Structure of the Stomach

The **stomach** is a muscular, [hollow organ](https://en.wikipedia.org/wiki/Hollow_organ) in the [gastrointestinal tract](https://en.wikipedia.org/wiki/Gastrointestinal_tract) of humans and many other animals, including several [invertebrates](https://en.wikipedia.org/wiki/Invertebrate). The stomach has a dilated structure and functions as a vital organ in the [digestive system](https://en.wikipedia.org/wiki/Digestion). The stomach is involved in the [gastric phase of digestion](https://en.wikipedia.org/wiki/Gastric_phase), following [chewing](https://en.wikipedia.org/wiki/Mastication). It performs a chemical breakdown by means of enzymes and hydrochloric acid.

In humans and many other animals, the stomach is located between the [esophagus](https://en.wikipedia.org/wiki/Esophagus) and the [small intestine](https://en.wikipedia.org/wiki/Small_intestine). The stomach secretes [digestive enzymes](https://en.wikipedia.org/wiki/Digestive_enzyme) and [gastric acid](https://en.wikipedia.org/wiki/Gastric_acid) to aid in food digestion. The [pyloric sphincter](https://en.wikipedia.org/wiki/Pyloric_sphincter) controls the passage of partially digested food ([chyme](https://en.wikipedia.org/wiki/Chyme)) from the stomach into the [duodenum](https://en.wikipedia.org/wiki/Duodenum), where [peristalsis](https://en.wikipedia.org/wiki/Peristalsis) takes over to move this through the rest of the intestines.

## **Structure[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=1)**]**

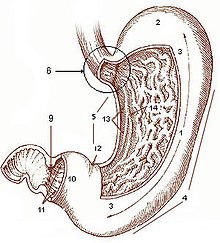
In the [human digestive system](https://en.wikipedia.org/wiki/Human_digestive_system), the stomach lies between the [esophagus](https://en.wikipedia.org/wiki/Oesophagus) and the [duodenum](https://en.wikipedia.org/wiki/Duodenum) (the first part of the [small intestine](https://en.wikipedia.org/wiki/Small_intestine)). It is in the [left upper quadrant](https://en.wikipedia.org/wiki/Quadrants_and_regions_of_abdomen#Quadrants) of the [abdominal cavity](https://en.wikipedia.org/wiki/Abdominal_cavity). The top of the stomach lies against the [diaphragm](https://en.wikipedia.org/wiki/Diaphragm_(anatomy)). Lying behind the stomach is the [pancreas](https://en.wikipedia.org/wiki/Pancreas). A large double fold of visceral [peritoneum](https://en.wikipedia.org/wiki/Peritoneum) called the [greater omentum](https://en.wikipedia.org/wiki/Greater_omentum) hangs down from the [greater curvature](https://en.wikipedia.org/wiki/Curvatures_of_the_stomach) of the stomach. Two [sphincters](https://en.wikipedia.org/wiki/Sphincter) keep the contents of the stomach contained; the [lower esophageal sphincter](https://en.wikipedia.org/wiki/Oesophagus#Sphincters) (found in the cardiac region), at the junction of the esophagus and stomach, and the [pyloric sphincter](https://en.wikipedia.org/wiki/Pyloric_sphincter) at the junction of the stomach with the duodenum.

The stomach is surrounded by [parasympathetic](https://en.wikipedia.org/wiki/Parasympathetic_nervous_system) (stimulant) and [sympathetic](https://en.wikipedia.org/wiki/Sympathetic_nervous_system) (inhibitor) [plexuses](https://en.wikipedia.org/wiki/Plexuses) (networks of [blood vessels](https://en.wikipedia.org/wiki/Blood_vessel) and [nerves](https://en.wikipedia.org/wiki/Nerve) in the [anterior](https://en.wikipedia.org/wiki/Anterior) gastric, [posterior](https://en.wikipedia.org/wiki/Posterior_(anatomy)), [superior](https://en.wikipedia.org/wiki/Anatomical_terms_of_location#Superior_and_inferior) and [inferior](https://en.wikipedia.org/wiki/Anatomical_terms_of_location#Superior_and_inferior), celiac and myenteric), which regulate both the secretory activity of the stomach and the motor (motion) activity of its muscles.

