)

The minor salivary glands secrete saliva through short ducts directly or indirectly into the oral cavity. Their contribution to the total saliva is small.

The major salivary glands lead directly into the oral cavity, secrete the most amount of saliva, and consist of three pairs of major salivary glands.



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Glandula parotideae (parotid gland)

These glands are located inferior and anterior to the ears; they cover the ***musculus masseter*** and cranially touch the ***arcus zygomaticus*** and the ***meatus acusticus externus*** in a dorsal direction. The biggest part of the gland lies deep in the ***fossa retromandibularis***. The glands secrete saliva through the ***ductus parotideus (ear saliva duct)***, which extends through the ***musculus buccinator*** and ends in the vestibule opposite to the second upper molar tooth.

The parotid glands solely consist of **serous acini (parts of the glands that secrete**

serous fluid). Saliva is highly fluid and comprises of many proteins and enzymes. It contains immunoglobulins, which are secreted as a complex of immunoglobulins by the gland cells. They act as an immunologic defense against germs within the oral cavity.

***Glandula submandibularis* (submandibular gland)**

At the bottom of the mouth, we find the submandibular gland, which is located in a canal between the inner side of the mandible, *musculus mylohyoideus*, *musculus hyoglossus*, and *lamina superficialis fasciae cervicalis*.

Its ducts lie on both sides of the midline beneath the mucosa (**ductus submandibularis**) and reach the oral cavity next to the lingual frenulum. The submandibular gland mainly consists of serous acini and a few mucosal acini (parts of the gland that secrete mucus).

***Glandula sublingualis* (sublingual gland)**

The sublingual gland lies lateral to the **musculus genioglossus** on the **musculus mylohyoideus** and above the submandibular glands. Its small ducts (**ductus sublinguales minores**) empty into the bottom of the mouth directly into the oral cavity. It mainly consists of mucosal acini and just a few serous acini.

Structure of the teeth

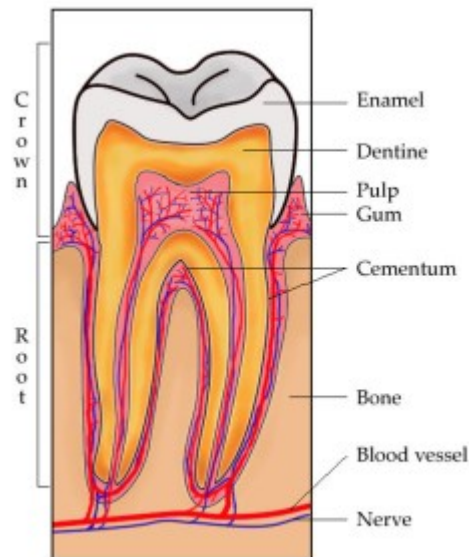
Teeth (**dentes**) are included as part of the accessory digestive organs. They lie in the caves of the alveolar extensions in the upper and lower jaw.

The alveolar extensions are covered by the gingiva that slightly reaches into every hole. On the inner side of these holes, there is the periodontal ligament (**peridontium**), which consists of connective tissue fibers that hold the teeth in place.

A tooth consists of three main parts, as follows:

- **Crown**
- **Roots**
- **Neck**

The **visible part** that lies above the gingival is called the crown. One or three roots are invisibly located inside the holes. The constricted **connection between the crown and the roots** is called the neck.



Picture: 'Tooth section' by Sam Fentress. License: [CC BY-SA 2.0](#).

The main inner part of a tooth is called the **dentin** and consists of calcified connective tissue that is responsible for the tooth's form and consistency.

At the crown, the dentin is covered by enamel (***substantia adamantinea***), which consists of calcium phosphate and calcium carbonate. Due to its high concentration of calcium, enamel is harder than bones, making it the hardest substance in the body.

The main function of enamel is to protect the teeth **against wear** from chewing and **against acids** that could dissolve the dentin. The dental cement is connected to the periodontal ligament and covers the dentin at the roots.