Because it is a [distensible](https://en.wiktionary.org/wiki/distensibility) organ, it normally expands to hold about one litre of food.[[3]](https://en.wikipedia.org/wiki/Stomach#cite_note-3) The stomach of a newborn human baby will only be able to retain about 30 millilitres. The maximum stomach volume in adults is between 2 and 4 litres.[[4]](https://en.wikipedia.org/wiki/Stomach#cite_note-pmid9863573-4)[[5]](https://en.wikipedia.org/wiki/Stomach#cite_note-5)

### Sections**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=2)**]**

*"Cardia" redirects here. For the ancient Greek colony, see*[*Cardia (Thrace)*](https://en.wikipedia.org/wiki/Cardia_(Thrace))*.*

[](https://en.wikipedia.org/wiki/File:Illu_stomach.jpg)

1. [Body of stomach](https://en.wikipedia.org/wiki/Stomach#Sections) 2. [Fundus](https://en.wikipedia.org/wiki/Stomach#Sections) 3. [Anterior wall](https://en.wikipedia.org/wiki/Stomach#Structure) 4. [Greater curvature](https://en.wikipedia.org/wiki/Curvatures_of_the_stomach) 5. [Lesser curvature](https://en.wikipedia.org/wiki/Curvatures_of_the_stomach) 6. [Cardia](https://en.wikipedia.org/wiki/Stomach#Sections) 9. [Pyloric sphincter](https://en.wikipedia.org/wiki/Pylorus#Pyloric_sphincter) 10. [Pyloric antrum](https://en.wikipedia.org/wiki/Pylorus#Antrum) 11. [Pyloric canal](https://en.wikipedia.org/wiki/Pylorus#Pyloric_canal) 12. [Angular incisure](https://en.wikipedia.org/wiki/Angular_incisure) 13. Gastric canal 14. [Rugae](https://en.wikipedia.org/wiki/Rugae)[[6]](https://en.wikipedia.org/wiki/Stomach#cite_note-6)

In classical anatomy the human stomach is divided into four sections, beginning at the cardia.[[7]](https://en.wikipedia.org/wiki/Stomach#cite_note-7)

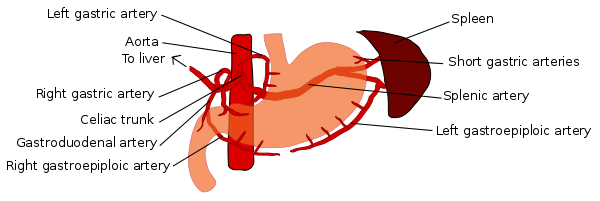
* The *cardia* is where the contents of the esophagus empty into the stomach.[[8]](https://en.wikipedia.org/wiki/Stomach#cite_note-SCHWARTZ2010-8)
* The *fundus* (from [Latin](https://en.wikipedia.org/wiki/Latin_language) 'bottom') is formed in the upper curved part.
* The *body* is the main, central region of the stomach.
* The [*pylorus*](https://en.wikipedia.org/wiki/Pylorus) (from [Greek](https://en.wikipedia.org/wiki/Greek_language) 'gatekeeper') is the lower section of the stomach that empties contents into the [duodenum](https://en.wikipedia.org/wiki/Duodenum).

The cardia is defined as the region following the "z-line" of the gastroesophageal junction, the point at which the [epithelium](https://en.wikipedia.org/wiki/Epithelium) changes from [stratified squamous](https://en.wikipedia.org/wiki/Stratified_squamous_epithelia) to [columnar](https://en.wikipedia.org/wiki/Columnar). Near the cardia is the lower esophageal sphincter.[[8]](https://en.wikipedia.org/wiki/Stomach#cite_note-SCHWARTZ2010-8) Research has shown that the cardia is not an anatomically distinct region of the stomach but a region of the esophageal lining damaged by reflux.[[9]](https://en.wikipedia.org/wiki/Stomach#cite_note-9)