The dentin encompasses a defined range of each tooth. The pulp cavity is the part of the enlarged space inside the crown, which is filled with dental pulp. The **dental pulp** contains blood vessels, nerves, and lymph vessels.

The **root canals** are small expansions of the pulp cavity that traverse the root of a tooth and hold a hole at its bottom—the apical foramen—where nerves, blood, and lymph vessels are attached.

Over the course of their lives, humans have two dentitions, the primary dentition and the permanent dentition. The first milk tooth (***dentes decidui***) bursts through after 6 months. Each month of a baby's life, one or two more teeth appear until all 20 teeth are in place. Generally, all milk teeth shed between the age of 6 and 12, after which they are then replaced by the permanent dentition.

The permanent dentition (***dentes permanentes***) consists of 32 teeth, 16 in the upper jaw and 16 in the lower jaw, respectively. Each half of the jaw contains three molars, two bicuspids, one canine, and two incisors.

The first molars (16, 26, 36, and 46) burst through at the age of 6 years, the second molars at the age of 12 years, and the so-called wisdom teeth (third molars) after the age of 17 years. Their function is to crunch and grind up food.

In many cases, the human jaw does not provide enough space behind the second molars to allow the wisdom teeth to burst through. When this occurs, the third molars remain embedded in the alveolar bone. Sometimes, this causes pressure and pain to the extent

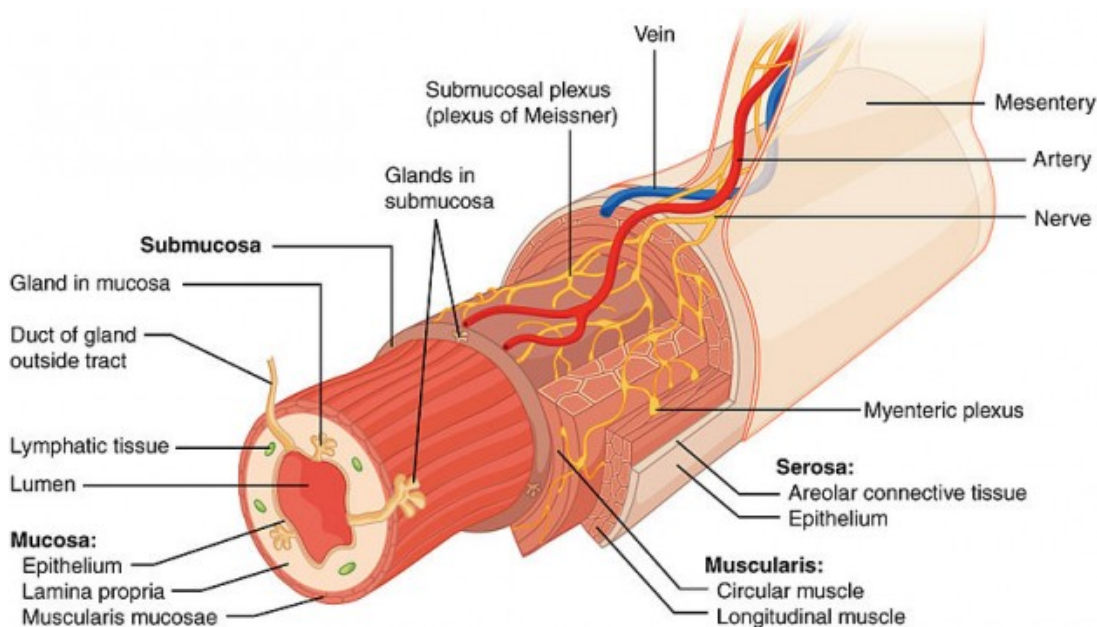
that they have to be surgically removed. Some people experience that the third molars atrophy or do not develop at all.

The Layers of the Gastrointestinal Tract

The wall of the gastrointestinal (GI) tract consists of four layers, each constructed in the same basic order—from the lower esophagus to the anus.