### Anatomical proximity**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=3)**]**

The **stomach bed** refers to the structures upon which the stomach rests in mammals.[[10]](https://en.wikipedia.org/wiki/Stomach#cite_note-10)[[11]](https://en.wikipedia.org/wiki/Stomach#cite_note-11) These include the [tail of the pancreas](https://en.wikipedia.org/wiki/Tail_of_the_pancreas), [splenic artery](https://en.wikipedia.org/wiki/Splenic_artery), left [kidney](https://en.wikipedia.org/wiki/Kidney), left [suprarenal gland](https://en.wikipedia.org/wiki/Suprarenal_gland), [transverse colon](https://en.wikipedia.org/wiki/Transverse_colon) and its [mesocolon](https://en.wikipedia.org/wiki/Mesocolon), and the [left crus of diaphragm](https://en.wikipedia.org/wiki/Left_crus_of_diaphragm), and the [left colic flexure](https://en.wikipedia.org/wiki/Left_colic_flexure). The term was introduced around 1896 by Philip Polson of the Catholic University School of Medicine, Dublin. However this was brought into disrepute by surgeon anatomist J Massey.[[12]](https://en.wikipedia.org/wiki/Stomach#cite_note-12)[[13]](https://en.wikipedia.org/wiki/Stomach#cite_note-13)[[14]](https://en.wikipedia.org/wiki/Stomach#cite_note-14)

### Blood supply**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=4)**]**

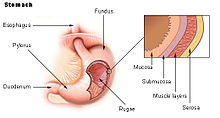
[](https://en.wikipedia.org/wiki/File:Stomach_blood_supply.svg)

Schematic image of the blood supply to the human stomach: [left](https://en.wikipedia.org/wiki/Left_gastric_artery) and [right gastric artery](https://en.wikipedia.org/wiki/Right_gastric_artery), [left](https://en.wikipedia.org/wiki/Left_gastroepiploic_artery) and [right gastroepiploic artery](https://en.wikipedia.org/wiki/Right_gastroepiploic_artery) and [short gastric artery](https://en.wikipedia.org/wiki/Short_gastric_artery).[[15]](https://en.wikipedia.org/wiki/Stomach#cite_note-Moore150-15)

The lesser curvature of the human stomach is supplied by the [right gastric artery](https://en.wikipedia.org/wiki/Right_gastric_artery) inferiorly and the [left gastric artery](https://en.wikipedia.org/wiki/Left_gastric_artery) superiorly, which also supplies the cardiac region. The greater curvature is supplied by the [right gastroepiploic artery](https://en.wikipedia.org/wiki/Right_gastroepiploic_artery) inferiorly and the [left gastroepiploic artery](https://en.wikipedia.org/wiki/Left_gastroepiploic_artery) superiorly. The fundus of the stomach, and also the upper portion of the greater curvature, is supplied by the [short gastric arteries](https://en.wikipedia.org/wiki/Short_gastric_arteries), which arise from the splenic artery.

### Microanatomy**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=5)**]**

#### Wall**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=6)**]**

[](https://en.wikipedia.org/wiki/File:Illu_stomach2.jpg)

The gastrointestinal wall of the human stomach.

*Main article:*[*Gastrointestinal wall*](https://en.wikipedia.org/wiki/Gastrointestinal_wall)

Like the other parts of the gastrointestinal tract, the human stomach walls consist of a [mucosa](https://en.wikipedia.org/wiki/Mucosa), [submucosa](https://en.wikipedia.org/wiki/Submucosa), [muscularis externa](https://en.wikipedia.org/wiki/Muscularis_externa), [subserosa](https://en.wikipedia.org/wiki/Subserosa) and [serosa](https://en.wikipedia.org/wiki/Serosa).[[16]](https://en.wikipedia.org/wiki/Stomach#cite_note-16)

The inner part of the lining of the stomach, the [gastric mucosa](https://en.wikipedia.org/wiki/Gastric_mucosa), consists of an outer layer of [column-shaped cells](https://en.wikipedia.org/wiki/Columnar_epithelium), a [lamina propria](https://en.wikipedia.org/wiki/Lamina_propria), and a thin layer of [smooth muscle](https://en.wikipedia.org/wiki/Smooth_muscle) called the [muscularis mucosa](https://en.wikipedia.org/wiki/Muscularis_mucosa). Beneath the mucosa lies the [submucosa](https://en.wikipedia.org/wiki/Submucosa), consisting of [fibrous connective tissue](https://en.wikipedia.org/wiki/Fibrous_connective_tissue).[[17]](https://en.wikipedia.org/wiki/Stomach#cite_note-17) [Meissner's plexus](https://en.wikipedia.org/wiki/Meissner%27s_plexus) is in this layer interior to the oblique muscle layer.[[18]](https://en.wikipedia.org/wiki/Stomach#cite_note-18)

Outside of the submucosa lies another muscular layer, the [muscularis externa](https://en.wikipedia.org/wiki/Muscularis_externa). It consists of three layers of muscular fibres, with fibres lying at angles to each other.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] These are the inner oblique, middle circular, and outer longitudinal layers. The presence of the inner oblique layer is distinct from other parts of the gastrointestinal tract, which do not possess this layer.[[19]](https://en.wikipedia.org/wiki/Stomach#cite_note-19) Stomach contains the thickest muscularis layer consisting of three layers, thus maximum peristalsis occurs here.