From the luminal surface to the outer surface, four layers can be distinguished, as follows:

- **Mucosa**
- **Submucosa**
- **Muscularis**
- **Serosa**



Picture: 'Layers of the gastrointestinal tract' by OpenStax College. License: [CC BY 3.0](https://creativecommons.org/licenses/by/3.0/).

The **mucosa** is the innermost layer of the GI tract and it is a mucous membrane consisting of an epithelial layer, a thin layer of connective tissue, and another thin layer consisting of smooth muscle cells.

The epithelial layer serves as a protective layer and with the help of the single-layered columnar epithelium, it contributes to secretion and resorption. Additionally, exocrine cells are located between the epithelial cells, which secrete mucus and liquid into the lumen (the inner space of a cavity) of the GI tract.

The submucosa or **lamina propria** (Latin *lamina* = thin, flat layer; *propria* = own) contains many blood and lymph vessels. The *lamina propria* enables nutrients that are reabsorbed in the GI tract to reach other parts of the body. They also contain the majority of the cells of the **mucosa-associated lymphoid tissue (MALT)**, which in turn contains cells of the immune system that help protect the body from diseases.

The **muscularis mucosae** is a thin layer of smooth muscle fibers that enlarges the surface for better digestion and resorption and further ensures that all reabsorbing cells get in contact with the substances in the GI tract.

The **submucosa** consists of loose reticular fibers that strike through numerous fenestrations (**areolar connective tissue**) and connect the mucosa to the muscularis. Its structure comprises many blood and lymph vessels that contain absorbable food molecules. The special feature of the submucosa is the included **Meissner's plexus**, a vast network of neurons. It can also contain glands and lymphoid tissue.

The **muscularis** of the GI tract consists of skeletal muscles as well as smooth muscle fibers. The arbitrary swallowing is generated by the muscularis of the mouth, the pharynx, and the upper and middle parts of the esophagus. On the other hand, the deliberate control of defecation is possible due to the skeletal muscles found at the outer anal sphincter.

The smooth muscles are located in the rest of the GI tract and are characterized by an inner layer of circular fibers and an outer layer of longitudinal fibers. They help to degrade food, mix up digestive secretions, and move food along the tract. The second plexus of neurons, the so-called **Auerbach's plexus**, is located between the layers of the muscularis.

The **serosa** or surface layer is a serous membrane of areolar connective tissue and single-layered squamous epithelium. The surface layer of the esophagus is composed of just one single layer of areolar connective tissue (adventitia) with the absence of a serosa.

Specifics of the wall structure of the esophagus, small intestine, and large intestine

Esophagus:

The esophagus has the same wall structure as all the other segments of the GI tract.

The **mucosa** (mucous membrane) of the esophagus consists of non-keratinized multi-layered squamous epithelium, *lamina propria*, and the *muscularis mucosa* (smooth muscle), which is responsible for the onward movement of food (**peristalsis**) to the stomach.

The **muscularis** consists of fasciated skeletal muscles (voluntary muscles) in the upper third, whereas the lower third consists entirely of smooth muscles. In between are voluntary as well as smooth muscle cells.

Small intestine:

The small intestine is organized in three parts: the duodenum, jejunum, and ileum. The wall of the small intestine also consists of the same four layers as the larger part of the GI tract. However, the small intestine has some specifics.

The epithelial layer of the small intestine's mucosa is built of a single-layered cylindrical epithelium, which contains many different cell types, as follows:

- **Resorption cells:** These cells are responsible for digesting and reabsorbing nutrients in the bolus.
- **Goblet cells:** These cells are responsible for secreting mucus.

The mucosa of the small intestine contains many deep fissures.

Intestinal glands (crypts of Lieberkühn) are the cells that furnish the fissures and secrete the intestinal juice. Apart from resorption and goblet cells, intestinal glands contain

Paneth cells and enteroendocrine cells.

The **submucosa** of the **duodenum** contains **Brunner's glands** that secrete alkaline mucus to neutralize the stomach acid in the chymus.

The **muscularis** of the **small intestine** consists of two layers of smooth muscles.

- Longitudinal fibers—outer, thinner layer
- Circular fibers—inner, thicker layer

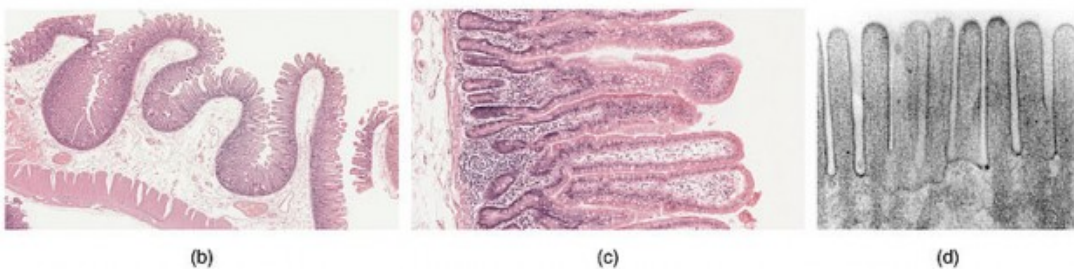
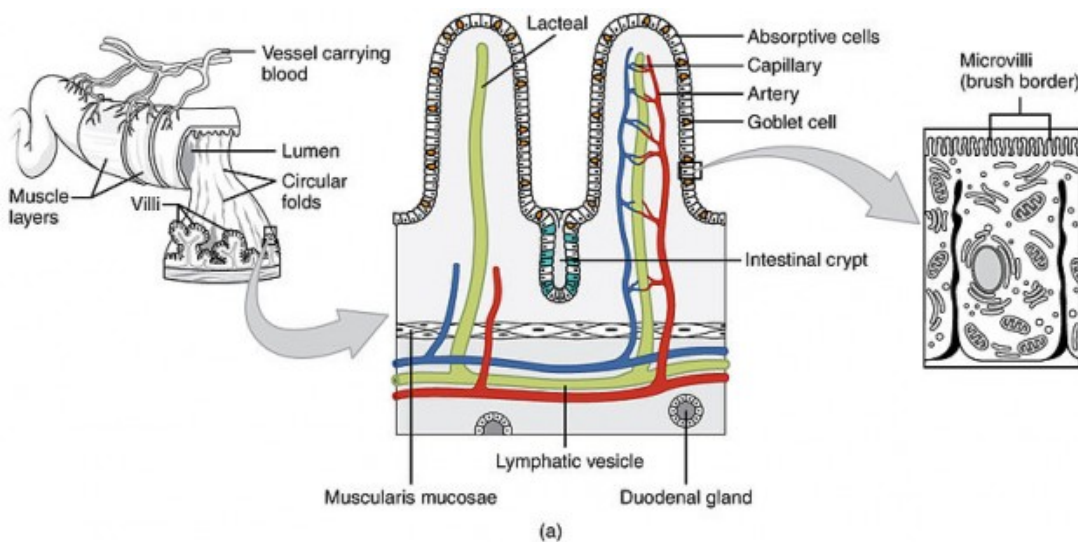
Apart from the main part of the duodenum, the **serosa** covers the entire small intestine.

Specifics of the small intestine

Special structural characteristics of the **small intestine** facilitate digestion and resorption—the so-called **valves of Kerckring**. They are mucosal and submucosal folds. They boost the resorption by extending the surface and allow the chymus to move **helically instead of straight** through the intestine.

The small intestine also has **villi**, which do some resorption and digestion and give the **intestinal mucosa** its velvety appearance.

Apart from valves of Kerckring and villi, the small intestine also contains **microvilli**, extensions of the free membrane of the resorption cells, which build a fuzzy line (brush border) and reach into the lumen of the small intestine.



Picture: 'Histology of the small intestine' by OpenStax College. License: [CC BY 3.0](https://creativecommons.org/licenses/by/3.0/).

Specifics of the large intestine

Just like the esophagus and small intestine, the large intestine contains four typical layers: mucosa, submucosa, muscularis, and serosa.