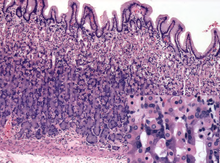
* The *inner oblique layer:* This layer is responsible for creating the motion that churns and physically breaks down the food. It is the only layer of the three which is not seen in other parts of the [digestive system](https://en.wikipedia.org/wiki/Digestive_system). The antrum has thicker skin cells in its walls and performs more forceful contractions than the fundus.
* The *middle circular layer:* At this layer, the [pylorus](https://en.wikipedia.org/wiki/Pyloric_valve) is surrounded by a thick circular muscular wall, which is normally tonically constricted, forming a functional (if not anatomically discrete) pyloric [sphincter](https://en.wikipedia.org/wiki/Sphincter), which controls the movement of [chyme](https://en.wikipedia.org/wiki/Chyme) into the [duodenum](https://en.wikipedia.org/wiki/Duodenum). This layer is concentric to the [longitudinal axis](https://en.wikipedia.org/wiki/Anatomical_terms_of_location#Axes) of the stomach.
* [Auerbach's plexus](https://en.wikipedia.org/wiki/Auerbach%27s_plexus) (myenteric plexus) is found between the outer longitudinal and the middle circular layer and is responsible for the innervation of both (causing [peristalsis](https://en.wikipedia.org/wiki/Peristalsis) and mixing).

The *outer longitudinal layer* is responsible for moving the bolus towards the pylorus of the stomach through muscular shortening.

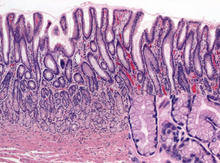
To the outside of the muscularis externa lies a [serosa](https://en.wikipedia.org/wiki/Serosa), consisting of layers of connective tissue continuous with the [peritoneum](https://en.wikipedia.org/wiki/Peritoneum).

#### Glands**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=7)**]**

*Main article:*[*Gastric glands*](https://en.wikipedia.org/wiki/Gastric_glands)

[](https://en.wikipedia.org/wiki/File:Histology_of_normal_fundic_mucosa.png)

Histology of normal fundic mucosa. Fundic glands are simple, branched tubular glands that extend from the bottom of the gastric pits to the muscularis mucosae; the more distinctive cells are parietal cells. H&E stain.

[](https://en.wikipedia.org/wiki/File:Histology_of_normal_antral_mucosa.png)

Histology of normal antral mucosa. Antral mucosa is formed by branched coiled tubular glands lined by secretory cells similar in appearance to the surface mucus cells. H&E stain.

The mucosa lining the stomach is lined with a number of these pits, which receive gastric juice, secreted by between 2 and 7 [gastric glands](https://en.wikipedia.org/wiki/Gastric_glands).[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] Gastric juice is an acidic fluid containing [hydrochloric acid](https://en.wikipedia.org/wiki/Hydrochloric_acid) and the digestive enzyme [pepsin](https://en.wikipedia.org/wiki/Pepsin).[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] The glands contains a number of cells, with the function of the glands changing depending on their position within the stomach.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

Within the body and fundus of the stomach lie the *fundic glands*. In general, these glands are lined by column-shaped cells that secrete a protective layer of [mucus](https://en.wikipedia.org/wiki/Mucus) and [bicarbonate](https://en.wikipedia.org/wiki/Bicarbonate). Additional cells present include [parietal cells](https://en.wikipedia.org/wiki/Parietal_cell) that secrete hydrochloric acid and [intrinsic factor](https://en.wikipedia.org/wiki/Intrinsic_factor), [chief cells](https://en.wikipedia.org/wiki/Chief_cell) that secrete [pepsinogen](https://en.wikipedia.org/wiki/Pepsinogen) (this is a precursor to pepsin- the highly acidic environment converts the pepsinogen to pepsin), and neuroendocrine cells that secrete [serotonin](https://en.wikipedia.org/wiki/Serotonin).[[20]](https://en.wikipedia.org/wiki/Stomach#cite_note-Dorland777-20)[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