The epithelium of the mucosa contains most notably resorption cells whose purpose is to reabsorb water and goblet cells that secrete mucus, thus lubricating the mucosal lining. The resorption and goblet cells are located in the intestinal glands (crypts of Lieberkühn), which are found in the entire diameter of the mucosa.

As opposed to the small intestine, there are no valves of Kerckring or villi. However, **microvilli** of the resorption cells are present for the purpose of reabsorption.

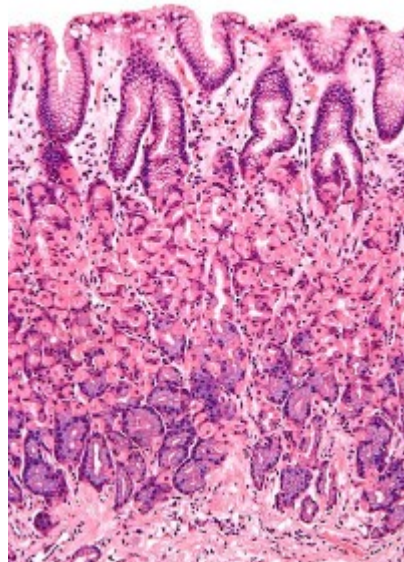
The muscularis consists of the following layers:

- Outer layer of the smooth longitudinal muscles
- Inner layer of the circular muscles

One characteristic of the GI tract is the presence of longitudinal muscles, which are thickened into three well-visible longitudinal ligaments (***taeniae coli***). These ligaments run across the whole length of the large intestine. Clonical contractions give rise to a range of pockets (*haustra coli*, singular: *haustum*), which give the colon its puckered appearance.

Between the longitudinal ligaments, there is one single layer of smooth circular muscles.

Gastric Mucosa and the Histology of Its Glands



Picture: 'Normal gastric mucosa intermed mag' by Nephron. License: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/).

Apart from some deviations, the gastric mucosa consists of the same four layers as the whole GI tract.

One single layer of **cylindrical epithelial cells** constitute the surface of the **mucosa**. Their function is to secrete mucus. The mucosa consists of a **lamina propria** with areolar

connective tissue and **muscularis mucosae**, which is characterized by smooth muscles.

Many epithelial cells are located in the *lamina propria*, forming columns with secretory cells. These are called **gastric glands**, which in turn are lined with many narrow canals, the so-called **gastric pits**. Each of these gastric pits is filled with the secretion of several gastric glands before the secretion flows into the lumen of the stomach.

The gastric glands contain three types of exocrine gland cells, as follows:

- **Foveolar cells:** They secrete mucus just like the mucous cells at the surface.
- **Gastric chief cell:** Their main function is the secretion of pepsinogen and gastric lipase.
- **Parietal cells:** They produce hydrochloric acid and intrinsic factor, which is essential for the reabsorption of vitamin B12.

Gastric juice consists of the secretions of the foveolar, parietal, and gastric chief cells. They produce 2–3 liters of gastric juice per day.

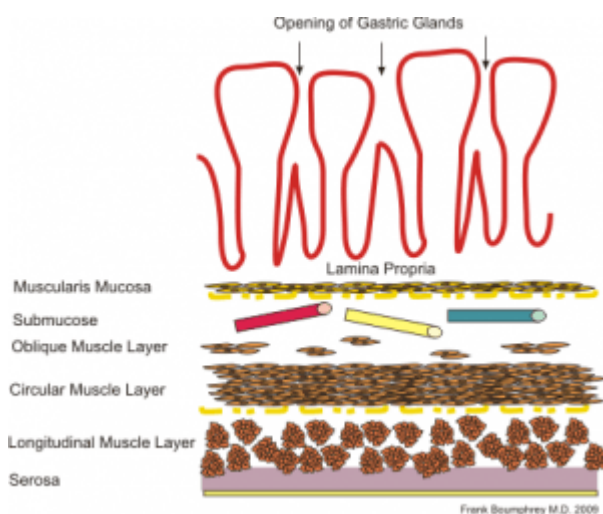
The G cell, an **enteroendocrine cell** that secretes the hormone gastrin into the blood, is also one of the gastric glands and is mainly located in the pyloric glands of the stomach antrum.

Three additional layers—the **submucosa**, **muscularis**, and **serosa**—lay beneath the mucosa.

The submucosa is characterized by the areolar connective tissue.

The muscularis of the stomach has three layers of smooth muscles: an outer longitudinal layer, a middle circular layer, and an inner angular layer that is primarily limited to the corpus of the stomach.

The serosa consists of single-layered squamous epithelium and areolar connective tissue. It covers the stomach and is part of the peritoneum viscerale. At the small curvature of the stomach, it reaches into the liver.



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Liver: Lobules and Glisson's Capsule

The **liver** is the heaviest organ in a human body and is located below the diaphragm. At the bottom of the liver, there is a pear-shaped, 7-10 cm long pouch: the gallbladder.

The liver can be divided into two main lobes separated from each other by the **falciform ligament**, as follows:

- **Right lobe**
- **Smaller left lobe**

The falciform ligament spreads from the bottom of the diaphragm through the two lobes to the upper surface of the liver. Its function is to 'fasten' the liver in the abdominal cavity.

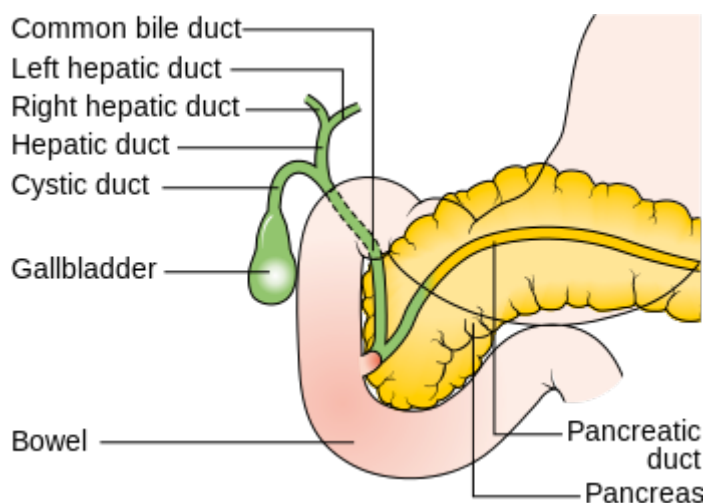
The lobes of the liver consist of many small functional units, the so-called liver lobules. These lobules have a hexagonal structure and are made of specialized epithelial cells that are called hepatocytes. The cells are arranged in irregularly branched and linked panels having a vein at the center.

The liver lobules additionally contain highly permeable capillaries through which blood flows. They are called **liver sinusoids**.

Kupffer cells are found in the liver sinusoids and are responsible for phagocytosis. They destroy dead WBCs and RBCs, and other bacteria as well as impurities that originate from the GI tract.

The hepatocytes secrete bile that reaches the small biliary canal and empties into the small bile ducts (*ductus biliferi*). The bile ducts create the large right and the left hepatic ducts, which incorporate and leave the liver as the common hepatic duct (***ductus hepaticus communis***). Together with the *ductus cysticus* (cystic duct), it creates one single bile duct after the gallbladder, the ***ductus choledochus***.

Blood supply of the liver



Picture: 'Diagram showing the position of the bile ducts' by Cancer Research UK uploader. License: [CC BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/).