Glands differ where the stomach meets the esophagus and near the pylorus.[[21]](https://en.wikipedia.org/wiki/Stomach#cite_note-21) Near the [junction between the stomach and the esophagus](https://en.wikipedia.org/wiki/Gastro-oesophageal_junction) lie *cardiac glands*, which primarily secrete mucus.[[20]](https://en.wikipedia.org/wiki/Stomach#cite_note-Dorland777-20) They are fewer in number than the other gastric glands and are more shallowly positioned in the mucosa. There are two kinds - either [simple tubular](https://en.wikipedia.org/wiki/Simple_tubular_glands) with short ducts or [compound racemose](https://en.wikipedia.org/wiki/Compound_racemose_glands) resembling the [duodenal](https://en.wikipedia.org/wiki/Duodenal) [Brunner's glands](https://en.wikipedia.org/wiki/Brunner%27s_glands).[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] Near the pylorus lie *pyloric glands* located in the antrum of the pylorus. They secrete mucus, as well as [gastrin](https://en.wikipedia.org/wiki/Gastrin) produced by their [G cells](https://en.wikipedia.org/wiki/G_cells).[[22]](https://en.wikipedia.org/wiki/Stomach#cite_note-22)[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

### Gene and protein expression**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=8)**]**

*Further information:*[*Bioinformatics § Gene and protein expression*](https://en.wikipedia.org/wiki/Bioinformatics#Gene_and_protein_expression)

About 20,000 [protein](https://en.wikipedia.org/wiki/Protein) coding genes are expressed in human cells and nearly 70% of these genes are expressed in the normal stomach.[[23]](https://en.wikipedia.org/wiki/Stomach#cite_note-23)[[24]](https://en.wikipedia.org/wiki/Stomach#cite_note-24) Just over 150 of these genes are more specifically expressed in the stomach compared to other organs, with only some 20 genes being highly specific. The corresponding specific proteins expressed in stomach are mainly involved in creating a suitable environment for handling the digestion of food for uptake of nutrients. Highly stomach-specific proteins include [GKN1](https://en.wikipedia.org/wiki/GKN1), expressed in the mucosa; [pepsinogen PGC](https://en.wikipedia.org/wiki/Pepsin) and the [lipase LIPF](https://en.wikipedia.org/wiki/Lipase), expressed in [chief cells](https://en.wikipedia.org/wiki/Gastric_chief_cell); and gastric [ATPase ATP4A](https://en.wikipedia.org/wiki/ATPase) and [gastric intrinsic factor GIF](https://en.wikipedia.org/wiki/Gastric_intrinsic_factor), expressed in [parietal cells](https://en.wikipedia.org/wiki/Parietal_cell).[[25]](https://en.wikipedia.org/wiki/Stomach#cite_note-25)

## **Development[**[**edit**](https://en.wikipedia.org/w/index.php?title=Stomach&action=edit&section=9)**]**

In early [human embryogenesis](https://en.wikipedia.org/wiki/Human_embryogenesis), the ventral part of the [embryo](https://en.wikipedia.org/wiki/Embryo) abuts the [yolk sac](https://en.wikipedia.org/wiki/Yolk_sac). During the third week of development, as the embryo grows, it begins to surround parts of the sac. The enveloped portions form the basis for the adult gastrointestinal tract.[[26]](https://en.wikipedia.org/wiki/Stomach#cite_note-LARSEN2009-26) The sac is surrounded by a network of [vitelline arteries and veins](https://en.wikipedia.org/wiki/Vitelline_arteries). Over time, these arteries consolidate into the three main arteries that supply the developing gastrointestinal tract: the [celiac artery](https://en.wikipedia.org/wiki/Celiac_artery), [superior mesenteric artery](https://en.wikipedia.org/wiki/Superior_mesenteric_artery), and [inferior mesenteric artery](https://en.wikipedia.org/wiki/Inferior_mesenteric_artery). The areas supplied by these arteries are used to define the [foregut](https://en.wikipedia.org/wiki/Foregut), [midgut](https://en.wikipedia.org/wiki/Midgut), and [hindgut](https://en.wikipedia.org/wiki/Hindgut).[[26]](https://en.wikipedia.org/wiki/Stomach#cite_note-LARSEN2009-26) The surrounded sac becomes the primitive gut. Sections of this gut begin to differentiate into the organs of the gastrointestinal tract, and the esophagus, and stomach form from the foregut.[[26]](https://en.wikipedia.org/wiki/Stomach#cite_note-LARSEN2009-26)