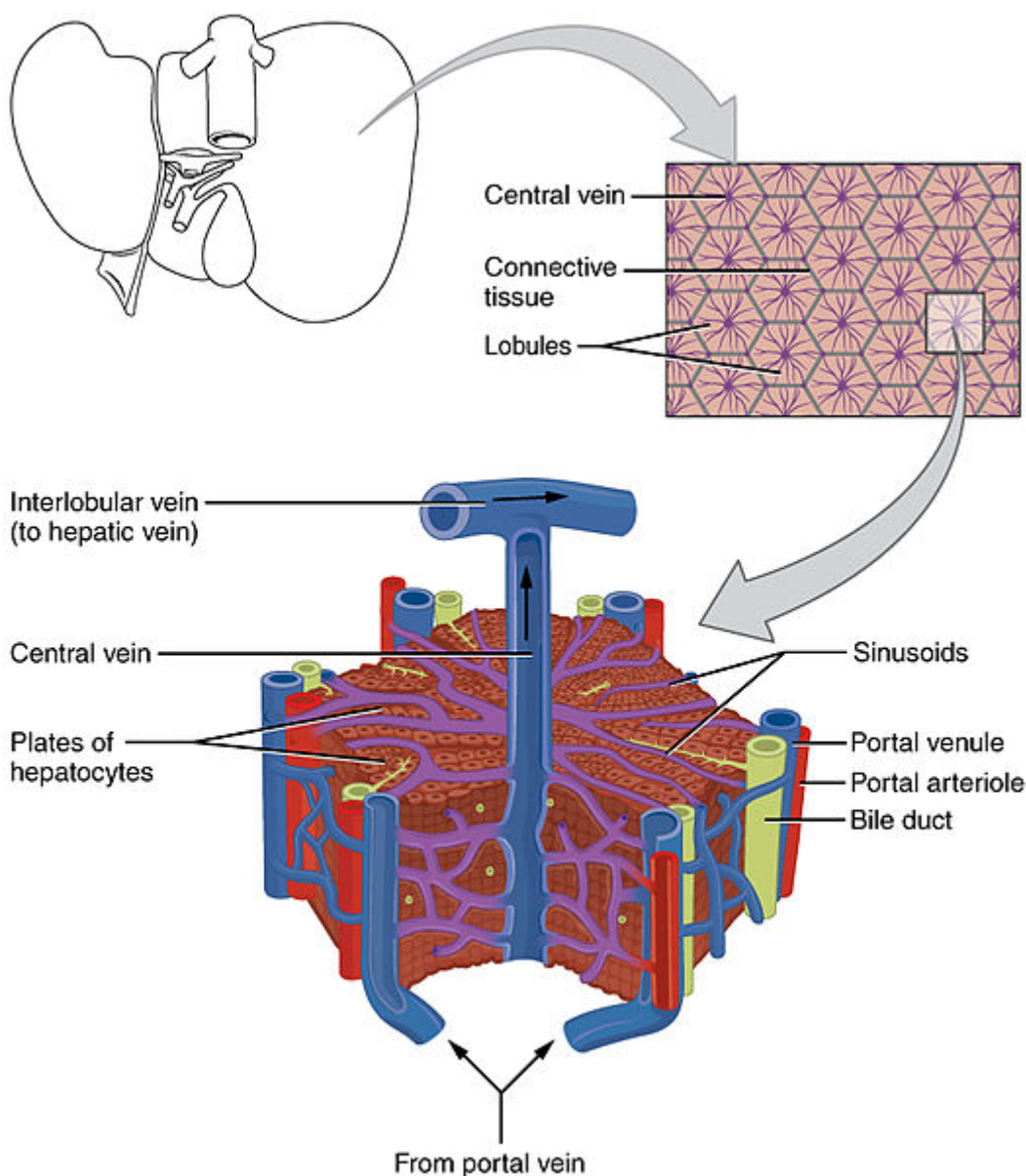
The liver receives blood from two different sources, as follows:

- Blood rich in oxygen from the **hepatic portal vein (*arteria hepatica*)**
- Blood poor in oxygen from the **hepatic arteries (*vena portae*)**, including nutrients, pharmaceutical substances, and possibly microbes and toxins from the GI tract

The hepatic portal vein and the hepatic arteries carry blood into the sinusoidal liver capillaries, where oxygen, nutrients, and specific toxins are absorbed by the hepatocytes. Through the central vein, which ends in a liver vein, specific nutrients required by different cells are carried through the blood.

Glisson's capsule (*trias hepatica*)

Glisson's capsule is located at the edge of the liver lobules and consists of the branching of the **portal vein**, the **proper hepatic artery**, and the **bile duct**.



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Notes